

## Teaching Real-life Risk Management to MS Construction Students

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### Abstract

The nature of the ‘messiness’ of the real projects in which we are involved determines how our construction practice proceeds. In order to train future construction students, we need to prepare them with the skills to deal with this messiness. Faculty must have these skills first as well as fresh experience of using them. This paper discusses the synergies to be experienced between teaching, consulting, research, and in-company training. These abilities then need to be passed on to the students. Technique training provides an important tool-kit, but the key skills have to be acquired through guided experimental learning, with the learning loop closed by guided reflection-fostered activity and aided by mentors.

### Introduction

The question “What makes for good CONSTRUCTION or AEC education?” is ultimately linked with the questions of “what is a good contractor/architect/engineer?” and “what is construction?” This article explores the issue “What makes for good AEC education?” with specific reference to the thinking behind and teaching of several construction classes. In exploring this issue, the whole portfolio of what is offered to the student must be addressed, as it is taught, as an integral whole. The message of this article is that this whole portfolio is needed to give an effective Construction education.

This paper will examine, in particular:

- The nature of the construction world for which we are preparing our students;
- The role of academic members of the department, and what is often termed the “academic/practitioner interface”;

- The underlying research culture of a department to support a practitioner; and
- The teaching of techniques.

### **What is CONSTRUCTION (RM) Education?**

The overall aim of a typical Construction (MS) course is to convert high quality graduates in numerate disciplines into good construction practitioners appropriate to the needs of the practicing profession. The aim is to produce someone who will be attractive to professional construction groups and project management companies who specialize in the application of risk management, scheduling and estimating techniques to enhance decision-making. To achieve this, the course in which the author is involved has three overall aims:

- to realize the potential of graduates who have already demonstrated their ability so that they can immediately play an effective role in providing efficient and quick decisions;
- to develop a rigorous academic understanding of a range of theories, concepts and methods, and to develop students' ability to apply them to the real world in a creative and practical way;
- to equip students with the intellectual and personal skills needed to work on complex issues within organizations, often as part of a team.

One of the keys in the above set of aims is the use of the word "immediately". This distinguishes an MS from typical undergraduate courses which aim to produce someone with the basics to be trained up as an construction risk manager. The postgraduate should be in the position that, on the first day of his /her first job in the industry, they could be presented with an invitation to tender, produce a costed proposal, win and then execute the job.

### **Challenges in Construction's Future**

The most profound recent developments in construction are seen as: the increasing complexity of many of its projects and organizations; the increasing technological complexity of projects; more complex interdependencies and variations in the relationships between its organizations; and institutions; and proliferating regulations from government. At the project level, management has just begun to integrate design, procurement, and construction into one total process through total quality management (TQM), value engineering and constructability analysis. Based on previous and existing industry conditions, the author foresees that numerous issues and challenges that will dominate the near future (Banik and Barnes, 2002) such as:

- There are now and will continue to be shortages of resources, including skilled workers, and technical and supervisory staff.

- There will be more and more stringent governmental regulations relating to matters such as safety in design and construction methods, the environmental consequences of projects, and human resource policies at all levels (EEO).
- Progressively the regional building and fire codes will be standardized in the international format and will be enforced more rigorously, especially due to recent terrorists' attacks.
- Global construction will increase due to an international strengthening of world economies.
- Innovative project delivery systems such as design-build, performance specifications and warranties, and best value contracts will become more popular and change how contractors do business. Contractors will be selected based on performance, quality, safety, reliability, and other factors rather than cost only.
- The Internet will minimize the necessity for the design team to be in the same locality. Design coordination by electronic means can lead to fewer design errors and omissions. Fewer complete designs will take place before construction starts; instead some version of fast-track design will evolve into the normal design process.
- Advanced technology and composite materials will be used for fast, cost effective and safe construction. High strength concrete, ceramics, composites, and fiber-reinforced polymers will be in common use. Wood products will be largely high performance, pre-assembled units. Construction materials will be increasingly recyclable and recycled.
- The use of preassembly, modular and standardized construction systems will expand to reduce cost, accidents and time of construction.
- Industry will look for more new concepts such as constructability, life cycle cost analysis, partnering and total quality management, and these will be implemented more frequently.
- User-friendly project management, estimating and scheduling software will be offered as a means to minimize construction time, risk, and improve project control. Even small contractors will try to use them.
- The price of construction will be based on its value to the customer, and the quality of the work, rather than the cost to the builder and a mark-up.
- The image problems of the construction industry will be an ongoing issue. Construction still is not recognized as a profession due to poor impressions about the integrity of contractors, and the nature, safety and quality of work. High school graduates and university students are not generally motivated to enter the construction industry for work. Many people, who are at the forefront of the industry, don't even encourage their children to enter the construction business.

### **The Nature of Construction RM Problems**

What is this "real-life" for which we are preparing students? It is well-known, and needs little elaboration, that construction has moved in recent decades from solving well-structured "problems" to attacking "messes". A clear illustration of this is given by Pidd (1996), whose

figure is replicated in Figure I below. This figure offers a definition of three situations: a "puzzle" where the formulation of the situation to be solved is straightforward and can be agreed, as is also the solution to the formulation, through to a "mess", where neither the formulation nor its solution can be taken as read but must be argued as a matter of opinion; these three situations are to be taken as three points on a spectrum.

	<b>Puzzles</b>	<b>Problems</b>	<b>Messes</b>
<b>Formulation</b>	Agreed	Agreed	Arguable
<b>Solution</b>	Agreed	Arguable	Arguable

Figure I: Problems and Messes (Pidd, 1996)

The situations we are preparing our graduates for are nearly always, in the real world, "messes". This has significant ramifications for how we approach our construction practice and thus the skills and abilities we need to instill into our graduates.

The nature of construction/AEC practice is a subject that has been developed over the past 50 years by a number of authors/practitioners to understand the reality of decision making (risk management) in organizations and also reflecting on our theories of practice. The AEC education may be more appreciated and relevant if it tried to discover ways of helping the decision maker think and decide more intelligently within the real social and political world of which they are a part. It can only be achieved through an increased emphasis on developing decision support systems, making the style of analysis more apparent to the client with less 'back-room wizardry' and finding ways of combining the techniques of the behavioral science interventionist with the analytical skills entrenched in Construction. As a RM, we need to find ways of using our analytical ability to work on the content and structure of debate upon the combination of traditional quantitative modeling skills with new methods of modeling ideas, arguments, beliefs and qualitative statements about an issue.

Simply teaching of construction "techniques" to solve problems implies closure to the problem-solving process which always feels good to a student RM practice. However "messes" are rarely solved in a closed process. Many consultants and academics disown the concept of problem solving in organizations and they insist on referring to the problem finishing/alleviation /closure /disposal as the appropriate description of the outcome of their practice. Problem finishing is a

better description of the outcome of the problem solving process. The nature of finishing is such that it is related not to an analysis of the situation, but to the owners of the problem. The general sense of this writing and the implications of the content of this article are to place emphasis on the role of the PM including RM as an agent of change -an interventionist as well as analyst. There is a substantial group of analysts for whom the word "intervention" correctly suggests that the world will go on without them unless they negotiate a contributory analytical role with the intention of changing the content and/or process of deliberation (Boothroyd, 1984). Problem finishing as a description of working on a problem has directed the attention to the 'management of meaning' and thus the role of the consultant intervening in the act of deliberation."

Furthermore, as well as the abilities to deal with these types of situations, students need to learn the underlying issues so that they can make conscious choices about their style of practicing the profession. As one example, Eden and Sims (1996) describe three paradigms that a consultant may adhere to in order to affect the actions of the client: (s)he may attempt to coerce the client into using models and solutions devised by the consultant; (s)he may attempt to develop empathy with the client, discover the definition of the problem and help the client to devise a satisfactory course of action; or (s )he may attempt to negotiate with the client to redefine the problem and subsequently try to help the client solve it. The student needs to think through this type of issue to decide where to position his/her consulting practice.

### **Teachers: The False Dichotomy of Academics and Practitioners**

If this is the type of practice for which we need to prepare students, what sort of teachers do we need? Fundamentally, we can only prepare our students for the world if we ourselves are familiar with the world -if in some sense we are do-ers as well as teachers (otherwise we can not fulfill the aims and objectives of a practitioner-facing MS). The phrase often used to taunt teachers or lecturers -"those who can do, can't teach"- must be untrue of RM more than perhaps any other profession. These questions have dogged the RM (construction) profession for decades -the division between those called "practitioners" and those called "academics".

Practitioners have to be researchers too. The 'R' in 'RM' is Research, and true risk managers are involved in research all the time. In general, once a method is systemized, or original modeling work is no longer needed, the work can be handed over to a client organizer and the "RM" moves on. The practice and responsibility of RM is ever- changing. The main reasons given for this continual state of transformation are the "migration of subject matter and methods to other activities and the dissemination of RM methods to other disciplines". The envisaged future for RM is summed up as "A future of continuing change". The main argument for this view is that the role of risk managers has remained stable for many more years. A mixture of adaptability, opportunism, innovation, and responsiveness to client needs is both part of the role and the

means of maintaining it -in other words, practitioners must research and develop new methods as part of the on-going development of the field. Indeed, the need for the subject to develop and grow in response to client needs was one of the arguments forcibly put against professional membership in the debate. Having said that, practitioners don't have to be *academic* researchers - academic research, looking for generic results and general applicability, implies standards of methodology and reporting which are different from -in general arguably significantly more rigorous than -those of practitioners doing research for the immediate needs of their practice.

On the other hand, academics must also be practitioners. "Academics who do not go outside to practice their craft are not RM (construction) academics- even if they come under that title. RM is only RM when motivated either to solve real problems, or to develop tools known to be needed to solve real problems. This means that academics should have under their belt experience of what it is they are preparing their students for. Preferably they have been full-time "practitioners" at some point, but certainly keeping a lively involvement in solving real problems for real clients -or at the very least, have fresh experience that they can draw upon. Although this may bring up a whole set of issues of time management -the academic is then not available on-tap to the student. Indeed, he might be away from the office for whole periods satisfying the requirements of a project-based discipline which can have significant implications for the training of students back in the University.

### **What to Teach?**

It is in this type of academic culture that the teachers who should be instructing the class reside, because the course aims to produce students who are capable themselves of immediately playing an effective role in an organization. In order to ensure that this aim is met, an MS must provide a well-rounded and integrated package that will give students the necessary toolkit of skills relevant for practicing the construction, with the other learning experiences that are needed that can only be generated by working on realistic problems.

Working with decision makers on real issues in this "messy" world presents a variety of challenges. Data may be inadequate; it may not be obvious what sort of model to use, and the most rational proposal can fall foul of organizational politics. While traditional teaching can alert students to such issues, understanding needs to be reinforced by experience. In tandem with this need to provide experience is the desire to make it a worthwhile learning experience. Not only should students learn how to use their technical skills on a real problem but they should also be able to develop the skills needed to work in the real world. In addition, students should be able to deal with the social and political dimensions of the working environment within which RM works.

## Teaching the Skills

Of course, the students also need within their tool-kit a set of skills. Some of these are RM techniques are statistics, simulation, system dynamics and so on. Others are "process skills" necessary for the process of carrying out RM. Which techniques and skills need to be taught? Key, of course, is to consider topics the industry wants. On most MS's, course development can draw from the experiences of an Advisory Board of senior RM managers and practitioners. The aim should be to determine what RM groups would like to have in such a course. The information needs to gather from advisory board which topics or skills are important and which are unimportant, the kind of computing knowledge that would be useful and any subjects that haven't previously been considered.

- Topics would have high demand are report writing, presentation skills, group work, live project work, basic statistics, basic computing, traditional risk management methods and simulation.
- Topics may have a low score include game theory, renewal processes and aspects of mathematical programming
- Computing topics that would be important are spreadsheets, microcomputers, programming and databases.
- But of course, as has been made clear in the previous discussion, the techniques themselves will be only part and by far the simplest part of the RM education.

The classical RM mathematical programming techniques are least used and computing, simulation, forecasting, regression and statistical tests are most frequently used. Mathematical programming and dynamic programming are rated as having been covered too much in their education, with simulation, surveys, heuristics and decision analysis as inadequate. But more importantly, feedback will highlight areas of failure or success in education. Some of the main areas being, too little about computers and computing, report writing and presentations, manager/client relationships, management of an RM project; too much emphasis on techniques applied to well defined problems not enough on sparse data or poorly defined problems. And they will highlight problems facing RM education, including the teaching of methodology to deal with ill-defined problems, preparing students for the political and working environment of organizations and the fostering of desirable personal characteristics in individuals. Several areas of success in the RM education which include RM techniques -problem solving methodology, ability to work to deadlines or under pressure, ability to write reports and do presentations, as well as "being aware of the techniques available.

The process skills are taught in an MS by a variety of methods-mentoring, experiential learning and so on. But the key element for effective teaching is always the grounding in

current (or at least fresh) process experience on the part of the mentor. Such process skills include:

- consulting practice skills: the role of the consultant; stakeholders; interviewing skills; client/consultant relationships and "buy-in"; implementation issues and reward systems;
- the context of business management;
- proposal preparation and proposal "selling"; costing; project planning;
- problem structuring methods, methodological issues, ethical issues;
- how groups of people work; and
- the use of decision support systems to help decision makers (both operationally and with the strategic process).

Some of the elements on these issues can clearly be taught by some form of conventional teaching (e.g. face-to-face or directed reading): the standard problem structuring methods, or the strategic decision-making systems. But the teaching of even these becomes dry and sterile if simply taught conventionally and not motivated by real, or apparent problems. In general the other skills can only be taught by a mentor, with real and fresh experience, guiding the students as they learn through experience.

### **Teaching RM Techniques**

Turning to the RM techniques themselves, as opposed to the process skills, we have considered to some extent the question: "Which topics should be taught?" But two other questions are raised themselves: "to which depth?" And "how should they be taught?"

There are basic areas of knowledge every RM needs. Some techniques such as statistical and probabilistic clearly need to be taught in more depth. But as far as the production of a tool-kit goes, for many techniques the key is to be aware that a technique exists, its nature and when it is applicable, and then to be able to find out about it and pick it up, understand it and apply it very quickly. A student might not learn all of the techniques of data-mining -but (s)he needs to have a flavor of what they are, and be able, when needed, to recognize a data-mining issue, familiarize him(her) self with the techniques and go and apply them possibly in an environment where no-one about him/her knows anything about data-mining.

Lead in with the third question "How should these techniques be taught?" Traditionally the classes in any University course consist of lectures and tutorials. As part of the ongoing process within the department to improve the effectiveness of RM teaching, a new component has been



added to the traditional teaching methods. Students learn by their own investigation of the system through exploration and experimentation with interactive models and graphics. The immediate visual feedback provided in this process engages the students actively in the learning process, encouraging active rather than passive learning. The efficiency gain is clear. Efficient use of staff and resources is increasingly important in higher education and there is clearly the potential to incorporate computer-based learning into a traditional teaching regime to reduce staff/student contact time. The effectiveness gain is also usually (although not universally) agreed, but different institutions use the software in different ways. The author has found that with an MS class, the software provides a very useful adjunct to traditional technique-teaching methods; it is used either directly as a teaching aid or as a stream running parallel to and supporting a pared-down teaching course.

## Conclusions

The nature of the "messiness" of the real projects in which we are involved determines how our RM practice proceeds. In order to train the future generation of RMers, we need to prepare them with the skills to deal with this messiness.

First, of course, the teachers themselves must have these skills, and be continually honing them in practice. Now as RM academics we do many things in particular. We teach, consult, research and carry out in-company training. One key message of this paper is synergy. The research culture of carrying out real work for real clients leading to the development theory and thus generic results of general applicability, clearly brings synergy between consultancy and research. The work represented by this consultancy/research clearly informs teaching and training, making it fresh and relevant. But, company training can also spark off interest leading to interesting consultancy and thus research. Added to this are synergistic opportunities, teaching, and training in novel situations which will lead to research outcomes.

These abilities need to be passed on to the students. Technique training provides an important tool-kit, but there are key process skills that are essential to practice in the real "messy" world. These skills have to be identified, then they must be learned through guided experiential learning and mentoring, with the learning loop closed by guided reflection (fostered and aided by mentors).

Various implications for the technique/teaching have also been discussed, but, apart from a few vital RM concepts, the essential is to equip the student with a tool-kit of both techniques that (s)he can pull out and use on demand, and also of knowledge of existing techniques so that the student can go and find out more about a technique if required.

We are here to supply graduates who are able to grapple with complex, messy, real- world problems and provide useful input to decision-making processes.

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