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Jim Roche
Technological University Dublin, jim.roche@tudublin.ie

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The space between the notes – reflections on a collaborative student project on the work of Irish engineer Peter Rice

Jim Roche
jim.roche@dit.ie

Abstract
This paper is a reflection on a collaborative pedagogic process at the Dublin School of Architecture (DSA), Dublin Institute of Technology, on aspects of the work of Irish engineer Peter Rice (1935–92) who, in his short life, combined contemporary tools of computer-analysis and mathematics with a careful sensibility for materials, natural light and structure. He collaborated with many famous architectural practices on what have now become iconic works of architecture such as the Sydney Opera House, the Centre Pompidou, Lloyds of London and Kansai Airport. The collaborative project on his work was undertaken at DSA in the fall semester of 2012 involving 3rd and 4th year architectural students who were asked to research and analyze a total of eleven of Rice’s projects and represent their findings through freehand sketches and physical and digital models. In addition six 4th year architectural students collaborated with the architectural technology students and each wrote an analytical text on one of the projects for their History Theory Criticism module. The paper will explore both the process undertaken by the students, some of the results and four critical structural themes that underpin much of Rice’s attitude to an integrated approach to structure and architecture.

Key words: structure, architecture, integration, collaboration, multi-disciplinary
Like his great predecessors, whether Brunel or Brunelleschi, Peter Rice is able to step outside the confines of his professional training, transferring technical problems into practical solutions. His design combines order with delight, science with art.

Richard Rogers Architect

I would distinguish the difference between the engineer and the architect by saying the architect’s response is primarily creative, whereas the engineer’s is essentially inventive.

Peter Rice

Introduction
When architect, and board member of the National College of Art and Design, Seán O Laoire reviewed the analytical drawings and models by third year architectural students from the Structure and Fabric Project at the DSA SHOW13 (Fig. 1) he suggested that we should undertake a project on the work of Peter Rice that would complement the planned Office of Public Works (OPW) exhibition of Rice’s work at Farmleigh House. The staff in 3rd and 4th year architectural technology undertook this challenge. It was clear to us that Rice’s innovations in materials and design greatly advanced the nature of modern architecture as he stretched the boundaries of materials and instability. Such a study would thus enhance the students' learning of the integral nature of structure and architecture.

Eleven of Rice’s projects were chosen, students were divided into groups of 5-7, with both years equally represented in each group, and asked to systematically research, analyse, reverse engineer under specific topics and represent their findings about the building and the collaborative process through annotated sketches, computer modelling and physical models. For three weeks joint studio sessions were held as well as workshops and reviews with invited guests Seán O Laoire, Peter Flynn from Arups and Gerard Crowley from Gerard Modelmakers, along with DSA staff. (Fig. 2)
Through their explorations the students learned much and taught us all about the buildings but also about the collaborative process between architect, engineer, other related professionals and industry, a process Peter Rice believed essential to the success of each project. In the Centre Pompidou project for example, he not only ensured the building held together but he was “the gel necessary” in holding the team together.

Multiple themes dominating Rice’s work became evident in the students’ analysis and in the joint studio sessions and workshops. This paper will focus on four of these:

- the lightness of the structure across huge spans
- the innovative choice of materials
- the expression of the joint
- the multi-disciplinary collaboration

These themes were avidly discussed, much understood and their representations resolved through the studio sessions, the reviews and at a marathon 6-hour long non-stop workshop with structural engineer Peter Flynn from ARUPs and then DSA Structures lecturer John Lauder (Fig. 2).

LIGHTNESS OF STRUCTURE
Peter Rice saw every structural problem as an opportunity. Instead of thinking about what could go wrong as must engineers do (often understandably!), Rice thought “What can I do?” In the Sydney Opera House the structure, and hence the dead weight, of the enclosing shells, is lightened by creating voids in both the tapering curved ribbed beams (which change in section from solid rectangular at the bottom to hollow y-shaped at the top) and the enclosing hollowed out interlocking secondary structural chevrons. The big challenge for this student group was both understanding and representing the complex curved geometry of the intersecting shells and the equally complex assembly process both of which were well represented with sketches and two exquisite models. (Fig. 3)
In Centre Pompidou the truss girder spanning 45 meters is lightened by sub-dividing both the top and bottom chords into two and through its clever connections to the cast steel rocker beams known as gerberettes. The initial approach of this student group, and indeed the studio staff, was to focus on modeling the gerberette, but at the structural workshop with ARUP Engineer Peter Flynn it was agreed that a bigger challenge, and one equally representative of Rice’s contribution, was to model one whole bay of the entire building depth - a decision proving multidisciplinary collaboration at work. Student Andrei Triffo’s physical and Revit models (Fig. 4) capture the combined elegance of both the double boom truss and the gerberette ensemble.
Many more examples of structural lightness, efficiency and elegance were learned such as the choice of the inverted light U-beam and waffle slab to span and keep clear the floor plate of the Lloyd’s Building the classic case of the balanced structure (like an elderly person with two shopping bags, as Peter Flynn noted!) in the rather expressive compressive and tensile structure of the Pat’s Centre factory, in the novel combination of stone and steel cabling for the giant columns of the Pavilion of the Future in Seville, the ever so light cable trusses developed for La Villette Pavilion in Paris, and lastly in the gigantic curved triangular trusses of Kansai Airport, their precise sectional shape determined by the needs of internal airflow, held either end by sliding joints onto angled tree columns which sit on base stub columns which can be (and already have been) jacked up as the manufactured island settles, the latter splendidly captured in Ian Plunkett’s, Ross Harrell’s and other students’ models and sketches (Fig. 5).
INNOVATIVE CHOICE OF MATERIALS

In his book *An Engineer Imagines* Peter Rice writes:

“The search for an authentic character of a material is at the heart of any approach to engineering design ….. Innovation should have a real purpose and be contributing to the project.”

In all the projects studied by the students the choice of materials is key to the success of the symbiosis between architecture and engineering. In the IBM Pavilion, polycarbonate was chosen for the skin due to its clear non-distorting, transparent properties and its robustness, a vital property to withstand the constant assembly, dis-assembly and onerous travelling of the many components. Polycarbonate’s structural weakness was compensated for by the strength of the joints made from aluminium and timber captured in exquisite sketches and models by students Akvile Klapautauskaite, Mark Doyle, James Maguire and their team (Fig. 6).

One of the most innovative choices of materials in Rice’s work is that of ferro-cement for the light reflecting leaves of the Menil Museum in Huston, Texas. Invented by architect Luigi Nervi, but never before used in buildings, Rice and Renzo Piano had experimented with ferro-cement before deciding to use it at the Menil Museum. The process of its making effectively involves trowelling layers of plaster on to layers of reinforcement thus allowing in this crafting technique for very thin sculptural forms (Fig. 7). The challenge at Menil was that the sculptural leaves had to be so precise in order to control the lighting conditions so, after a lengthy process of analysis, they were instead cast in fiberglass moulds and then finished by trowel.
EXPRESSION OF THE JOINTS

Rice once drew a wonderful analogy between music and structure when he said; “the space between the notes is just as important as the notes themselves”. Just as silences in a Harold Pinter play are such an essential ingredient of the overall theatrical experience, the spaces formed in and around the structural joints in Rice’s work become an essential part of the architectural ensemble. Perhaps this is best expressed in the way the gerberettes connect to, but never touch, the columns in the Pompidou Centre, while the main truss connects ever so lightly to one end of the gerberette. The spatially exemplified load distribution in this architectural ensemble is well captured by Andrei Triffo’s exploded Revit model and in the analytical sketches by Anna Cullen and other members of that group (Fig.8)

In the traveling IBM Pavilion, cast aluminium brackets join tapered laminated timber truss chords in an expressive celebration of the joint. The joint is key to the whole structure, which is a 12-meter wide 3-pinned arch, and is vividly celebrated here. With minimal published information available this student team dissected the minutiae of the structural jointing of this
pavilion and represented it beautifully through balsa models and expressive exploded 3-d sketches (Fig. 9).

Figure 9: DSA Students’ Akvile Klapautauskaite, Mark Doyle, James Maguire and their team’s drawings detail joints on the IBM Pavilion

In is in this fascination with the expression of the joint that we see Rice’s preoccupation with the tactile, the desire to express the evidence of those who build - the *traces de la main* as he called it. As he wrote in his book:

“This is the positive role for the engineer’s genius and skill: to use their understanding of materials and structure to make real the presence of the materials in use in the building, so that people warm to them, want to touch them, feel a sense of the material itself and of the people who made and designed it. To do this we have to avoid the worst excesses of the industrial hegemony. To maintain the feeling that it was the designer, and not industry and its available options, that decided, is one essential ingredient of seeking a tactile *traces de la main* solution.”

This, and his legendary story of the elderly woman fondly stroking the gerberette at Centre Pompidou, shows Rice’s linkage with both the Ruskinian tradition of expression of the making and the haptic experience of architecture as promulgated by Juhani Palasmaa and others.

**MULTI-DISCIPLINARY COLLABORATION**

Multiple examples abound among the projects analysed by the students of multi-disciplinary collaboration including for example the collaboration between Rice, Piano and Arup Service Engineers on the Menil Museum. Piano’s early sketch of the quadrant reflector became, with Rice’s influence, a stretched sculpted leaf made from cast ferro-cement, a material heretofore not used in architecture. The resultant leaf functionally combines structure - in forming the bottom boom of the truss, and environmental engineering - as a giant light reflector and distributor of fresh air, in an elegant architectural ensemble hovering high over the museum space under the glass roof.
Dominika Zubianka’s (Figs. 10 & 11) freehand analytical sketches of the entire ensemble give it an eerily skeletal feel while this team’s model (sadly not cast, but still cleverly made from painted perspex and car filler with help from Gerard Crowley Modelmakers!) perfectly captures the leaf’s elegant sculptural quality.

The analytical workbooks, A1 posters and models by the architectural technology students along with analytical texts on Rice’s work by fourth year architecture students and an interpretative model of the Full Moon Theatre, Peter Rice’s last project, by then recent DSA architectural graduates Samuel Teo and Mark Walker were publicly exhibited for two weeks at the exhibition Learning from Peter Rice – Under the Skin at the NCAD Gallery in October 2013 (Fig. 12). On the opening night the architectural technology students’ work was particularly acknowledged as demonstrating a clear understanding of the immense engineering skills and the collaborative working method of Peter Rice. A colloquium on the night explored the relevance of Rice’s legacy on education and practice in Architecture, Engineering and Design with many of the speakers acknowledging the different approaches and use of language between architects and engineers but calling for more collaboration, including during their education, between the two disciplines.
The students and staff could have learned all described here and much more about these projects and Rice’s working method from books but it was really stimulating when students explained it and represented it well, having interrogated the projects in detail – a classic example of learning through doing. Both students and staff learned much from this collaborative analysis, from each other’s critiques, from our visiting guests but most of all - we learned from Peter Rice.

It is intended that the students’ work will find a permanent home in the County Museum in Dundalk, Ireland - a fitting tribute to their efforts and to the legacy of one of Dundalk’s famous sons.

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Students

Staff
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David Wright

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Cormac Allen, Assistant Head Discipline of Architectural Technology, DSA
Ger Crowley, Modelmaker
Peter Flynn, Engineer ARUP
Seán O Laoire, Architect

Clients
Declan Mc Gonagle, Director, National College of Art and Design, Dublin
Seán O Laoire Architect, Board Member, National College of Art and Design, Dublin