A CALL TO ARMS:

Engineering and Conservation Education - addressing competency, education and training in preservation engineering

John A Fidler MA arch. MA conservation, AAGrad Dipl conservation

RIBA, IHBC, Intl Assoc AIA, FRICS, FSA, FIIC, FAPT

Staff Consultant & Practice Leader

Simpson Gumpertz & Heger Inc., Consulting Engineers

1055 West 7 Street, Suite 2500

Los Angeles, CA 90017

213-271-1915 / jafidler@sgh.com / www.sgh.com

ABSTRACT

This paper describes the background to today's situation where few educational programs exist internationally for structural engineers to learn the specialist skills of preservation engineering. The author suggests reasons for this situation and describes efforts in the United Kingdom and elsewhere to generate drivers for change that may have lessons for American engineering education and practice.

KEYWORDS

Preservation, engineering, competency, education and training.

INTRODUCTION

There are two large and inter-connected problems that confront the international preservation community in the context of this colloquium. Firstly, there is an undoubted shortage of structural engineers who are expert in preservation engineering. Secondly, there is an over-supply of civil and structural engineers working on historic buildings and structures with absolutely no understanding of the subject.

Both situations are evidently harmful to the built heritage and threaten its future welfare both here in America and further afield. No other profession has neglected its specialist competencies in this regard to such an extent and degree. The problems are occasionally debated (ICCROM, 1983 and Jokilehto, 1995) but rarely acted upon strategically at either national or international level. On a world scale, few educational establishments have addressed the issue. Where structural engineers have managed to receive a generic education in historic preservation, the amount of time devoted to structural engineering matters is minimal.

Significant numbers of buildings still remain from the distant and recent past that are not all built of steel and concrete. The 'churn' in the numbers of existing buildings being demolished and rebuilt is slowing across the developed world as vacant land becomes more difficult to find or use because of environmental and socio-economic factors. So more existing buildings are being retained, repaired and reused than in the recent past. Yet the syllabuses of many schools of engineering have not taken this fact into account and remain focused on new development.

BACKGROUND

Until the recent global economic recession, there was an international shortage of general practice structural engineers in Europe and North America. Some countries have suffered large gaps in

their employment demographics, for example like the United Kingdom, where over 6,000 engineers are missing from the profession's current cohorts as significant numbers of engineers are about to retire and too few young engineers are taking their places. There has been a general 25-35% downturn in the numbers of students taking vocational education in engineering among developed countries - only offset for mainstream engineering by surges in numbers of Asian students graduating in Pakistan, India and China, and as visiting students graduating in American and European universities.

Most undergraduate engineering education is undertaken in Civil Engineering, the broader technical discipline that includes soil and geo-technical engineering, environmental engineering (including water treatment), transport and traffic engineering, and structural engineering. Countries such as the United Kingdom, and a few American states, distinguish between civil and structural engineers. But generally this is not the case. So academic establishments are delivering general practice engineers to the construction industry: Jack-(and Jills)-of-all-trades, but masters of none.

Engineering as a discipline came late to British academia with the first department established at Kings College, London in 1838 – some 70 years after the first architectural course started in the Royal Academy Schools in 1768. The first President of the Institute of Civil Engineers, Thomas Telford (1757-1834), started his career as a mason, while Isambard Kingdom Brunel, (1806–1859) trained with a French watchmaker (Thorne, 1993 p22-23).

Now Civil Engineering is a three- or four- year undergraduate program at university level and does not require a postgraduate component to achieve professional competency, although some professional institutes, if not the licensing bodies, would like to increase the length of the training to Masters Degree level.

Internationally, the history of engineering and the repair of older engineering structures and buildings are no longer taught in undergraduate education and this is a major cause for concern in preservation circles. Recent graduate engineers have no knowledge or awareness of structural engineering history, and no familiarity with traditional materials and construction including mass masonry, timber framing, cast and wrought iron structures, or of composite structures involving these materials. Furthermore, knowledge of the performance and susceptibilities of vernacular materials e.g. adobe, are for the most part completely unknown.

INACTION AND TOKENISM

The debate about this appalling situation has been going on for some time – at least 40 years. For example in 1968 a UNESCO experts meeting in Pistoia, Italy declared that,

> "*closer collaboration be developed between architects and specialists in other university disciplines concerned with preserving the heritage of monuments, such as…engineers….etc., by directing or supplementing their training to meet preservation requirements*," (ICCROM, 1983 p230).

The same mantra was heard in Helsinki in 1995,

> "*Engineers should have special training to understand how historic structures work*," (Jokilehto, 1995 p26)

And this is being reiterated at this colloquium today. But we have not seen much activity by the professional institutes, licensing boards or academic establishments to correct this situation. There have been no significant drivers for change.

Building conservation is mostly taught in schools of architecture, and although engineers do attend such postgraduate training courses, in extremely small numbers, they receive very limited specialist engineering training. This is because the majority of students taking the courses today

are not architects or engineers but more often archaeologists, anthropologists, historians and planners. Thus the technical content of the courses is rather low level and may only include a lay understanding of engineering, perhaps totaling less than 3-6 hours on a one- or two- year fulltime course.

SIGNS OF LIFE

Specialist preservation engineering courses do exist internationally but they are relatively recent and too few in number to deliver significant impacts on the world stage. There are courses at the University of Minho in Portugal, in Italy at the University of Padova and La Sapienza University in Rome, and at the School of Architecture and Engineering at the University of Bath in England. The International Center for Studies of the Conservation and Restoration of Cultural Property in Rome (ICCROM) has been considering putting on a three-month specialist course for structural engineers at its headquarters in Rome. But insufficient resources are available to develop the program. This is unfortunate because in many areas of the world, engineers are the only trained building professionals available for the conservation of historic buildings and archaeological sites – yet current training for this role is totally inadequate or non-existent.

In North America, the first Forum on Conservation Engineering was convened in Montreal by the Association for Preservation Technology (APT) in 1990. One of the action items identified was the need to develop criteria to enable engineers to be certified who had sufficient experience with historic structures. At the time, the model suggested was to have criteria for "Engineer" and "Conservation Engineer" written into the U.S. Federal Register as part of the National Park Service's definition of qualified professionals. This was achieved more recently by other means in the Secretary of the Interior's revised *Historic Preservation Professional Qualification Standards* that now include for Engineering (Appendix One). However, the pioneering work of Hugh Miller and Lee Nelson that set competency standards and training objectives for Park

Service employment (1989) as a precedent now seem to have been forgotten. Earlier competency definitions and training objectives for restoration engineers by Parks Canada (Ghassar, 1986) were a primer for the Park Service document and have similarly been overlooked.

RECENT ACTION

The International Council on Monuments and Sites (ICOMOS) established ISCARSAH as an International Scientific Committee for the Analysis and Structural Restoration of Architectural Heritage in 1996. Its Principles, ratified at the 14th General Assembly of ICOMOS in Zimbabwe in 2003, seek to guide those involve with the technical engineering aspects of preservation.

Relatively recent American initiatives also show promise towards assembling a coherent way forward. For example, the Association for Preservation Technology created a Preservation Engineering Technical Committee in 2003 to provide a focus for discussing issues relating to engineering and historic preservation. Special engineering issues of the APT Bulletin followed and regular discussions have been held on matters of professional standards and education both with the multidisciplinary Association but also across the engineering community itself.

The American Society of Civil Engineers has been developing its Body of Knowledge (ASCE, 2008) that seeks to influence educational establishments, licensing boards and others over questions of competency to practice engineering in the 21st century. The corpus of professional practice now recognizes the need to understand historic structures and to sustain the existing built environment as much as to create new developments.

The National Center for Preservation Technology and Training (NCPTT) has partnered with Michael Henry P.E. and Sam Harris P.E. to develop short course training modules with mid-career engineers in mind. The modules include “materials and older buildings,” “building

pathology," "investigations and diagnostics methodology," and "treatment strategies and interventions" and are being rolled out around the country

Certain countries have taken decisive action at another level. In Europe for example, there are accreditation systems already in place for qualified professionals to validate and promote their specialist skills, knowledge and experience in building conservation at mid-career level. Most of the programs are aimed at architects but gradually engineering programs are being added. In France, there is the long-standing formal training and examination system for the Architects en Chef des Monuments Historique (http://acmh.info). In Italy, conservation training is a mandatory unit in the curriculum for all architects in Italian schools of architecture.

In the United Kingdom, recent accreditation schemes that define competency in building conservation have been set up by the Royal Incorporation of Architects in Scotland, the Royal Institution of Chartered Surveyors, and the Royal Institute of British Architects and jointly by the Institute of Civil Engineers and the Institute of Structural Engineers. They are all based on a peer review of a portfolio of work that demonstrates competency in building conservation through awareness, knowledge, skills, judgment and experience. The process is driven by client demands in that English Heritage, Historic Scotland and the Heritage Lottery Fund make it a condition of grant aid that historic building owners only hire accredited professionals to undertake their conservation work. The professional institutes in the UK have defined competency in association with the national heritage bodies based on the ICOMOS Sri Lanka Guidelines (Feilden, 1993). Guidance for practitioners and materials to foster competency through education and training are freely available online at www.understandingconservation.org

The UK Institute of Civil Engineers (ICE) and the Institute of Structural Engineers (IStructE) have established an equivalent accreditation scheme for civil and structural engineers, called the

CARE scheme, that includes a single peer reviewed assessment system and a public register of specialist professional expertise www.ice.org.uk/downloads//Principles%20of%20Operation.pdf. These accreditation schemes and the nested work on multidisciplinary competency in building conservation are defining what in the U.K. is considered to be the special expertise necessary for a mid career practitioner to practice building conservation to a high standard. Similar programs are taking root in Australia where the engineering profession is in the lead.

CONCLUSIONS

No labor market analysis seems to have been undertaken to determine how many structural engineers with specialist skills in preservation are needed at regional, national and international level to sustain the architectural heritage in a benign and effective way. Without this strategic data it is impossible to decide how many and what type of educational programs are needed. Work in the UK by the National Heritage Training Group (NHTG) will commence shortly to deliver this important data and analysis for England.

Several steps have been taken to help define what constitutes competency in the general field of engineering, and in the specialist field of preservation engineering. But there is a growing divergence between what expert practitioner employers want of graduating staff, what the professional institutions will delineate, what licensing boards demand and what educational establishments are prepared to deliver.

Tensions also remain between general practice engineers and specialist preservation engineers about the levels of competence required to undertake work on historic buildings and this provides difficulties for professional institutes to remain even-handed for the benefit of their two constituencies of membership.

RECOMMENDATIONS

This colloquium provides a unique national opportunity to address the issues outlined in this paper, to collaborate on labor market studies and to refine definitions of specialist preservation engineering competency within the broader engineering body of knowledge.

The growing shortage of specialist engineers is likely to increase as the current generation of experts starts to retire. In this economic climate, there is cause for alarm - surely sufficient for a general “Call to Arms” to be organized to address the collective problem?

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WEBSITES

AABC Scheme: www.aabc-register.co.uk (register of architects accredited in building conservation

ACMH: http://acmh.info La Compagnie des Architects en Chef des Monuments Historique

Historic Scotland: www.understandingconservation.org Guidance on knowledge, skills, judgment and experience needed to be accredited in building conservation as a professional in the UK

CARE scheme: www.ice.org.uk/downloads/principles%20of%20operation.pdf Accreditation system for members of the UK Institutes of Civil and Structural Engineering

APPENDIX ONE

The Secretary of the Interior's Historic Preservation Professional Qualification Standards

ENGINEERING

www.nps.gov/history/local-law/gis/html/quals.html

Engineering is the practice of applying scientific principles to the research, planning, design, and management of structures and machines such as roads, bridges, canals, dams, docks, locomotives, and buildings, including their structural, electrical, or mechanical systems. Historic Engineering involves specialized training in engineering principles, theories, concepts, methods, and technologies of the past and appropriate methods of interpreting and preserving historic engineered structures or machinery.

STANDARD FOR ENGINEERING

(a) The applicant, employee, consultant, or advisor will have a State Government-recognized license to practice civil or structural engineering, PLUS, a minimum of two (2) years of full-time professional experience applying the theories, methods, and practices of engineering that enables professional judgments to be made about the documentation or treatment of historic structures and machines in the United States and its Territories; AND products and activities that demonstrate the successful application of acquired proficiencies in the discipline to the practice of historic preservation (see Documenting Professional Experience for Engineers); OR...

(b) A Masters of Civil Engineering degree with demonstrable course work in Historic Preservation, for historic structures rehabilitation, PLUS a minimum of two (2) years of full-time professional experience applying the theories, methods, and practices of Engineering that enables professional judgments to be made about the documentation or treatment of historic structures and machines in the United States and its Territories; AND products and activities that

demonstrate the successful application of acquired proficiencies in the discipline to the practice of historic preservation (see Documenting Professional Experience for Engineers); OR...

(c) A Bachelors of Civil Engineering degree with at least one year of graduate study in History of Technology, Historic Preservation, Engineering History, or a closely related field (see Academic Background for Engineers), PLUS a minimum of two (2) years of full-time professional experience applying the theories, methods and practices of Engineering that enables professional judgments to be made about the documentation or treatment of historic structures and machines in the United States and its Territories; AND products and activities that demonstrate the successful application of acquired proficiencies in the discipline to the practice of historic preservation (see Documenting Professional Experience for Engineers).

(Note: *only persons who are licensed to practice Engineering in that State may prepare and seal plans and specifications in order to obtain construction permits, authorize payments to contractors, and certify that the work is complete. However, State staff, State Review Board members, and CLG staff or Commission members who are not licensed, but who meet the Standard for Engineer under (b) or (c) above, can review proposed and completed work for compliance with the applicable Secretary's Standards for Tax Act, HPF Grant, or other related programs.)*

ACADEMIC BACKGROUND FOR ENGINEERING

Closely related fields: The Bachelor of Civil Engineering degree is a five-year degree that is unlikely to include historic preservation course work. The same is true of a Masters of Civil Engineering degree. An Engineer with an Engineering degree is well grounded in all aspects of engineering practice, including design, planning, construction specifications, and contract administration. Although this background is essential, additional training is needed in order to

understand and work with historic structures, sites, and machines, with their complex material evolution and treatment problems. Specialized training, to supplement that provided by the professional Engineering program, should be acquired in such areas as American Architectural and Engineering History, History of Technology, Architectural Preservation, Conservation, Historic Construction Technologies, Historic Building Materials, Historical Archeology, and Historic Preservation.

Discipline specialization: Civil Engineering, Electrical Engineering, Mechanical Engineering, and Structural Engineering are typical specializations within the broader discipline of Engineering. The two specializations most often used in historic preservation projects are Civil and Structural Engineering. Occasionally, there may be the need for a Mechanical Engineer to address issues concerning historic machinery such as locomotives, steam engines, water turbines, electric generators, and similar machines and equipment, or particularly complex mechanical systems in a historic structure.

APPLYING THE STANDARD FOR ENGINEERING

Documenting Professional Experience:

To be licensed by a State Government as a professional Engineer, an individual must pass a written exam and successfully fulfill education, training, and experience requirements. In addition, a professional Historical Engineer has both theoretical knowledge and technical skill associated with preserving historic structures and machines, and with the application of Engineering theories, methods, and practices that enables professional judgments to be made about the evaluation, documentation, or treatment of historic structures and machines in the United States and its Territories. A professional Historical Engineer typically has gained experience on structural preservation projects, which have included research and detailed investigations of historic structures or mechanical artifacts and preparation of recommendations

for the treatment of such properties in order to preserve them in accordance with the appropriate Secretary's Standards for Archeology and Historic Preservation (particularly the Secretary's Standards for the Treatment of Historic Properties).

Products and activities:

Professional experience and expertise must be documented through "products and activities that demonstrate the successful application of acquired proficiencies in the discipline to the practice of historic preservation." Products and activities that meet the Secretary Standards for Archeology and Historic Preservation may include:

- Plans and Specifications for the preservation, rehabilitation, or restoration of historic structures, such as bridges, dams, canal locks, and for the structural rehabilitation or seismic stabilization of buildings.
- Adaptive reuse or feasibility studies that make recommendations for preserving or structurally stabilizing historic structures, including bridges.
- Historic Structure Reports or Condition Assessments of historic structures or machines.
- Documentation that meets HABS/HAER standards for recording historic structures or machines.
- Experience applying the Secretary of the Interior's Standards for the Treatment of Historic Properties to the review of work on historic structures, sites or machines
- Awards for historic structure preservation, rehabilitation, or restoration received from local, regional, national, or international professional organizations.
- Publications, which might include articles in regional, national, or international professional journals, monographs, books, or chapters in edited books about the preservation of historic structures or machines.
- Presentations at regional, national, or international professional conferences, symposia, workshops, or exhibits about the preservation of historic structures or machines.

- Professional service on boards or committees or regional, national, or international professional organizations concerned with the preservation of historic structures or machines.