The Work of Foster and Partners Specialist Modelling Group

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Abstract

The following paper is a brief introduction to Foster and Partners and the work of its Specialist Modelling Group (SMG). The SMG was formed in 1997 and has been involved in over 100 projects. The SMG expertise encompasses architecture, art, math and geometry, environmental analysis, geography, programming and computation, urban planning, and rapid prototyping. The SMG brief is to carry out project-driven research and development. The group consults in the area of project workflow, advanced three-dimensional modelling techniques, and the creation of custom digital tools. The specialists in the team are a new breed of architectural designer, requiring an education based in design, math, geometry, computing, and analysis.

1. Foster and Partners

Foster and Partners is an international studio for architecture, planning and design led by Norman Foster and a group of Senior Partners. Norman Foster's philosophy of integration can be seen in the way the practice's London design studio works; it is essentially one large open space, shared equally by everyone, and free of subdivisions to encourage good communication between the many people who come together there. The practice's work ranges in scale from the largest construction project on the planet, Beijing International airport to its smallest commission, a range of door furniture. The scope of its work includes masterplans for cities, the design of buildings, interior and product design, graphics and exhibitions. These can be found throughout the world, from Britain, Europe and Scandinavia to the United States, Hong Kong, Japan, China, Malaysia, Saudi Arabia and Australia.

In developing and communicating the design concept, the project teams are supported by a broad spectrum of in-house disciplines. The advent of digital technologies has allowed the practice to design and build structures with complex geometric forms that would not have been feasible as little as twenty years ago. The practice's in-house Specialist Modelling Group (SMG) has introduced a highly advanced three-dimensional computer modelling capability that allows architects both to explore design solutions rapidly and to communicate data to consultants and contractors

2. The Specialist Modelling Group

The Specialist Modelling Group (SMG) was formed in 1997 and is lead by Hugh Whitehead, a Partner at Foster and Partners. Some of the over 100 projects that the SMG has made a contribution to include the Swiss Re Headquarters, the Sage Gateshead Music Centre, London City Hall, Albion Riverside residences, the Chesa Futura apartment building, and the new Beijing International Airport.

Figure 1: Swiss Re Headquarters, London City Hall, Chesa Futura Residences

The Specialist Modelling Group currently has seven members and has within it expertise in complex geometry, environmental simulation, parametric design, computer programming, and rapid prototyping. The SMG brief is to carry out project-driven research and development in the intense design environment of the Foster and Partners office. The group consults in the areas of project workflow, digital techniques, and the creation of custom CAD tools. These specialists work with project teams on either a short or long term basis and are involved with projects from concept design through to fabrication.

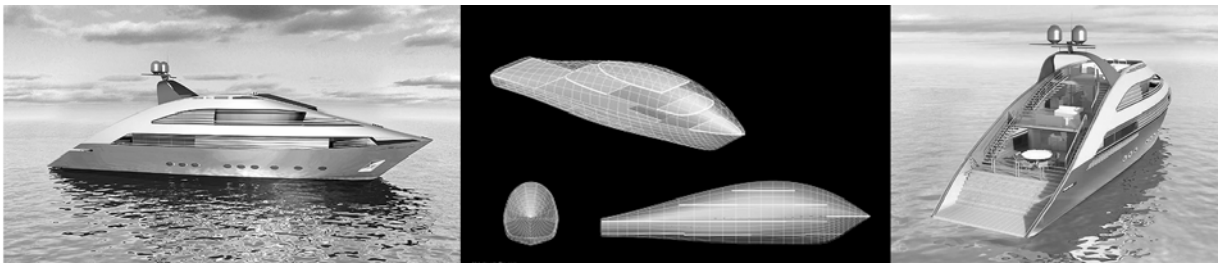

Figure 2: Parametric Design

One of the primary goals of the Specialist Modelling Group is to develop control mechanisms that drive geometry in response to relationships. These control mechanisms can be parametric models or custom programmed scripts. The CAD geometry that these mechanisms are driving responds to the constraints acting on the architectural design. These digital design tools must be flexible to allow designs to make dramatic shifts as the solution space is explored. Through the use of these techniques the designer is presented with feedback about the design through dynamic reporting, analysis, and evaluation. This system can rapidly generate comparative options. The evolution of the design concept starts with open-ended exploration and progresses towards a specific and detailed geometric definition. The linking of the parametric model to simulation and analysis tools is necessary to produce a design that responds to performance criteria. The use of rapid prototyping technology closes the loop in the digital design

process by recognizing the fact that key decisions are still made by the designer from the study of physical models.

Complex arrangements of three dimensional surfaces and solids are generated using parametric tools and generative programmed scripts. The controlling variables of these tools respect design constraints and proportional relationships. Parametric plans and sections are produced as templates specific to each project, for use by the design teams, while programmed scripts are produced to either perform a specific task, or as a general tool that can be used on many projects. For example, custom in-house software can produce mathematical surfaces while another can populate these surfaces with structural and cladding components. These panels can be coded and referenced in the 3D model so that they can be automatically laid out, unfolded and scheduled. Designs are rationalised as a precursor to communication with consultants and fabricators. The setting out geometry of a design is specified in a method statement, which describes a sequence of geometric procedures. The method statement is to be used by consultants and subcontractors and provides the framework for the validation of all consultants and subcontractors work.

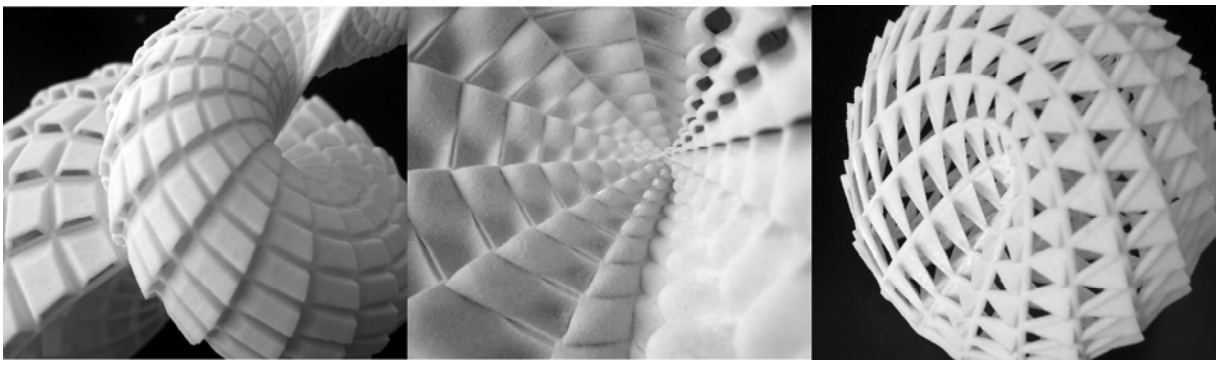

Figure 3: Generative Design: Mathematical Surfaces Populated with Structure and Cladding

3. The SmartGeometry Group

The SmartGeometry Group is an independent organisation whose aim is to further advanced education and research in the area of advanced 3D CAD applications. The group is dedicated to educating the construction professions in the new skills which will be required to use these new systems effectively. The SmartGeometry Group includes Lars Hesselgren (KPF), Hugh Whitehead (Foster and Partners), J Parrish (Arup Sport) and Robert Aish (Bentley). They are all pioneers of parametric modelling and digital technologies as applied to architecture.

Currently SmartGeometry's development efforts are focused on the new Generative Components technology being created by Robert Aish at Bentley Systems. The group has been running series of schools and seminars where this new technology is being explored both in the context of highly experienced professionals, and in advanced educational institutions. The SmartGeometry conferences bring together highly skilled professionals and educators from all over the world. The students and tutors participate in lectures and workshops focussing on advanced 3D parametric modelling and the programming of custom generative scripts. These workshops are one of the few opportunities for professionals to freely share ideas, tools, and techniques that relate geometry to architecture.

4. The Emergence of the Digital Design Specialist in Architecture

Architectural education must respond to the changing nature of the profession to accommodate the emergence of the Digital Design Specialist. Architects are not trained in the necessary skills and, as a result, one of the roles of the SMG is the education of architects in the use of digital techniques and the role of geometry in design of buildings. While many of these tools and techniques are new to architecture, they are currently used in other disciplines such as product design, aircraft manufacture, mathematics, and computer science.

The architect must understand the constraints that can act upon an architectural design and be able to make inspired and creative decisions that respond to these constraints. A successful way to explore a new design concept is the translation of the sketch into a parametric model. The parametric model should capture the designer's intent and involves the careful consideration of the controlling parameters and variables. The architect must understand of how geometric entities (linear elements, surfaces, solids) are created and controlled.

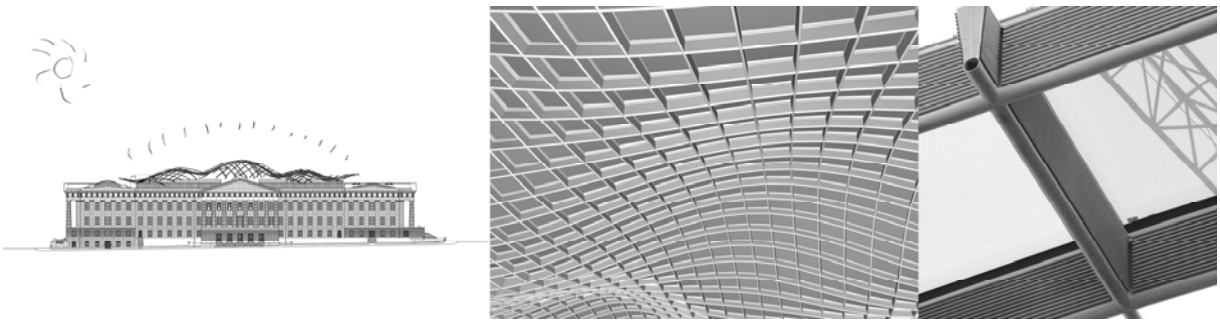

Figure 4: Sketch to Digital Design Model to Building: Smithsonian Courtyard Enclosure

Computer programming is becoming an increasingly valuable tool for these design specialists. The design logic for a project can be used as the basis of a computer program that can rapidly generate many options and large numbers of elements. In order to create a performance based model the digital design specialist needs to understand the analysis method. This can require one of many different skills depending on what aspect of building performance is being investigated. The designer must work with a broad range of consultants and have knowledge of specific disciplines previously considered non-architectural such as environmental analysis and form finding.

The new digital design specialists use geometry as a means of description and as a way to harness the complexity of a building design. Geometry is used to rationalise designs instead of being used to create more elaborate formal propositions. Increases in computational power and advances in digital fabrication have introduced the potential for mass-customisation in architecture. In order to properly take advantage of these new technologies, the designer must be able to design and generate the adaptive components, understand the method by which they will be fabricated, and have the ability to communicate the design information.

There is a new range of skills that is increasingly relevant to the practice of architecture. Digital tools and techniques are now used to solve the problems faced by architects and designers in the building industry. The new digital design specialist must have the ability to use science in an artistic manner. These designers must be able to imaginatively combine knowledge of building performance and fabrication methods with geometry and computer science to create beautiful architecture that responds intelligently to its environment.