

AC 2010-1627: FACILITATING COLLABORATION OF ENGINEERING AND ARCHITECTURE STUDENTS VIA AN INTERNATIONAL TRAVEL-STUDY WORKSHOP

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Michael Symans is an Associate Professor in the Department of Civil and Environmental Engineering at Rensselaer Polytechnic Institute where his primary focus is on the development and application of advanced technologies for seismic resistance of structures. His involvement in the Bedford Program began in earnest when he served as the School of Engineering representative on the search committee for the second Bedford Visiting Professor. Subsequently, he participated in his first Bedford Travel-Study Workshop in Spain; that experience serving as the catalyst for this paper. He is now a major proponent of the Bedford Program within the School of Engineering and anticipates future collaborative work with the School of Architecture to develop formal assessment processes for continuous improvement of the program.

Mark Mistur, Rensselaer Polytechnic Institute

Mark Mistur is the Associate Dean of Architecture and Associate Professor at Rensselaer Polytechnic Institute where he has been instrumental in developing a curriculum based on the inclusion of theoretical, design, and technical intelligences as necessarily integral to a progressive architectural design. His teaching and research focuses on innovations driven both by performance criteria and the integration of technology with design, but remains as concerned with phenomena, the human experience and social consequences of architectural space and urban/landscape form. This is most notably realized in his leadership of Rensselaer's fourth year Design Development Studio and Bedford A/E Initiatives which in 2005 received an NCARB Award of Excellence for the 'Creative Integration of Practice and the Academy'.

Bruce Danziger, ARUP

Bruce Danziger is a Structural Engineer and Associate Principal with Arup and has worked in Arup's offices in London, Seville, Los Angeles, New York and San Francisco. His experience includes teaching architecture and engineering students, an education that coupled engineering and architectural design (B.S. in Architectural Engineering at California Polytechnic State University at San Luis Obispo), project management with multi-disciplinary engineering teams, and extensive experience working with practicing architects. Examples of his work experience include The Pavilion of the Future at EXPO '92 (with Peter Rice's group), The Sony Center Roof in Berlin, the Lerner Student Center at Columbia University, and the Mondavi Center at UC Davis. His teaching experience includes the Bedford Visiting Professor at Rensselaer Polytechnic Institute, Hard Tech Faculty at Southern California Institute of Architecture, Visiting Lecturer at the University of Puerto Rico, and course instructor (with Professor John Johanson) at Pratt University School of Architecture.

Facilitating Collaboration of Engineering and Architecture Students via an International Travel-Study Workshop

Abstract

This paper presents an overview of a joint School of Engineering and School of Architecture initiative at Rensselaer Polytechnic Institute that facilitates collaboration between students, faculty, and practitioners from both disciplines. The program is presented with respect to its learning objectives and is described in terms of its historical development and the various components that contribute to its overall mission. The international travel-study workshop component is given particular emphasis in terms of its ability to expose students to best practices which rely upon cross-disciplinary intelligence and to foster collaborative work among engineering and architecture students as a precedent to the same in their professional lives and careers. This paper is primarily of a descriptive nature, including an informal assessment of the overall program with emphasis on the travel-study workshop.

Introduction

The development of substantive collaborative activities between engineering and architecture students can be challenging, especially given the natural reluctance among students (and disincentives for faculty) to embed themselves in study outside their discipline. Constructive interdisciplinary interactions can be facilitated via formal programs that structure collaborative interactions between these groups of students, especially under the leadership of instructors with relevant field experience. At Rensselaer Polytechnic Institute, such a program (the Bedford Program) exists and has been in operation for more than ten years. It is a joint School of Engineering and School of Architecture program that focuses on investigations of progressive architecture and engineering practice and the various and emerging interdisciplinary approaches to design. The full program consists of three component initiatives that are led by a visiting professor from architectural engineering practice. The activities that are coordinated by the visiting professor include an interdisciplinary seminar, a collaborative design studio, and an international travel workshop. The semester-long seminar course exposes a balance of architecture and civil (structural) engineering students to progressive contemporary and historic architectural projects and practices that have relied upon significant collaborations between architects and engineers. The Bedford Studio teams upper level architecture and engineering students in the design of a building through the design development phase with an emphasis on systems integration in the early design phases of an architectural project. The third initiative, also coordinated by the Bedford Visiting Professor, consists of an international travel-study workshop which annually seeks out and visits concentrations of exemplary buildings and practices. In recent years, the travel-study workshop has been held in major cities in England, Germany, France, Japan and most recently, Spain.

This paper provides an overview of the Bedford Program with a particular focus on the international travel-study workshop component. Emphasis is given to the ability of the program to foster collaborative work among engineering and architecture students and the student experience during the most recent ten-day travel-study program in Spain. Furthermore, a brief

discussion on plans for formal assessment of the travel-study workshop is provided, primarily in relation to the ability of the students to function well in multi-disciplinary teams as both leaders and contributors.

Early Development of the Bedford Program

The Bedford Program was established as the result of a gift to Rensselaer Polytechnic Institute by Clay Patrick Bedford, a 1924 alumnus of Rensselaer. Clay Bedford had a distinguished career with Kaiser Industries where he rose to become President of Kaiser Aerospace and Electronics Corporation. At Kaiser, he played major roles in a number of large-scale construction projects including the Boulder, Grand Coulee, and Bonneville Dams. He also provided notable contributions to the military, including supervising the construction and production of numerous World War II Liberty ships. During the Korean War, he served as special assistant to the Director of Defense Mobilization and subsequently became Assistant to the Secretary of Defense for production.

Bedford recognized that engineering had largely abandoned its interest in aesthetics and that architecture had lost its sense of practical enterprise that might be affected by creative integration of ‘the engineering’ and ‘aesthetic’ aspects of building design. As noted by Princeton Professor David Billington, “*It is as crucial for engineers to learn about art and aesthetics as it is for architects to learn about structures and construction.*”¹ Bedford was critical of the fact that these two professions, which were once practically inseparable, had grown apart and distinct in a manner detrimental to ambitious and progressive architecture which depends upon early collaboration, understanding and respect for the varied responsibilities and professional agendas. As a result of these concerns, he purposed a gift to Rensselaer that would inspire reintegration and progressive collaboration between the Schools of Engineering and Architecture. In response, the Bedford Initiatives were designed to instigate integrated and collaborative experiences for students and faculty with practitioners in the schools of Architecture and Engineering. The initiatives were based on confidence that by integrally structuring two pairings, one of ‘*architecture and engineering*’ and the other of ‘*practice and the academy*’, significant dimensions could be added to the Rensselaer education of an architect and an engineer; dimensions that would have strategic impact on both the perspectives and practices of Rensselaer graduates. Such initiatives are not new. Modern era joint architecture and engineering educational initiatives have been pursued as far back as the 1970's when Ted Happold, founder of Buro Happold, directed the interdisciplinary program for architecture and civil engineering at the University of Bath which was successful in producing a generation of creative architects and innovative building engineers.²

Components and History of the Bedford Program

The Bedford Program is centered on the following three primary initiatives:

1. An interdisciplinary design studio (annual – spring semester)
2. An interdisciplinary seminar (fall and spring semesters annually)
3. An interdisciplinary travel-study workshop (annual - summer)

By design, each of the initiatives is lead and catalyzed by the Bedford Visiting Professor, a professor from practice who is experienced in and champions interdisciplinary collaboration. The Visiting Professorship was established to support, on a three-year rotating basis, accomplished professionals from recognized, progressive building engineering or architecture practices to teach at Rensselaer while maintaining their industrial relationship in order to ensure that students, faculty and the two Schools gain strategic access to contemporary best-practices, methods and thought. The expectation is that, for each component of the Bedford Program, both students and faculty would be engaged in a manner that challenges and changes the culture of misunderstanding, and catalyzes further collaborative engagements. The program is also designed to facilitate the development of a broadening international network between the Rensselaer community and professionals engaged in collaborative and interdisciplinary building design practices.

In 2001, Craig Schwitter, P.E., was appointed as the first Bedford Distinguished Chair of Architecture and Engineering (i.e., the Bedford Visiting Professor). Schwitter's engineering career began in 1992 at Buro Happold in Bath, England, where he focused on special structures and at the age of 33, was one of the youngest people in the practice to be made a principal. In the late 1990's, Schwitter led the formation of Buro Happold's North American startup in New York City and has since grown the office to over 60 professionals with a second office on the west coast. In 2006, Bruce Danziger, P.E., a structural engineer and Associate Principal with ARUP, Los Angeles was selected to assume the Bedford Professorship with a focus on Advanced Building Systems. Danziger joined ARUP in 1988 and worked in the London, Seville, New York, San Francisco, and Los Angeles offices. While in London, he teamed with Peter Rice's group designing innovative structures. He played an integral role in the design, development, and construction of international projects that required early and intricate coordination between architecture and engineering, including the Pavilion of the Future at the 1992 Universal Exposition in Seville, the Sony Center Roof in Berlin, and the Lerner Student Center at Columbia University. Schwitter and Danziger proved that the model of joining students, faculty, practicing architects, engineers and built works was effective in raising a discourse that had not previously existed while linking the Schools to an expanding network of progressive interdisciplinary practices.

Stimulated by the Bedford gift and with input from his son Patrick, also a Rensselaer alumnus, the first structured Bedford initiatives were proposed in 1998 by Architecture Professor Mark Mistur. In collaboration with Engineering Professor Michael O'Rourke, they piloted the first senior-level interdisciplinary studio (the Bedford Studio) linked to the senior capstone projects for structural engineering students. Architecture's fourth-year Design Development studio provided an ideal platform to join engineering and architecture students in a collaborative setting to raise cross-disciplinary awareness and respect for different professional responsibilities and agendas, to expose each culture to a different language, and to provoke an understanding of the benefits of collaboration at early stages of building design. In that same year, Professors Mistur and O'Rourke piloted a one-week workshop led by architect Merrill Elam of Scogin Elam and Bray, Atlanta, and structural engineer Jane Wernick, of ARUP, London. The workshop involved an equal number of architecture and engineering students (six + six) in a charrette to design a series of deployable lightweight structures for the 175th Anniversary of the Institute. This exercise was to become the precursor of the travel-study workshop.

The Bedford Studio continued annually under the professorships of Mistur and O'Rourke until the appointment of Schwitter who assumed the engineering side leadership of the studio team. Professor Schwitter was the first to offer the Fall and Spring cross-registered Bedford Seminars and conducted the first of many Bedford Travel-Study Workshops to London and Bath, headquarters of Buro Happold. The Bedford Seminar, taught exclusively by the Bedford Visiting Professor, is an upper-level interdisciplinary architecture and engineering course that is taught to an equal number of architecture and engineering students (typically 12-18 students total). Topics vary from semester to semester and have included Lightweight Structures, Conceptual Structures, Form follows Structure / Structure follows Form, a History of Structures (beginning in the enlightenment period), and non-traditional structures and/or materials in contemporary applications. In all cases, the seminar has been taught with emphasis on the complementary knowledge and skill sets of architects and engineers. The goal is not to teach 'architects' to become 'engineers' or vice-versa, but to expose the architecture students to engineering concepts and the ways in which engineering can inform and shape their designs and to expose engineering students to the ambitions and agendas that permeate architecture. The objective is to create cross-disciplinary awareness and respect for their various languages, agendas, and responsibilities, and to promote constructive collaboration methods and models of working. Evidence of the Initiative's success includes its 2005 receipt of a National Council of Architectural Registration Boards (NCARB) prize for "*Creative Integration of the Academy and Practice.*"

Travel-Study Workshop

The travel-study workshop was designed to expose students and faculty of the two disciplines to each other, to great works of architecture, and to best practices which embrace collaborative work and have ambitious agendas for contemporary architecture and engineering. Workshop locations have focused on international destinations with concentrations of accessible and relevant built projects and progressive architecture and engineering practices (see Tables 1 and 2). The workshop is held in the early summer and typically consists of an 8-10 day intensive itinerary that combines significant building-site visits and construction-site visits with in-office seminars. Concurrent with the site and office visits, interdisciplinary student teams are tasked with the conceptual design of a project – a means of catalyzing discussion and conversation through and about collaboration. The Bedford Program provides financial support for travel for twelve upper-level students (six from each discipline), two faculty (one from each discipline), and the Bedford Visiting Professor. The workshop is typically organized by the Bedford Visiting Professor with extensive linkage to their network of architects and engineers. Both Buro Happold and ARUP have been extraordinarily generous in their hosting and support of the travel-study workshop initiative at numerous cities and sites.

Student selection for the fully funded summer travel workshop is competitive, based on performance in related courses and their expressed understanding of the interdisciplinary agenda. No registration or tuition is required and no academic credits are given. Nevertheless, once selected, to create a baseline of references for discussion, each participant is expected to prepare by reading a series of scholarly articles and chapters by (or about) such persons as David Billington,¹ Peter Rice,³ Ted Happold,⁴ Ove Arup, Alan Holgate,⁵ and Cecil Balmond. In addition, the group meets on several occasions in advance of the trip to familiarize themselves

with the itinerate destinations including specific buildings, bridges, structures and firms that will be visited.

Table 1 History of Travel-Study Workshops

Year	Location	Bedford Professor	Arch./Engrg. Professor	Company Sponsor	Project
1998	Troy, NY	---	Mistur O'Rourke	---	Deployable Lightweight Structures
2000	England (London & Bath)	Schwitter	Mistur O'Rourke	Buro Happold	Waterloo Station Shed Redux
2002	Germany (Berlin & Stuttgart)	Schwitter	Mistur Feeser	Buro Happold	Hippo House Redux
2004	England (London & Cornwall)	Schwitter	Mistur List	Buro Happold	Environmental Pavilion
2007	England (London) France (Paris)	Danziger	Mistur ---	ARUP Buro Happold	Pedestrian Bridge over Seine
2008	Japan (Tokyo & Osaka)	Danziger	Mistur ---	ARUP Buro Happold	Chanel Pavilion Redux
2009	Spain (Seville, Madrid, Barcelona)	Danziger	Mistur Symans	ARUP Buro Happold	Sun and Shade Pavilion

Table 2 Examples of Engineering and Architecture Firms Visited During Travel-Study Workshops (listed alphabetically)

Engineering Firms	Architecture Firms
ARUP, London (Special Structures Group, Advanced Geometries Unit)	Arata Isozaki, Tokyo
ARUP, Berlin	Behnisch, Stuttgart
ARUP, Madrid	Foster and Partners, London
ARUP, Tokyo	Grimshaw, London
Atelier 10, London	Jurgen Meyer, Berlin / Seville
Battle and McCarthy, London	MBM Architects, Barcelona
Buro-Happold, Bath	MC2, Barcelona
Buro-Happold, London	Reid Fenwick, Madrid
Expedition Engineering, London	Renzo Piano Building Workshop, Paris
Hugh Dutton, Paris	Richard Rogers, London
Institute of Lightweight Structures, Stuttgart	Miralles / Tagliabue EMBT, Barcelona
Jane Wernick, London	Toyo Ito, Tokyo
Jörg Schlaich, Stuttgart	
Mutsuru Sasaki, Tokyo	
RFR, Paris	
Taiyo Kogyo, Tokyo	
Tekanaka, Tokyo	

The most recent summer workshop, “*Investigating Spanish Engineering and Architecture Practice*,” joined 12 students with Bedford Professor Bruce Danziger, Engineering Associate Professor Michael Symans, and Architecture Associate Professor Mark Mistur, on a trip to Seville, Madrid, and Barcelona with a focus on site visits and office seminars (see Table 3) and a collaborative A/E design exercise. For Danziger, Seville was a return to his roots where as a

young engineer under the tutelage of Peter Rice he worked on the design and supervised the construction of the stone arches at the Pavilion of the Future (see Figure 1). Starting the workshop at the Expo site provoked a conversation both about the forces within the remarkably thin stone block arch structure and its construction sequence (stabilized by steel struts and cables) – a conversation which did not find agreement amongst the faculty and/or students on either side of the disciplinary divide, but which set the stage for the manner in which the group would look at and discuss each visited project over the next nine days.

Table 3 Sites Visited During Travel-Study Workshop in Spain

Location	Site
Seville (2 days)	Cathedral of Seville (a.k.a., Catedral de Santa Maria de la Sede; largest Gothic cathedral)
	Isabel II Bridge (built for 1992 Expo)
	Barquetta Bridge (built for 1992 Expo)
	Alamillo Bridge (built for 1992 Expo)
	Pavilion of the Future (built for 1992 Expo (MBM Architects + ARUP/ Rice/ Carfrae/ Danziger)
	Cooling Towers (built for 1992 Expo)
	Plaza de Mayor - Metropol Parasol (by Jurgen Meyer + ARUP)
	Abengoa Headquarters (by Richard Rogers + ARUP)
	Santa Justa Train Station (by Cruz and Ortiz)
Madrid (3 days)	Atocha Train Station (original terminals by Alberto de Palacio Elissagne & Gustave Eiffel) (new terminals by Rafael Moneo)
	Prado Museum Extension (by Rafael Moneo)
	Caixa Forum Madrid (by Herzog & de Meuron)
	Museo Nacional Reina Sofia Extension (by Jean Nouvel)
	ARUP, Madrid
	Reid Fenwick Associates
	Faustino Winery (by Foster and Partners + ARUP)
	Madrid Barajas Airport (by Richard Rogers + ARUP)
Barcelona (2 days)	Market Place (by Miralles / Tagliabue, EMBT)
	Barcelona Pavilion (by Mies van der Rohe, built for 1929 Expo)
	Art museum (models of structures/architecture by Richard Rogers)
	La Sagrada Familia (by Antonio Gaudi)
	Park Guell (by Antonio Gaudi)
	La Pedrera of Caixa Catalunya (by Antonio Gaudi)
	Agbar Tower (by Jean Nouvel)
	BOPBAA – Architects
	Miralles / Tagliabue, EMBT
	MBM Architects

In addition to the historic stone buttressed cathedral and stone and iron bridges of Seville (see Table 1), the group toured two active construction sites; the new campus headquarters of Abengoa Corporation (see Figure 2) by London Architect Richard Rogers and ARUP engineering and the Plaza de Mayor Metropol Parasol by Jurgen Meyer Architects and ARUP (see Figure 3). Abengoa, a modernist concrete, steel and glass construction in the powerful sun of Seville revealed the product of a careful interface between architect and engineer in the integration of sustainable building systems (green roofs, solar strategies and chilled radiant cooling) and development of self shading strategies that would effectively permit a seemingly contradictory glass box in its hot dry climate. Our visit to the Plaza de Mayor Metropol Parasol

provided an entirely different set of exposures; from the implications of inserting a completely foreign mushroom shaped form into an historic urban setting over ancient Roman ruins, to the structuring and construction of complex (non-Cartesian) forms. Provoked by the necessity to minimize damage to 2000-year old masonry structures, a creative foundation solution comprised of tied arches (see Figure 3) spanned and protected the ruin while creating a publicly accessible archeological site unanticipated at the start of the project. Donning hardhats, ARUP site engineer Jan-Peter Koppitz presented the group with those aspects of the project that required strict coordination between both architect and engineer, including, but not limited to, the use of engineered wood to structure the multi-story mushroom-shaped parasol forms above the raised market plinth – something not achievable in the classroom (see Figure 4).

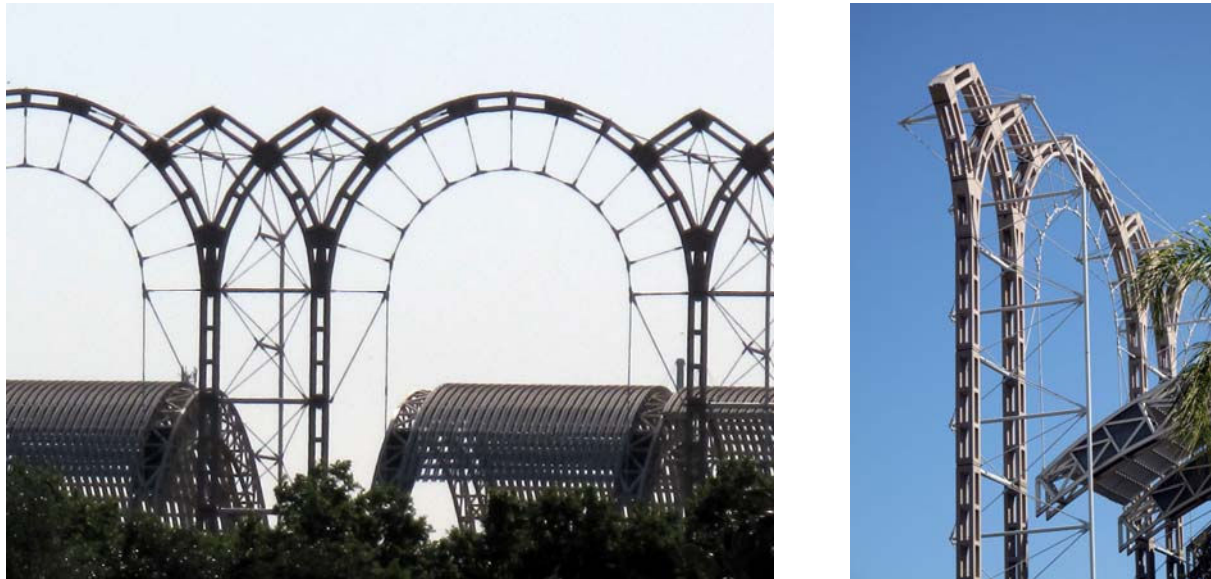


Figure 1 Pavilion of the Future, MBM Architects, ARUP Engineering

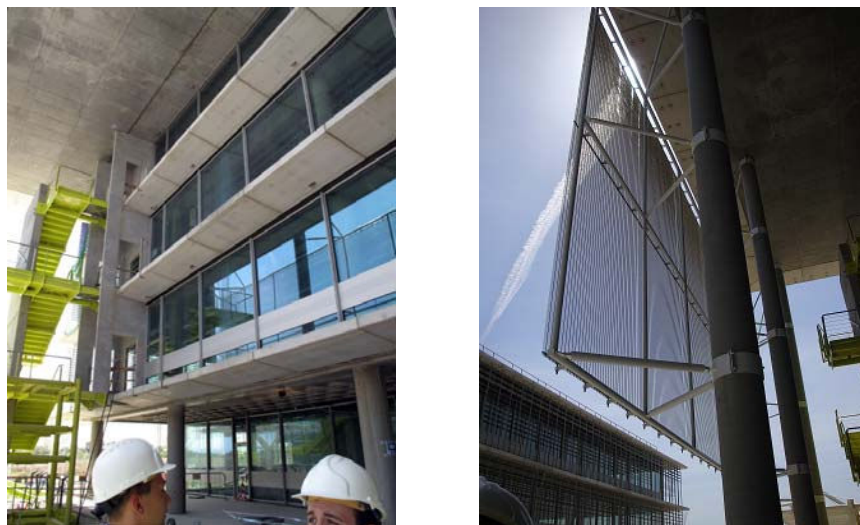


Figure 2 Abengoa Headquarters, Richard Rogers Architect, ARUP Engineering



(a) Travel-study workshop group on platform of Parasol



(b) Arches spanning over Roman Ruins

Figure 3 Plaza de Mayor Metropol Parasol – Jurgen Meyer Architect, ARUP Engineering



Figure 4 Plaza de Mayor – Wooden Superstructure

It was the sun-bleached, fabric-shaded streets of Seville that provided the stimulus for the collaborative design project. Teams of two engineering and two architecture students each were charged with the design of a public sun and shade pavilion measuring approximately 40 x 30 meters. The student teams worked in their hotels, on trains, at cafes and pubs throughout the trip on an exercise that, as in each travel workshop, was designed to provoke active and engaged interaction that complemented the observational and conversational modes of its other components.

Madrid awakened the group to a different set of experiences highlighted by visits to Barajas Airport Terminal by Richard Rogers Architects and ARUP engineers (see Figure 5), which owing to British High Tech architecture, day lighting and environmental control strategies, expresses its structure in a series of three dimensional, brightly-colored pinned frames; to the Renia Sophia Museum extension by Architect Jean Nouvel (see Figure 6) which spans an enormous roof above old and new buildings to form a public place beneath; and the more modest, but no less complex, Caixa Forum by Architects Herzog and de Meuron which ‘raised’ an historic building above the public street level supported by a folded plate deck to create a cool shaded public entry to the exhibits above and within (see Figure 7). During each site visit, the group contemplated the project designs through observation and discussion regarding the possible intentions of the architect, the manner in which the structure was designed to resist gravitational and lateral loads, and how the load resisting mechanisms were integrated within the architectural concept. An office seminar at the office of Reid Fenwick Architect and a day-trip to the then nearly completed Faustino Winery by Foster and Partners with ARUP engineering (see Figure 8) illustrated yet another lesson; that of the intimate relationship between programmatic performance and form.



Figure 5 Barajas Airport, Richard Rogers Architect, ARUP engineers

In Barcelona, the workshop concluded with visits to several of Miralles/Tagliabue EMBT’s projects before an office tour and talk (see Figure 9), visits to Antonio Gaudi’s La Sagrada Familia, Park Guell, and La Pedrera de Caixa Catalunya (see Figures 10, 11, and 12, respectively), home of the hanging chain catenary models used in the integrated structural / architectural formation of space and form that characterized Gaudi’s work (see Figure 13).

A final visit to the office of MBM Architects, designers of the Pavilion of the Future, concluded the workshop with a discussion focused on the project where it had begun 10 days prior. On the last evening, in the hotel lounge, teams presented their sun and shade pavilions, with an emphasis

not merely on the product, but on the process of engaging an expanded interdisciplinary agenda, to discover how to work effectively across disciplines in imagining and realizing ambitious architectural / engineering projects (see Figure 14).



Figure 6 Renia Sophia Extension Roof, Jean Nouvel Architect



Figure 7 Caixa Forum, Herzog and de Meuron

In general, students have found the Bedford Program, and particularly the travel-study workshop, to be a highlight of their undergraduate education. Engineering students are introduced to ambitious architectural practices and buildings with emphasis on the exciting challenges in the building engineering sector and several graduates of the program are now placed in these practices worldwide. Although a rigorous assessment of the success of the program has not been

performed, informal feedback from students has clearly indicated that the program is highly beneficial in terms of reducing barriers between architecture and engineering collaboration and thus enabling students to function well in multi-disciplinary teams as both leaders and contributors (leaders when the focus of discussion is on their discipline and contributors when the focus is on the other discipline). Furthermore, with regard to the travel-study workshop, the requirement for the students to maintain a journal throughout the duration of the workshop and to present their project designs both on paper and orally, has contributed to improving their communication skills in written, oral, and visual formats.



Figure 8 Faustino Winery, Foster and Partners + ARUP



Figure 9 Miralles / Tagliabue EMBT office visit

Future Goals of Program

Building on the success of the program in educating the next-generation of building engineers interested in progressive architectural practice and architects aware of the invaluable input of creative engineering early in the design process, the Bedford initiatives will continue to directly affect approximately 60 architecture and engineering students per year as it does in its current

mode. With concerted efforts to expand its influence to a broader set of architecture and engineering students and faculty, increased numbers of linkages between courses, faculty and collaborative projects are being developed. Efforts to consider earlier exposure to first and second year students are also being considered as a means of stimulating awareness earlier in the student's respective curriculum.



Figure 10 La Sagrada Família, Antonio Gaudi



Figure 11 Park Güell, Antonio Gaudi



Figure 12 La Pedrera de Caixa Catalunya, Antonio Gaudi

As mentioned previously, a formal assessment to determine the effectiveness of the Bedford Program has not yet been completed. It is anticipated that such an assessment will take place in the near future and will focus on specific outcomes of the program. Due to the relatively small number of students that participate in the Bedford Program, the assessment of the outcomes will likely be performed via interviews and surveys. These assessments would be performed for each of the three components of the program and would likely focus on the ability of the students to function well in multi-disciplinary teams as both leaders and contributors and their ability to communicate effectively in written, oral, and visual formats. The extent to which the outcomes are achieved will be evaluated with the intent of presenting the results in a future paper and will also be used in a publication about the program and its accomplishments, to further disseminate and promote its expansion as a model for greater public discussion and adoption. To expand the discourse to a broader audience both within the University and internationally, a bi-annual symposium focused on relevant contemporary topics in Architecture and Engineering is proposed, one that will be hosted at Rensselaer, paneled by former Bedford Professors and select guests, and published in symposium proceedings.

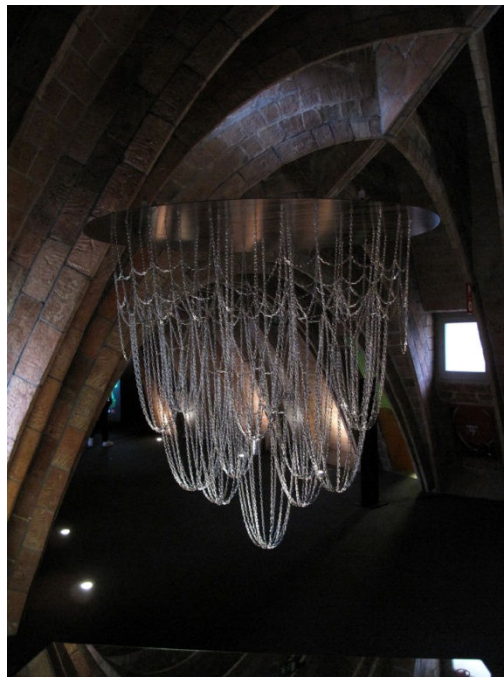


Figure 13 Catenary Models, Antonio Gaudi

Summary

This paper has described an ongoing initiative to engage architecture and engineering students in collaborative work leading to an appreciation for what can be accomplished by recognizing the strengths that each discipline brings to a project and integrating the efforts of those disciplines. To date, the program has proven to be highly beneficial both to students and faculty by virtue of the linkages and networks that are being made with some of the world's best building engineering and architectural practices, linkages which have spawned additional collaborations

and courses, provided professional opportunities for students and created a culture of collaboration between disciplines and departments. Furthermore, informal feedback from the student participants reveals that the students derive great benefit from collaborating with their peers and find the travel-study workshop to be an excellent culminating educational experience.



(a) Architects: Clayton and Smith
Engineers: Marden and Twomey



(b) Architects: Kafel and Albizu
Engineers: Vayda and Mencarelli



(c) Architects: Tan and Burke
Engineers: Fioravanti and Guo



(d) Visiting Bedford Professor Leading
Discussion on Design Project

Figure 14 Team Sun and Shade Pavilion Proposals

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