WESTMINSTER

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Output 3 (Design)

GENERATIVE COMPS

Martin, Andrei + Yau, Andrew (2006)
Generative Components research / 2006 Beijing Biennale exhibition

General Description:

Generative Components (GC) is the name given to a new kind of computer-aided-design software being pioneered by Bentley Microstation, and which over the last few years has being beta-tested by leading international architectural practices such as Gehry Partners, Foster & Partners, Morphosis or Kohn Pedersen Fox, and by leading engineering firms like Arup Engineers - as well as in educational institutions like MIT and Columbia University in the USA, and in Britain the University of Westminster or the Architectural Association's Design Research Laboratory. In basic terms, the aim of GC is to switch architects away from previous types of digital design software – which have relied on points and vectors, and thus simulate analogue drawing techniques – and replace this with the algorithm-based, parametric modelling of more advanced software which can rapidly generate a number of alternative design proposals once it is fed a set of defined input parameters. One of the advantages of GC is that allows a chance to script and use programming skills to enhance what is otherwise a comprehensive and integrated package, allowing customisation to a degree not available before in mass-produced digital design software. It is essentially an explorative and self-defining tool, and thus constitutes a sea-change in the way that digital design can be conceived and executed in architecture. Bentley is soon to announce the launch of GC through a 90-day free test download.

Urban Future Organization (UFO) is an internationally networked architectural practice which is actively involved in advanced digital design and fabrication. In terms of its own design work, it creates proposals which use free-form, fluid and linear architectural forms. This aim is being pushed forward by the search for new methods of digital design and manufacturing in architecture, and specifically in this goal - as a new form of digital input - it is now starting to use Generative Components as well. Both Martin and Yau are leading the teaching of GC at Westminster University through their postgraduate design studio there, as well as spearheading its use for test projects within UFO.

Research Questions:

The primary research issues in the Generative Components initiative include:

(1) How to use such an innovative piece of software in a creative way that can extend the possibilities of architectural education, as well as enhancing the kinds of projects that students might produce, and the skill-sets they might learn.

(2) How best to introduce GC into the practice environment, given its broad ability to span from the very earliest design concept stage through to detailed design and then the actual fabrication of complex double-curved components for buildings.

Thus the core of UFO's research work behind the Generative Components project lies in how the symbiotic relationship between architectural education and practice can help to develop cutting-edge digital design. In this aim, Martin and Yau at UFO have benefitted greatly from input at Bentley - most notably Robert Aish, who pioneered the beta-testing of GC - and colleagues who are teaching at the AA, MIT, Columbia and elsewhere.

Aims/Objectives:

(1) To pursue the teaching / development of Generative Components in an educational environment at Westminster University, using students' work to learn about the software.

Martin and Yau have taught the use of GC in their postgraduate design studio at Westminster for the past three years now, gradually building up greater expertise amongst themselves and the student body. The output now is extremely advanced, as can be seen in the sample images attached to this document, and compares exactly with the very best work being producing in other cutting-edge digital teaching environments in London or the USA. A special exhibition of the GC work was mounted as part of the Westminster end-of-year exhibition in June 2007, which was attended and viewed favourably by Robert Aish of Bentley, as well as others. A series of special student workshops on using GC software(also open to interested practitioners) has been held at places like Westminster, AA, UCL and Cambridge University over the past two years.

(2) To investigate the potential of a new kind of digital design tool from its early development stage, with a view to shaping it better for eventual use by the profession.

As mentioned, Generative Components is software that captures and graphically presents design components as well as the abstract relationships between them. This capability lets GC go beyond merely making geometry explicit; it can make design intent explicit as well. Although designers using GC are still working graphically, as in previous software programs, with their input being based on their intuition and experience in architectural design, with the advent of GC their work can be captured in a more logical and precise form. Above all, GC is an associative and parametric modeling system that is able to be used by architects and engineers to automate the design processes and accelerate the production of various design iterations. It gives designers and engineers new ways to efficiently explore alternative building forms without manually building the detailed design model for each scenario; instead it uses the computing power of the machines to do this work rapidly and accurately. GC can also increase the efficiency of architects and engineers in managing conventional design and documentation.

(3) To investigate the capability of the Generative Components software in the case of architectural practice, using the work of UFO as a key test-bes.

A notable contribution by Martin and Yau, along with UFO colleagues, was the design panels they were asked to produce for the British section of the 2006 Beijing Biennale. In these, they conceived, designed and represented - using GC as the central tool - a new form of sinuous curvilinear skyscraper building in which a deliirious melted-honeycomb steel frame was to be cast under the digital production control of GC software. These Beijing panels are included in the attached images, and show the high degree of computing power and visual freedom that GC offers to architects. As yet, the use of GC in architectural practice has tended to be limited to such dreamy speculative projects, or else in more practical and focussed tasks such as honing the double-curved forms in real skyscrapers such as St Mary Axe by Foster & Partners, or the proposed Bishopsgate Tower by Kohn Pedersen Fox (the latter mainly under the direction of Lars Hesselgren).

(4) To utilise the open network and collaborative approach of the UFO practice.

Again, the loose network approach of UFO allows it a chance to engage in innovative and fundamental digital research, despite being far smaller than firms like Fosters or KPF.

Context:

Urban Future Organization (UFO) is heavily involved in the research and development of Generative Components, both through their practice's own design projects and their postgraduate teaching at the University of Westminster and elsewhere. In its interest in GC, it is clear that UFO wishes to expand the use of such cutting-edge software beyond the typical commerically-driven, mega-projects of firms like Arup, Foster & Partners or Kohn Pedersen Fox. Instead, UFO wishes to see a more experimental and open use of the latest software such as GC, thereby echoing the long-standing interest in generative design tools - often referred to as 'evolutionary design' or 'emergent software' - by more visionary figures such as John Frazer or Mark Burry. The use of GC can also be definitely seen as becoming another vital tool in UFO's aim to explore a range of quasi-Deleuzian concepts in architecture, primarily through a preference for smooth flowing spaces and folded structures, and an accompanying interest in the physics of complexity and current ecological paradigms.

In broader terms, the impact of GC on computer-aided-design of course remains to be seen - but as Bentley readily point out, it certainly has the potential to become a major new player in the field. While also in itself being yet another form of BIM (Building Information Management) software, due to the integrated nature by which the whole process can be taken from concept stage to design stage to production, and the fact that it builds on the Microstation platform, it is also clear that GC does allow architects to engage in greater aesthetic and design freedom than previous packages did. Perhaps the best way to express the intentions of GC is to reprint the statement paper produced by Robert Aish back in 2003, which set out the goals for the software while still in its earliest development stage, and is here appended to this document.

Research Methods:

As well as receiving the beta-testing version of Generative Components free from Bentley, since UFO had been selected as one of the outlets in education and practice that were to be used to assess and promote the new software, Martin and Yau in their research methods have needed to engage extensively in range of collaborative exercises and workshops with other figures in this emerging field. This has involved, for instance, the ongoing consultancy work of Andrei Martin at Kohn Pedersen Fox, and the arranging of joint workshop sessions at Westminster and other institutions as part of UFO's wider teaching in London schools, and their participation in special international workshops in the USA to analyse the natures and capabilites of GC - indeed the latest workshop session, in which Martin and Yau were deeply involved, was held in New York in November 2007, along with colleagues from Columbia University, MIT and elsewhere in the USA.

Crucially, the research of UFO into GC has also by necessity involved an interaction with students in the teaching environment of postgraduate design studios, and in special workshop open to students from all institutions. This signals a more open, collaborative mode of research, one which is less bound up with teacher-student divisions, and undoubtedly an approach which appeals to the more democratic practice philosophy proposed by firms like UFO. All these strands feed into a tight research loop, involving academics, students, cutting-edge practitioners, and the relevant staff at Bentley - a kind of feedback loop that was promoted long ago by cyberneticians, and which mimicks the internal feedback loops used in advanced software such as Generative Components.

Dissemination:

UFO's work in terms of developing Generative Components software was given special prominence in their exhibition stand in the 2006 Beijing Biennale, and some of their work was likewise included in the catalogue for that show. In addition, the output of UFO and its students using GC software – aspects in which both Martin and Yau are closely connected – has been displayed publicly in a number of other exhibitions in Europe, USA and Britain.

In addition, special workshops in the application of GC software were held at the University of Westminster in September 2005 and September 2006, organised in conjunction with Richard Difford in the Department of Architecture. There has also been widespread promotion of UFO's work and of others involved in the GC development network in a series of public presentations by the likes of Martin and Yau, as well as in the highly regarded 'Smart Geometries' conferences which have been held in recent years at the University of Cambridge and elsewhere.

Esteem Indicators:

The most important indicators for Urban Future Organization in terms of its esteem in helping to research into and develop GC software can be given as follows:

- Invited to participate and exhibit their GC work as part of their contribution to the British section of the 2006 Beijing Architectural Biennale
- Organised a well-received exhibition at Westminster University on their students' work in GC, largely for the benefit of key participants in the development process, and most notably Robert Aish of Bentley (June 2007)
- Specially invited to run a digital workshop at the Korean National University of Art, Seoul (July 2007)
- Involved in running workshops at Columbia University and other institutions in the East Coast of the USA

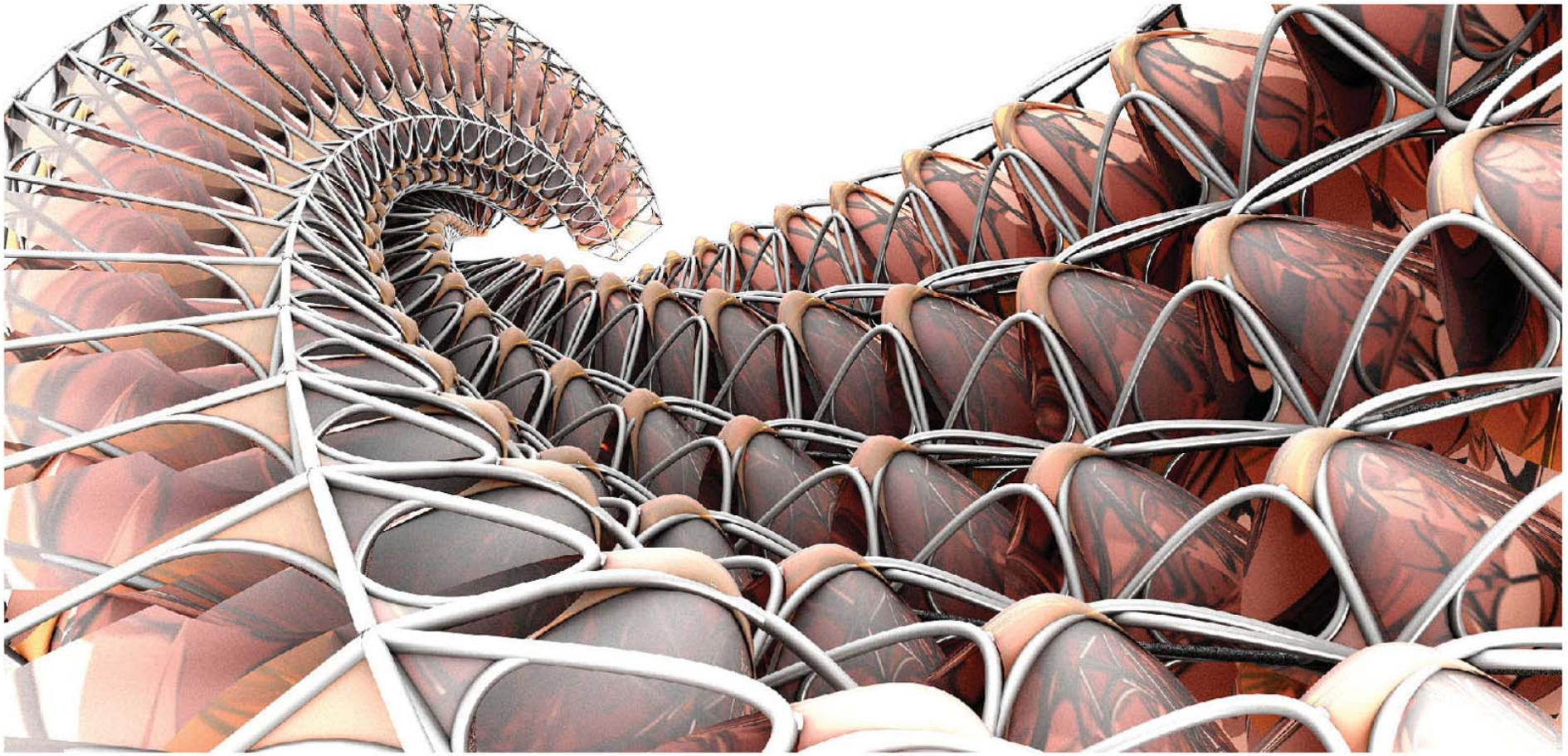


Image 1: Example of student work produced using Generative Components (GC) software (Paresh Chandegra)

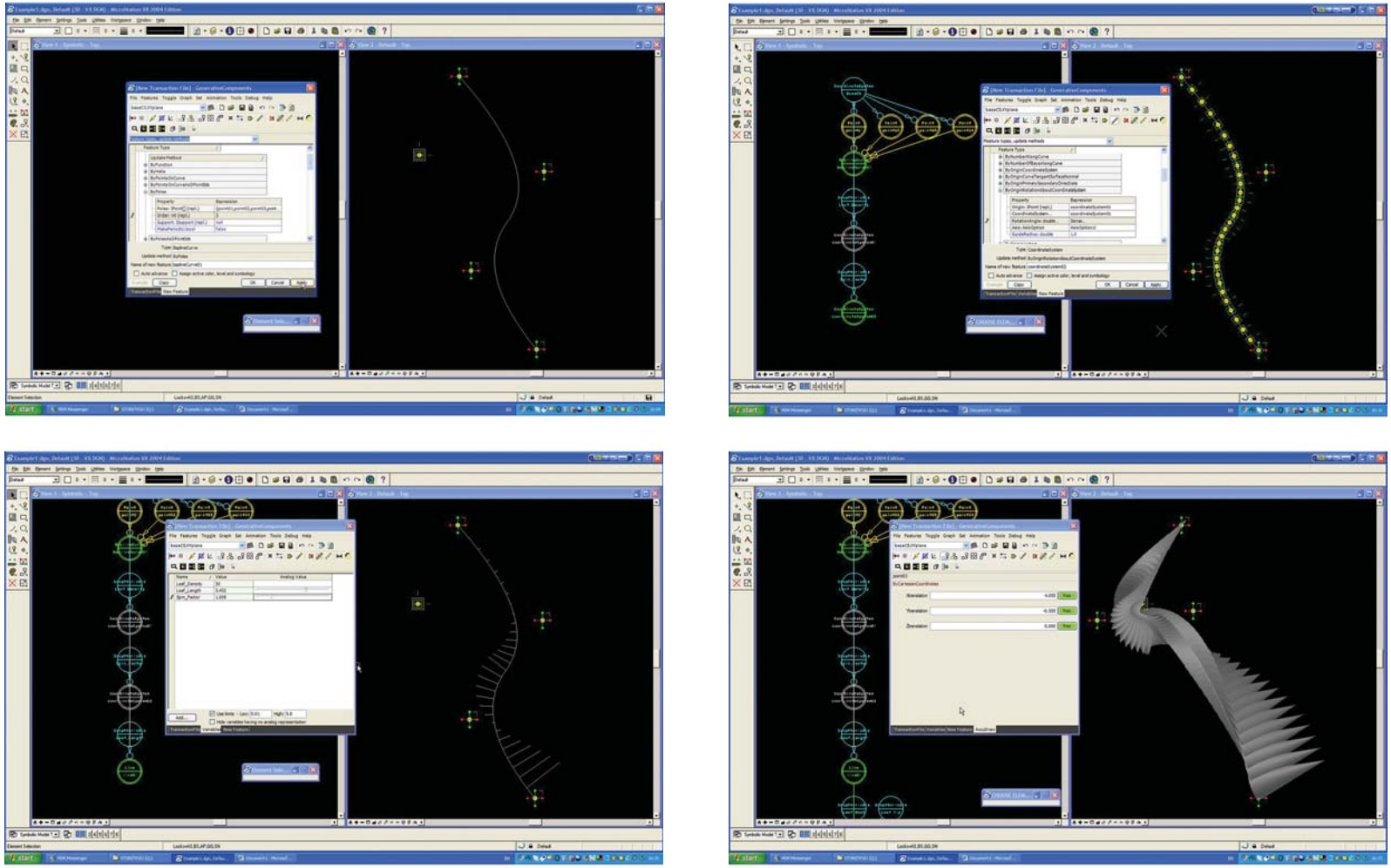


Image 2: Screen shots showing building up of a model using Generative Components software

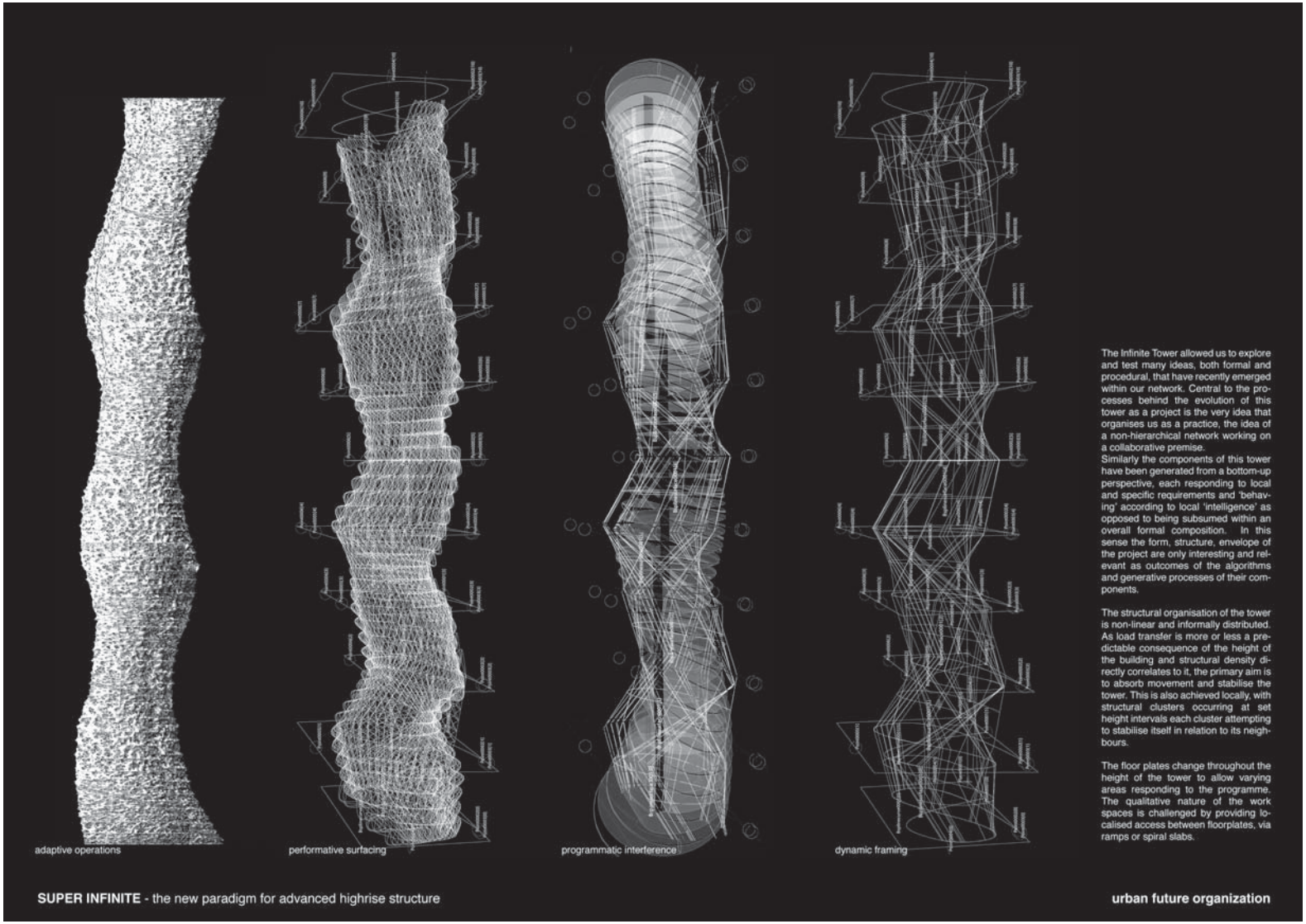


Image 3: UFO display panel for Beijing Biennale on a GC-generated tower

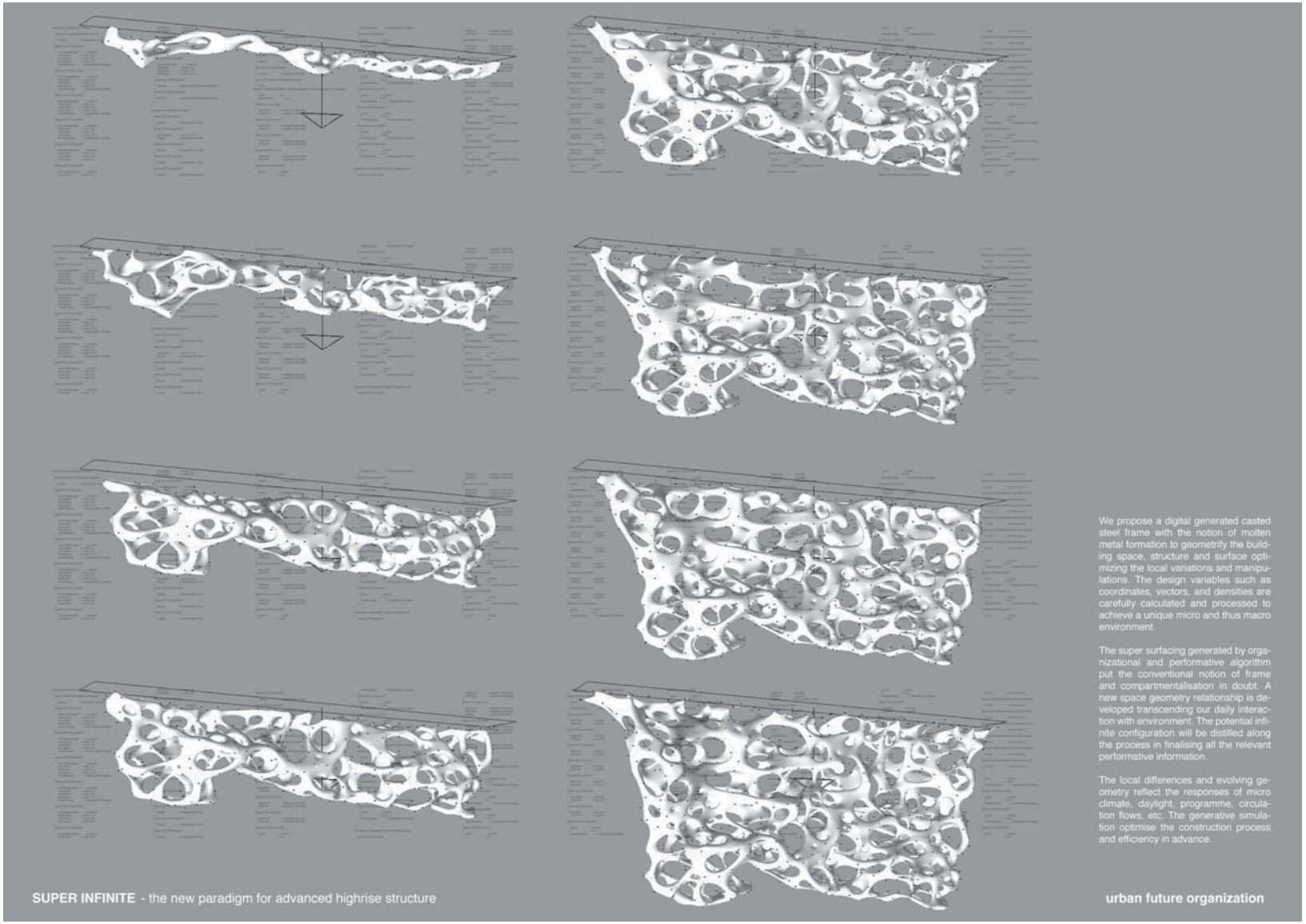


Image 4: UFO display panel for Beijing Biennale on digitally generated cast steel frame for high-rise tower

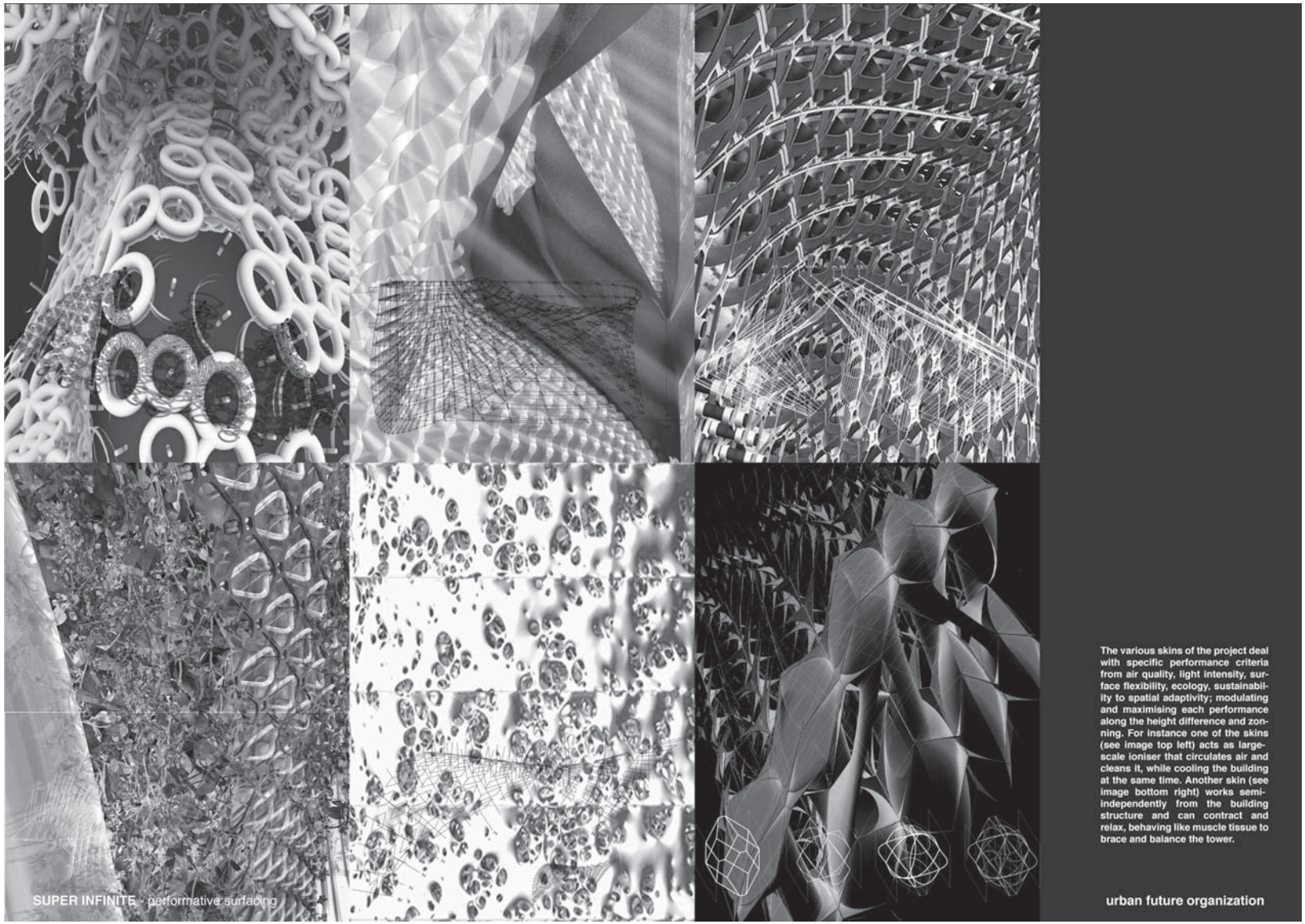


Image 5: Beijing Biennale panel on GC- generated skin for high-rise tower

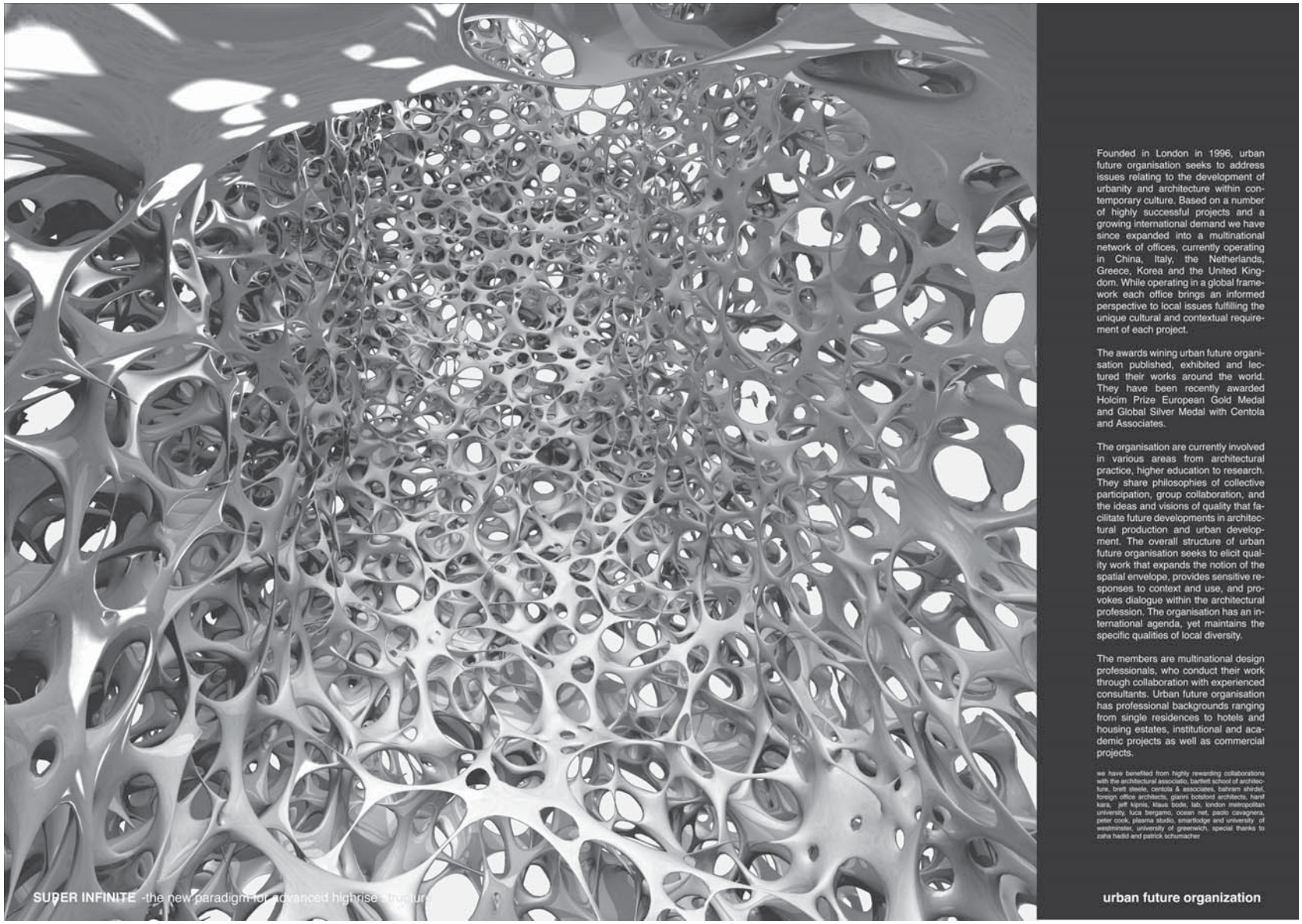


Image 6: Beijing Biennale panel about UFO, showing image of digitally-generated cast steel tower frame

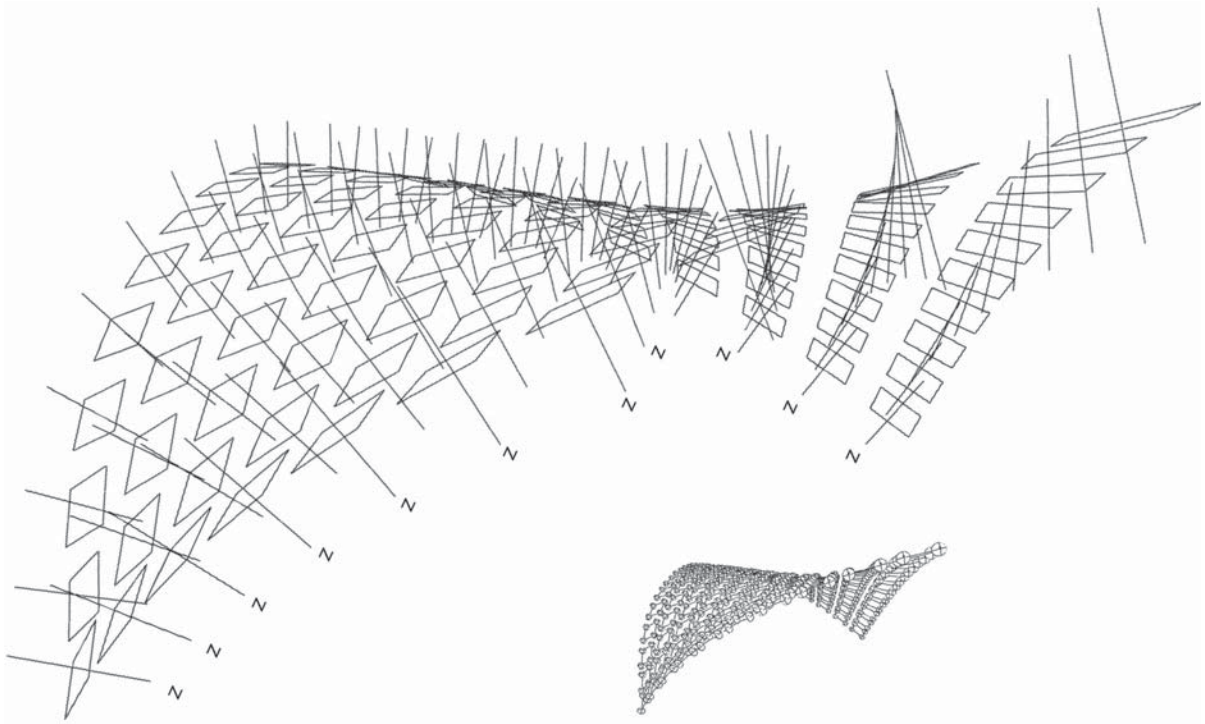
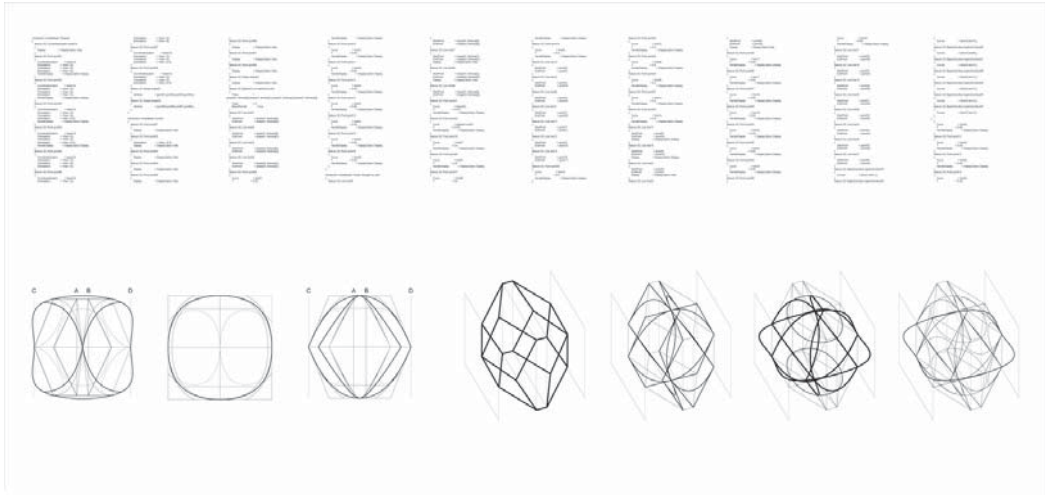
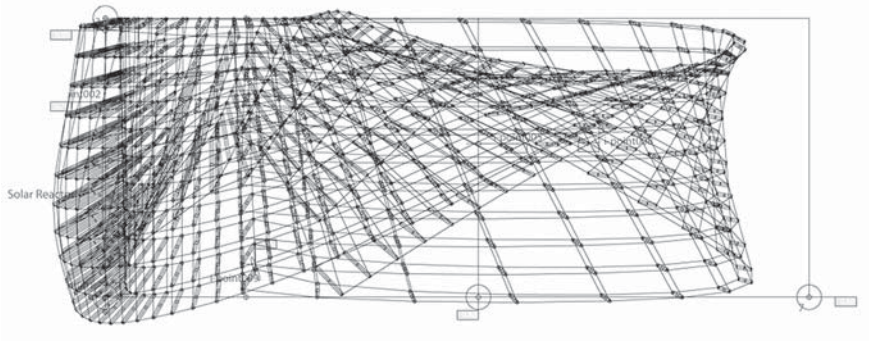


Image 7: UFO development studies using GC for Beijing Biennale panels





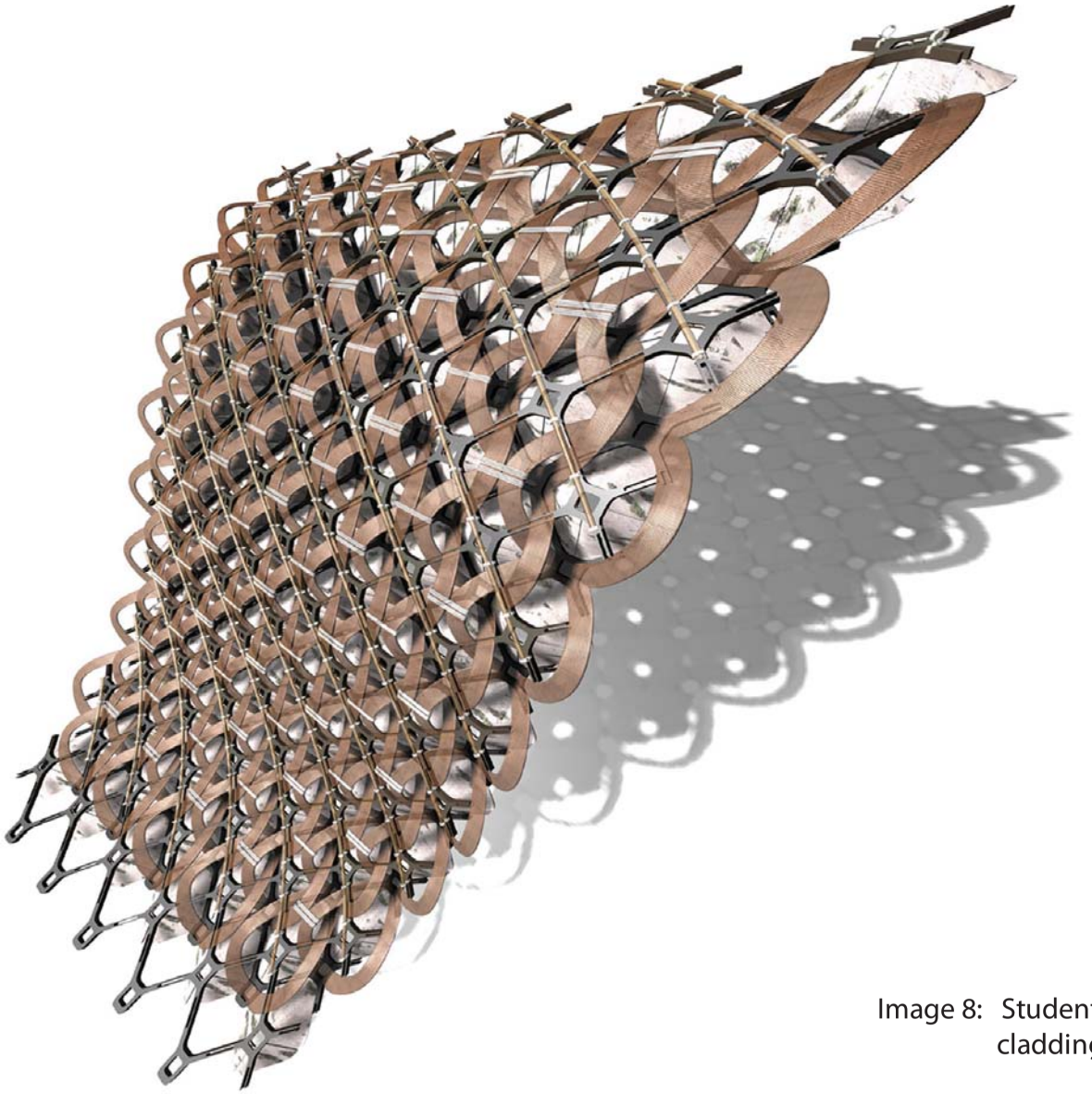


Image 8: Student development work for GC-generated cladding system (Dimitrios Dakos)

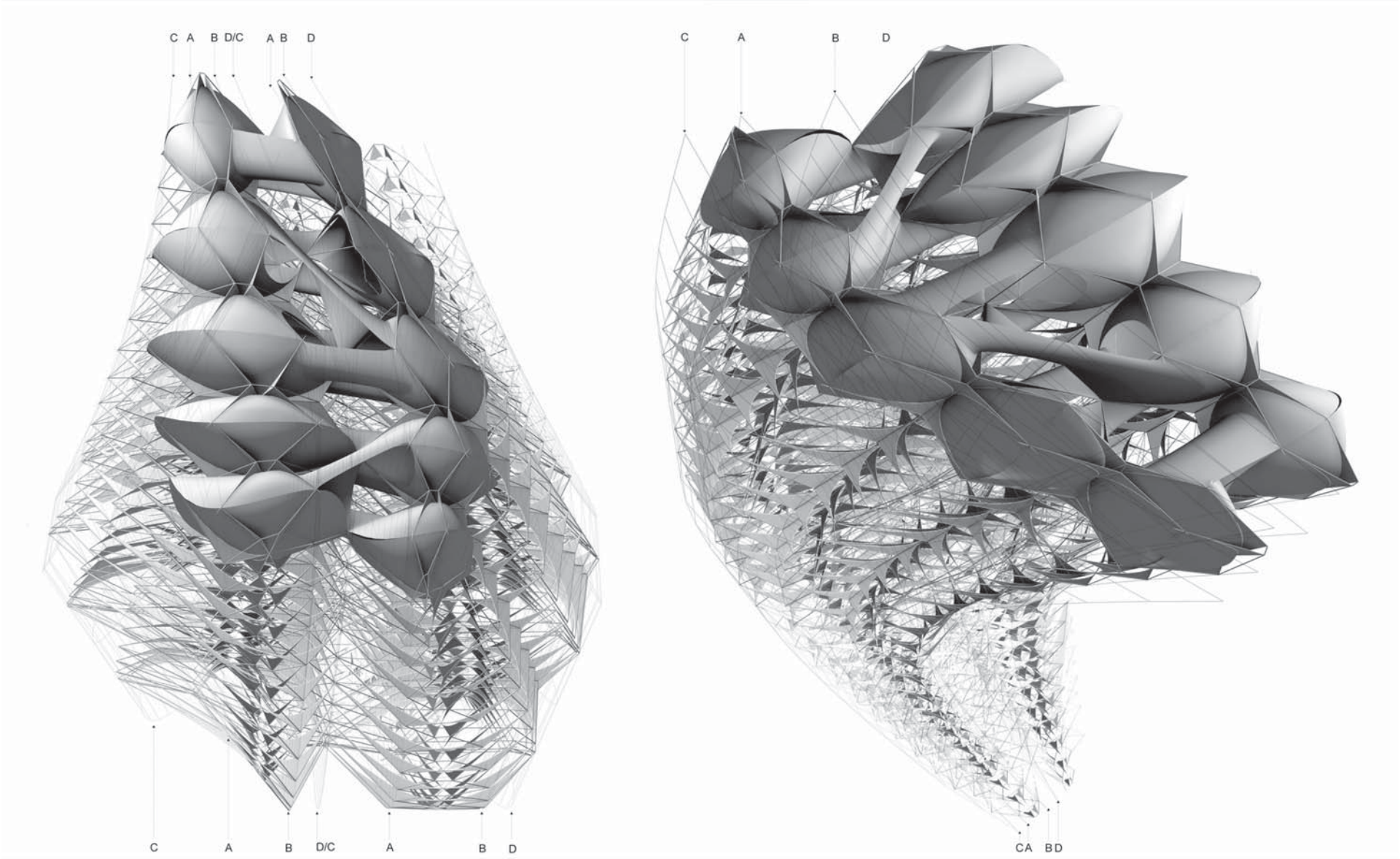
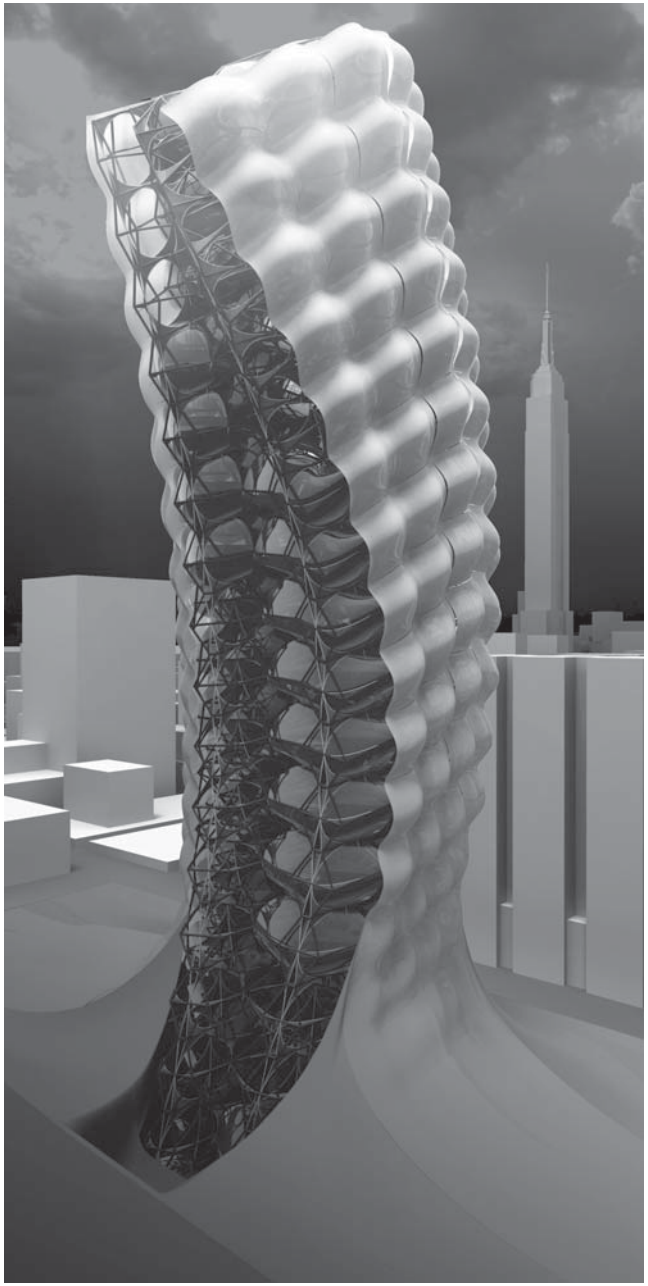


Image 9: Student work using GC for replicated tower structure (Dimitrios Dakos)



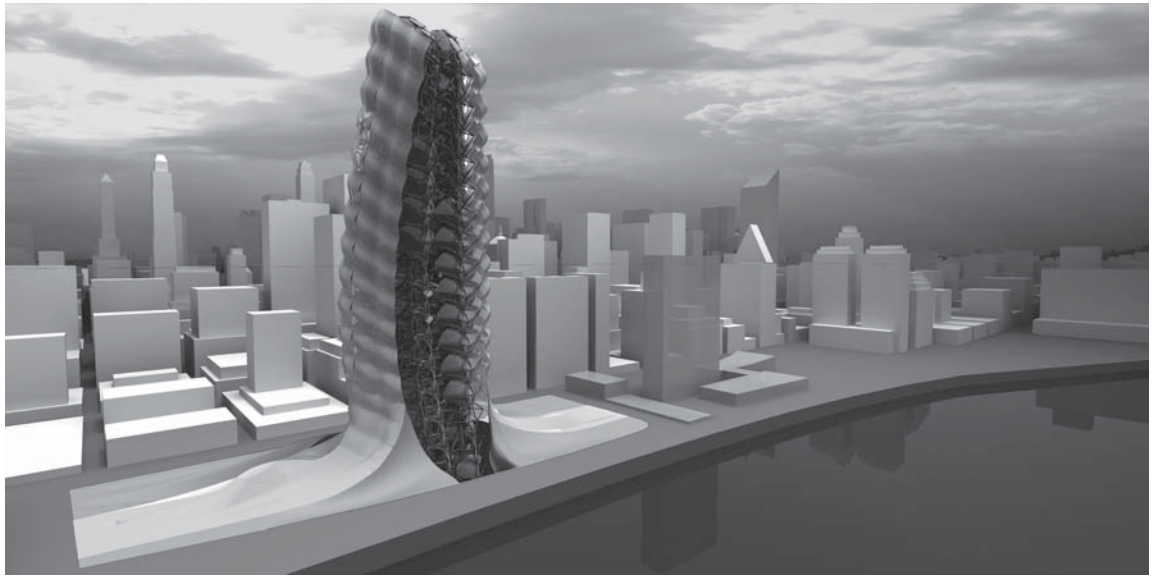
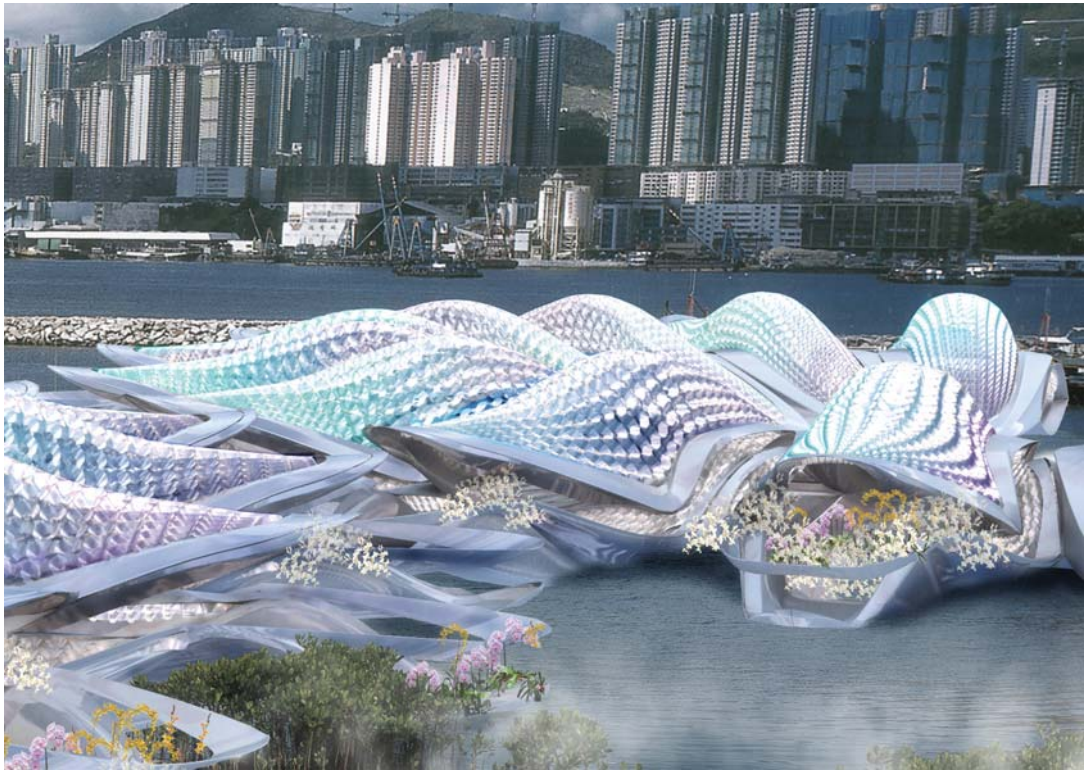


Image 10: GC-generated tower set into model of Manhattan (Dimitrios Dakos)



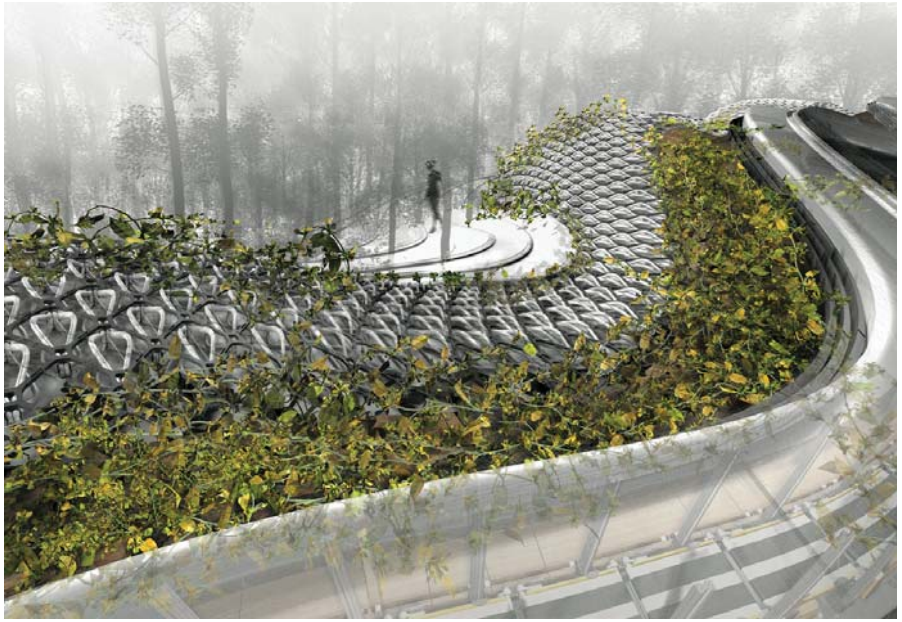
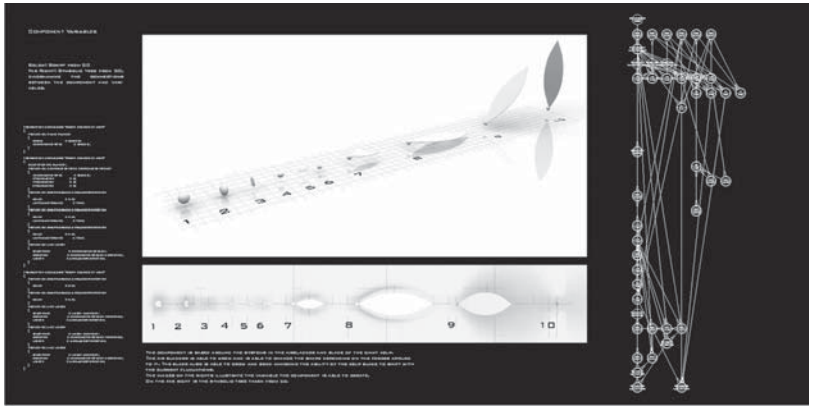


Image 11: Student projects using GC for low-rise groundscrapers



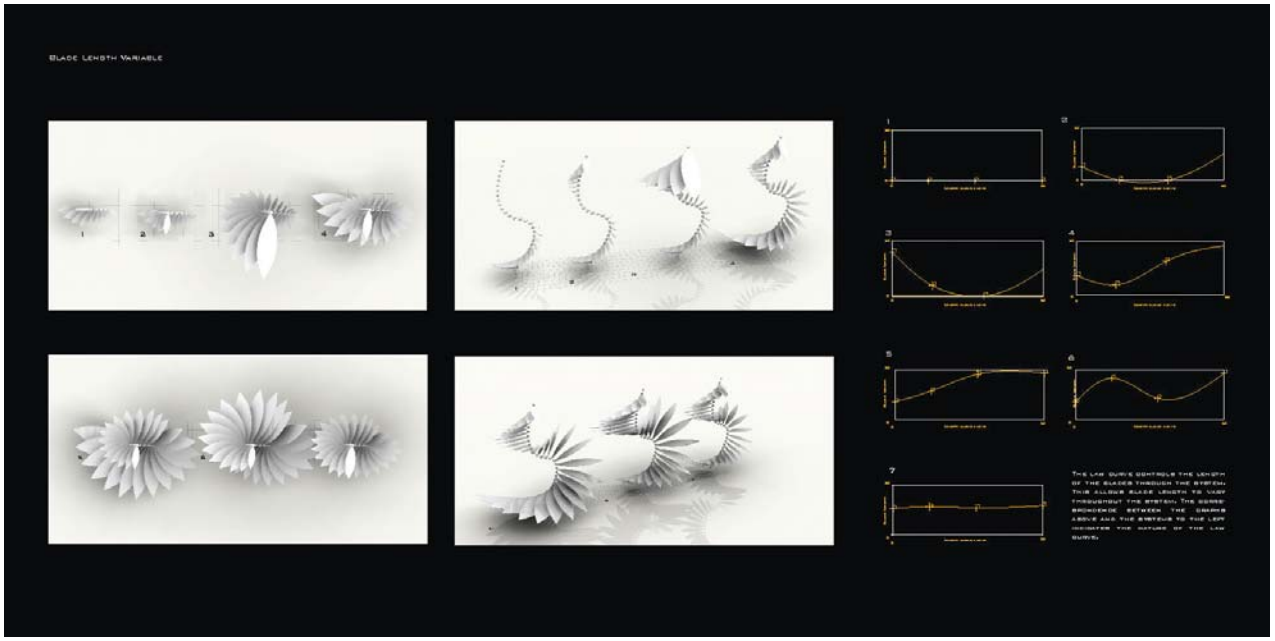
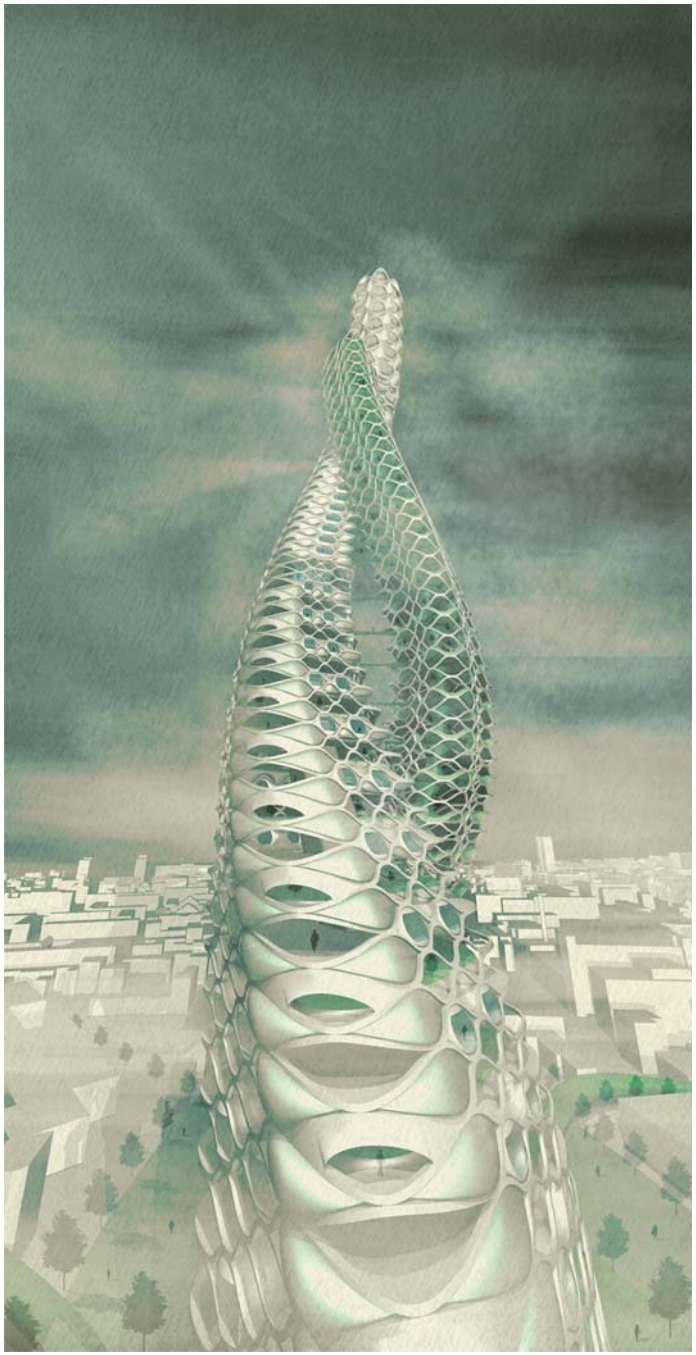
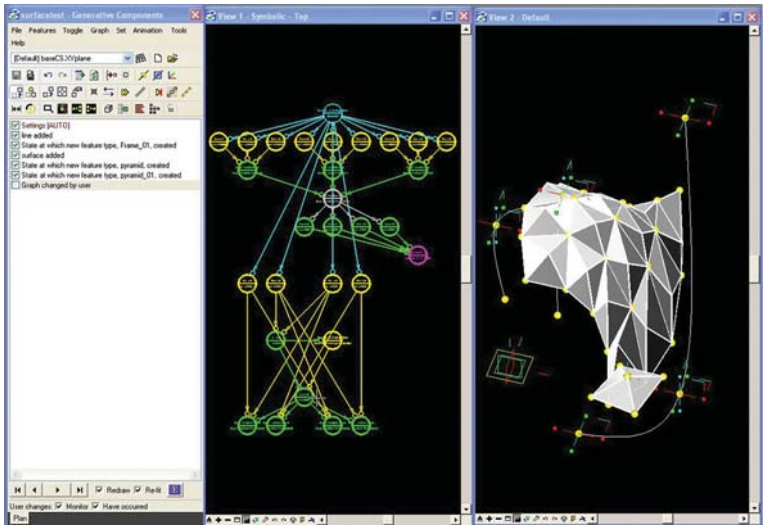


Image 12: Student project generating twisting forms using GC (Ben Johnson)





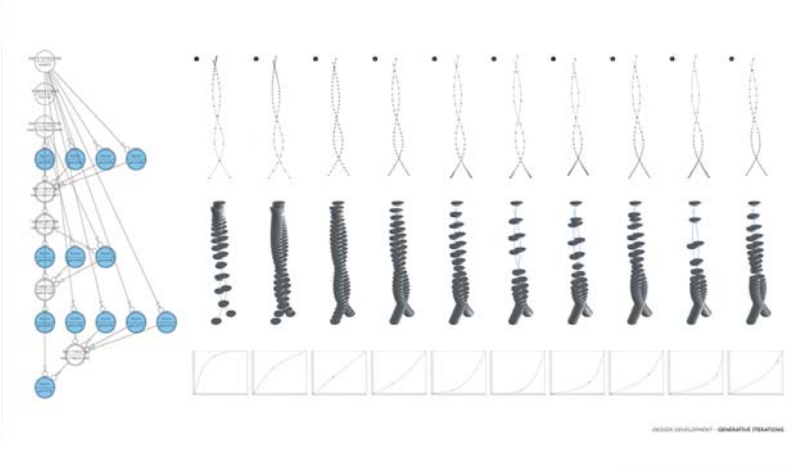


Image 13: GC-generated twisting tower (Mohamed Abdelghafar)

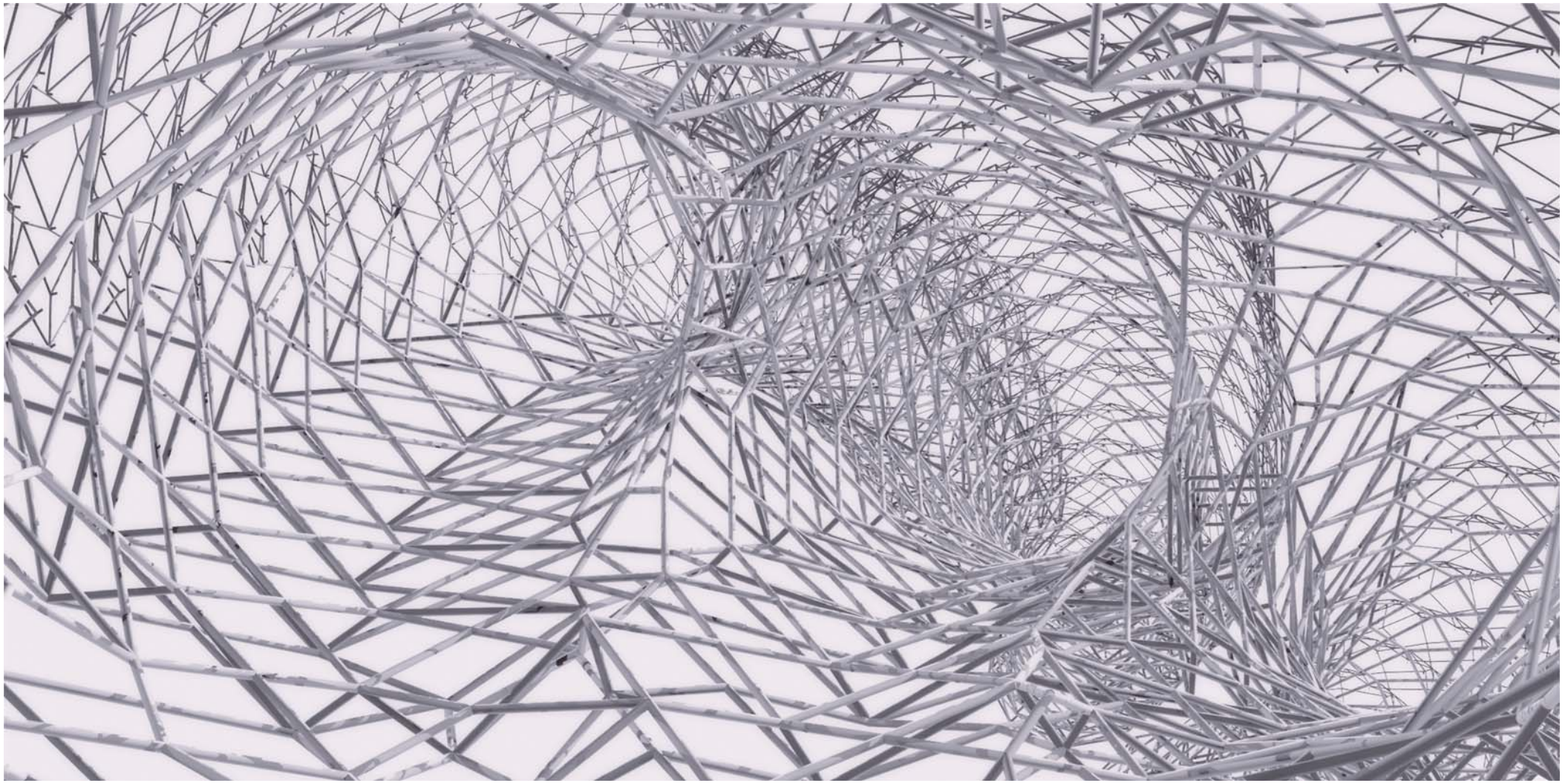


Image 14: Steel lattice frame for twisting skyscraper generated with Generative Components (Alisdair Mealey)

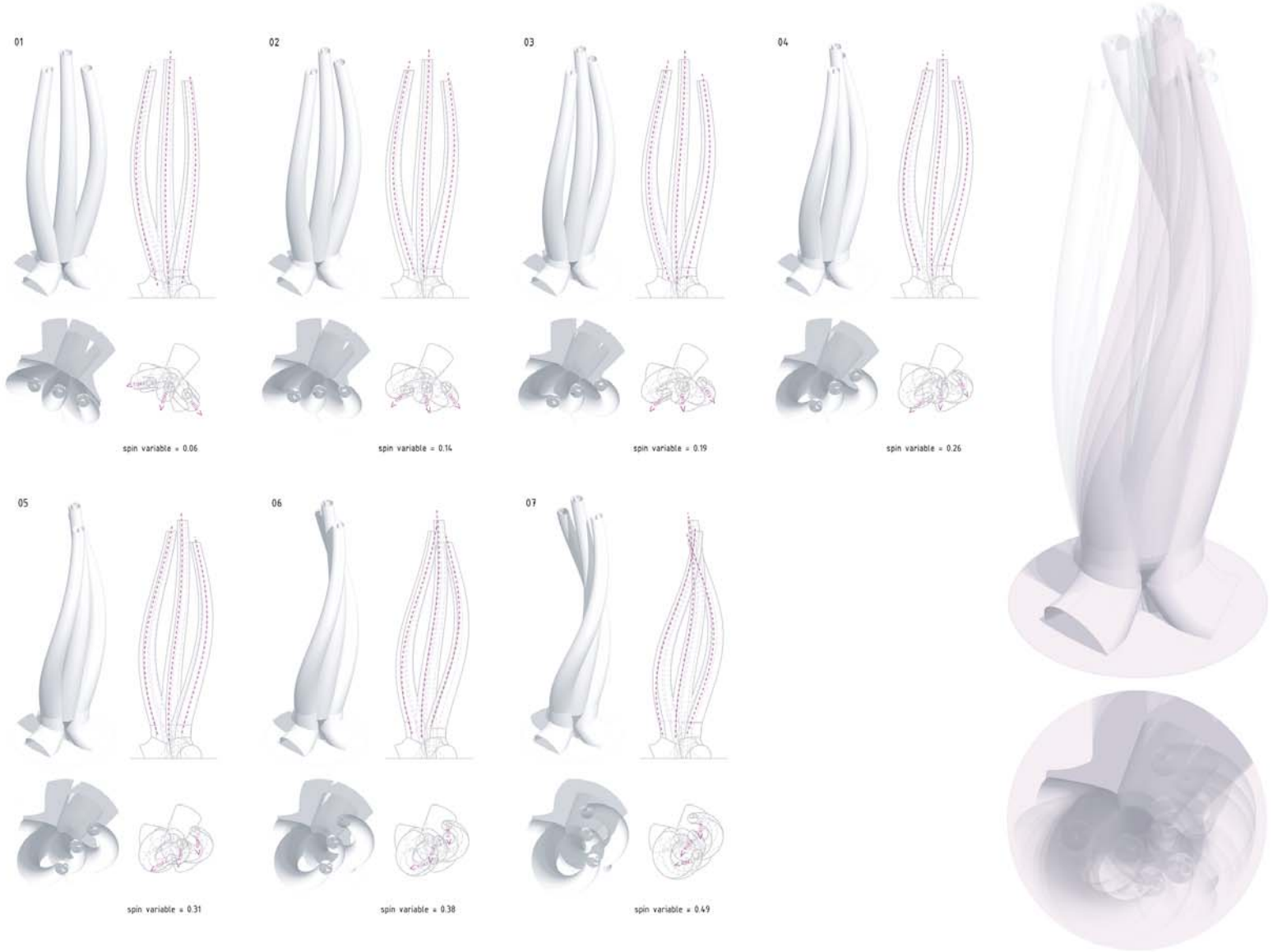


Image 15: Rapid parametric iterations in GC to generate the optimum form for a twisting skyscraper (Alisdair Mealey)

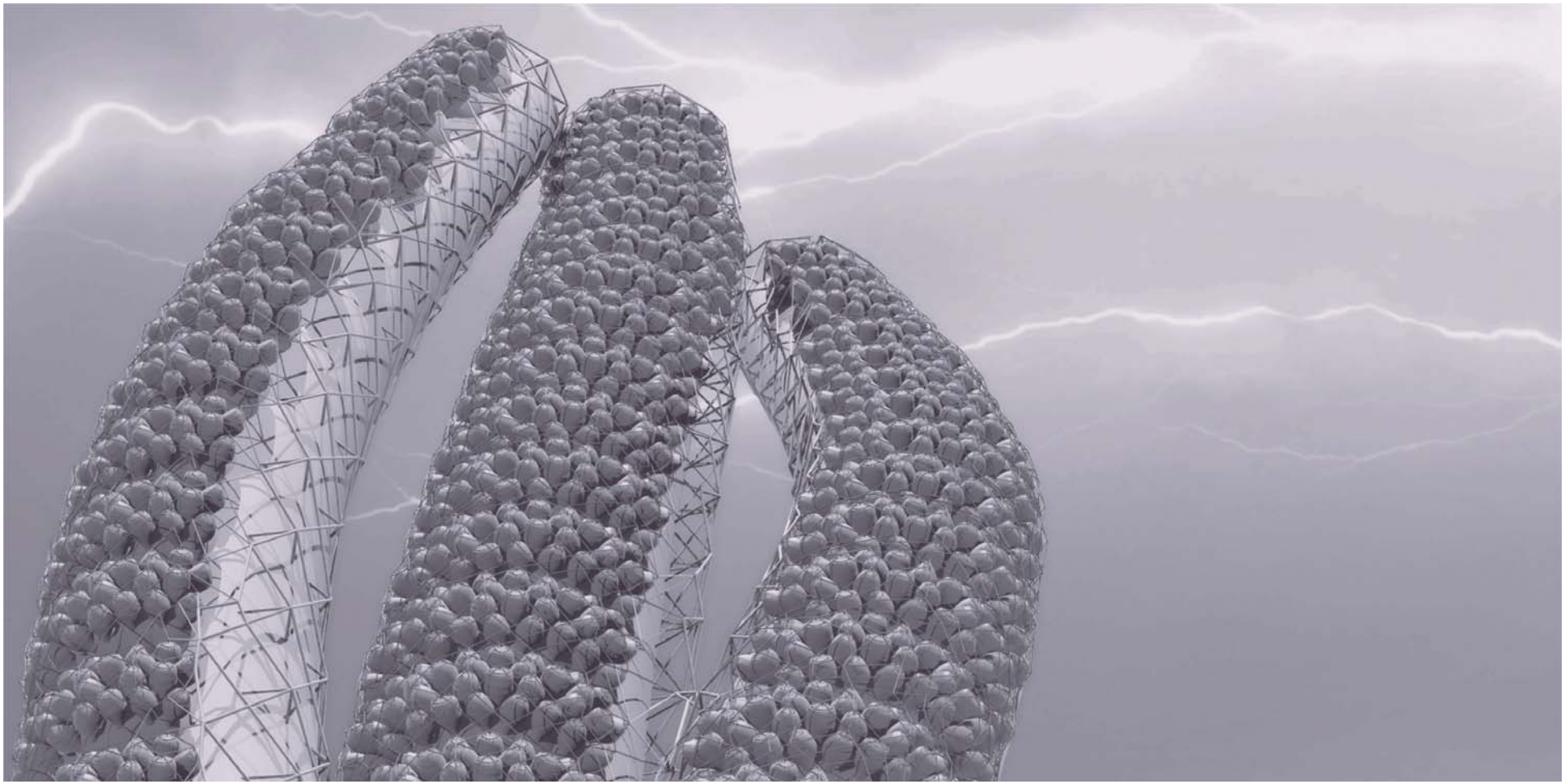
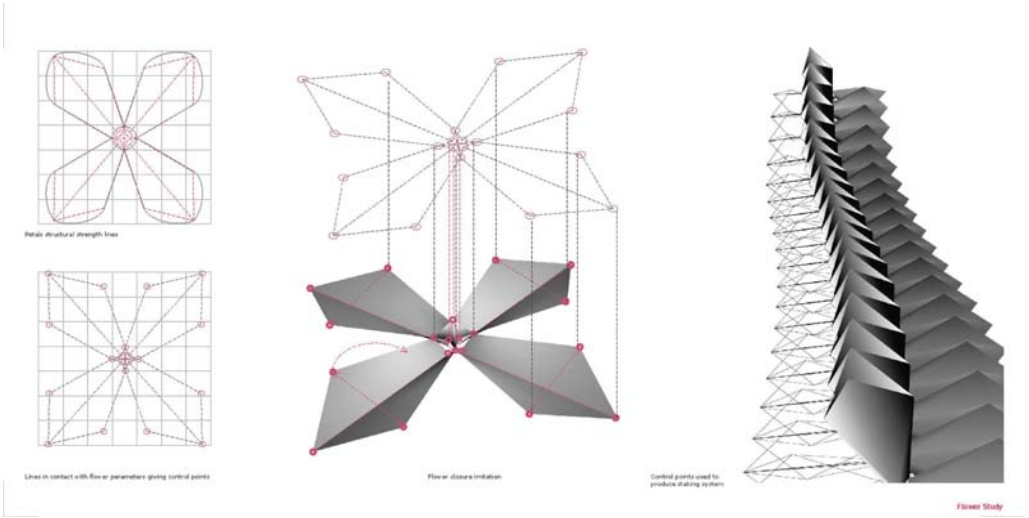


Image 16: GC-generated twisted skyscraper (Alisdair Mealey)



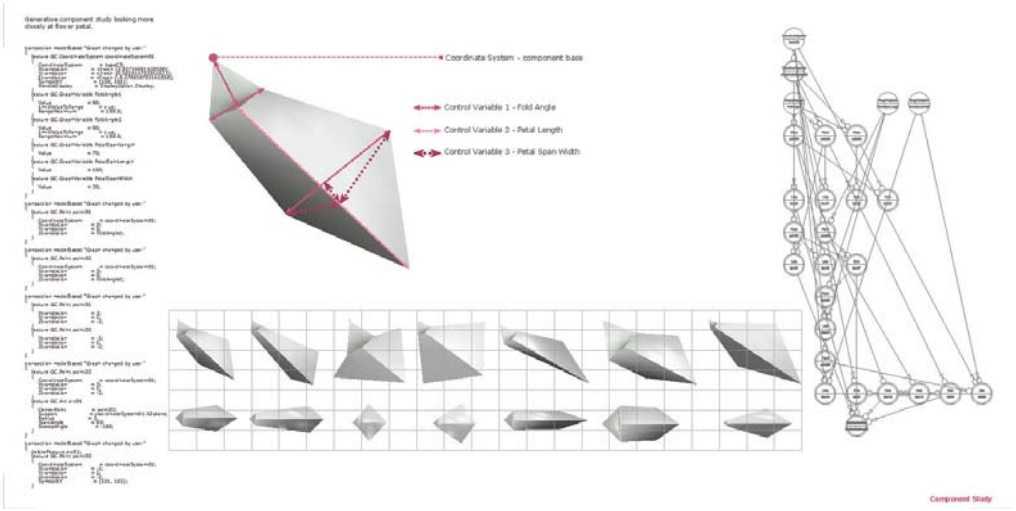
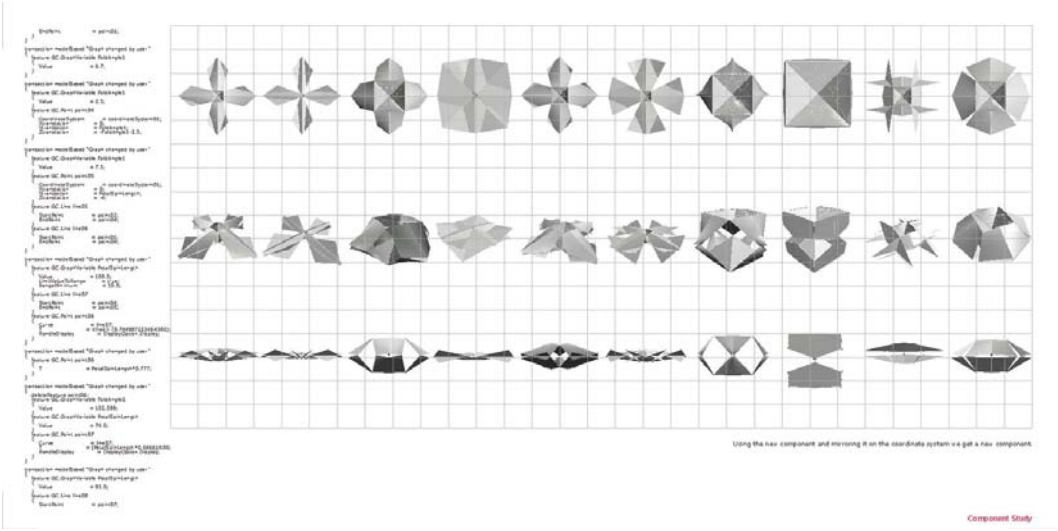


Image 17: Studies in generating type of components using GC (Paresh Chandegra)



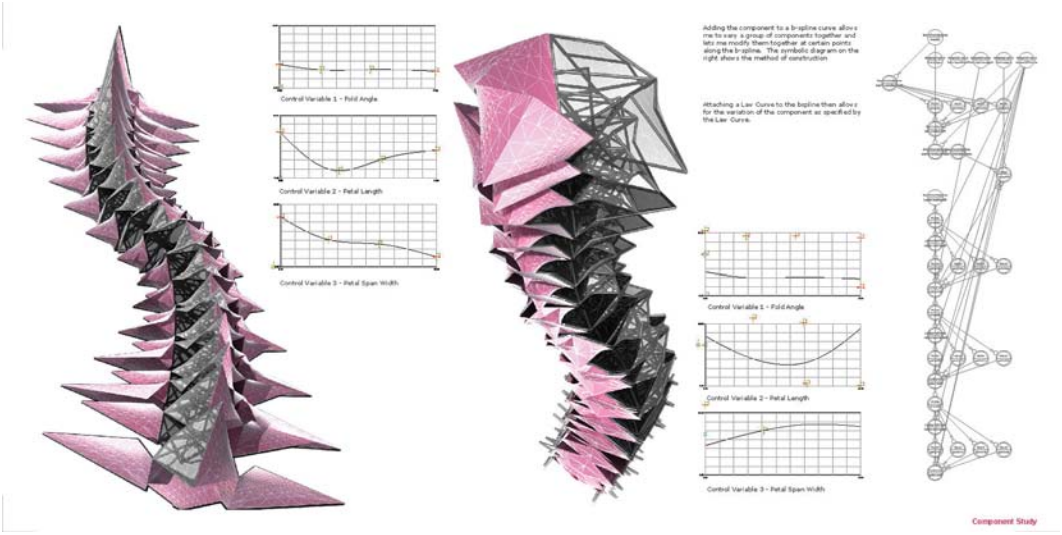
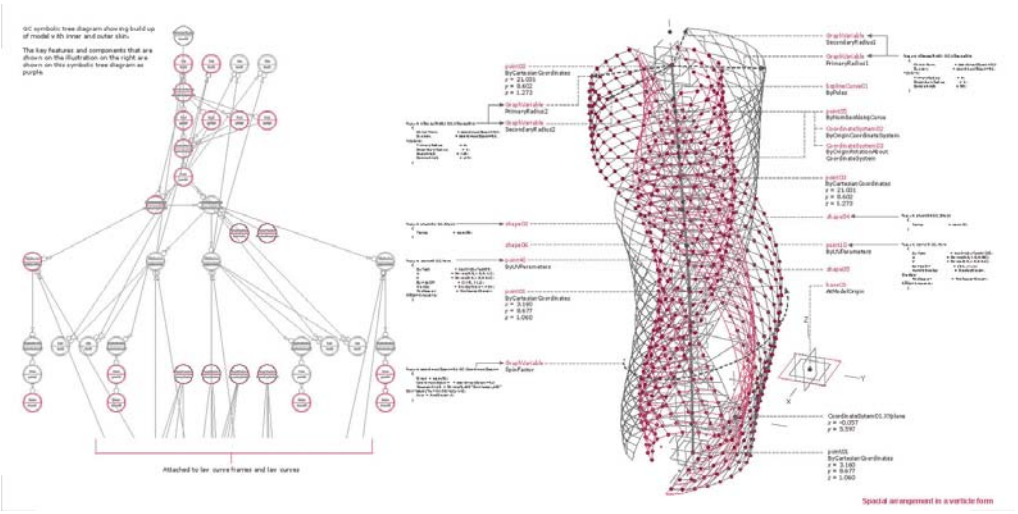


Image 18: Development of component types using GC (Paresh Chandegra)



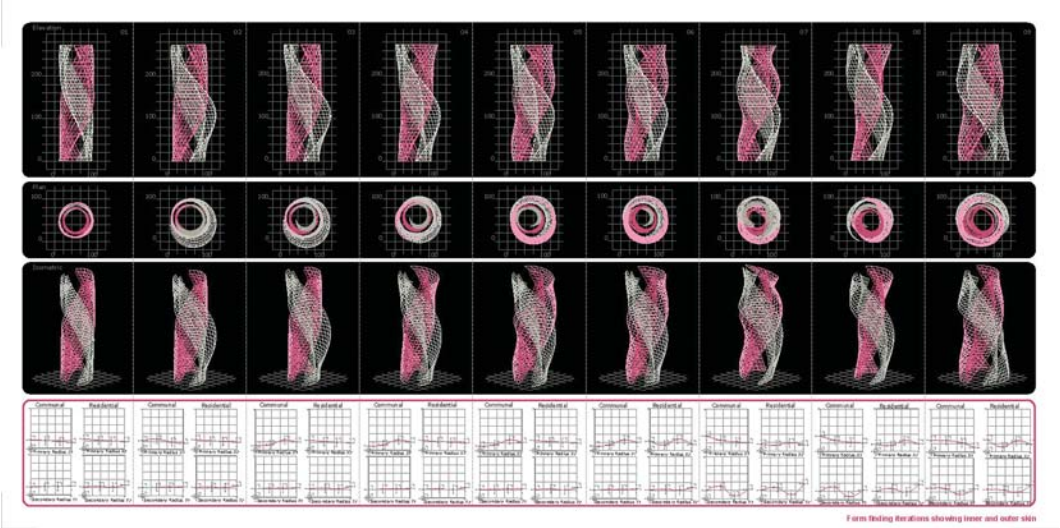
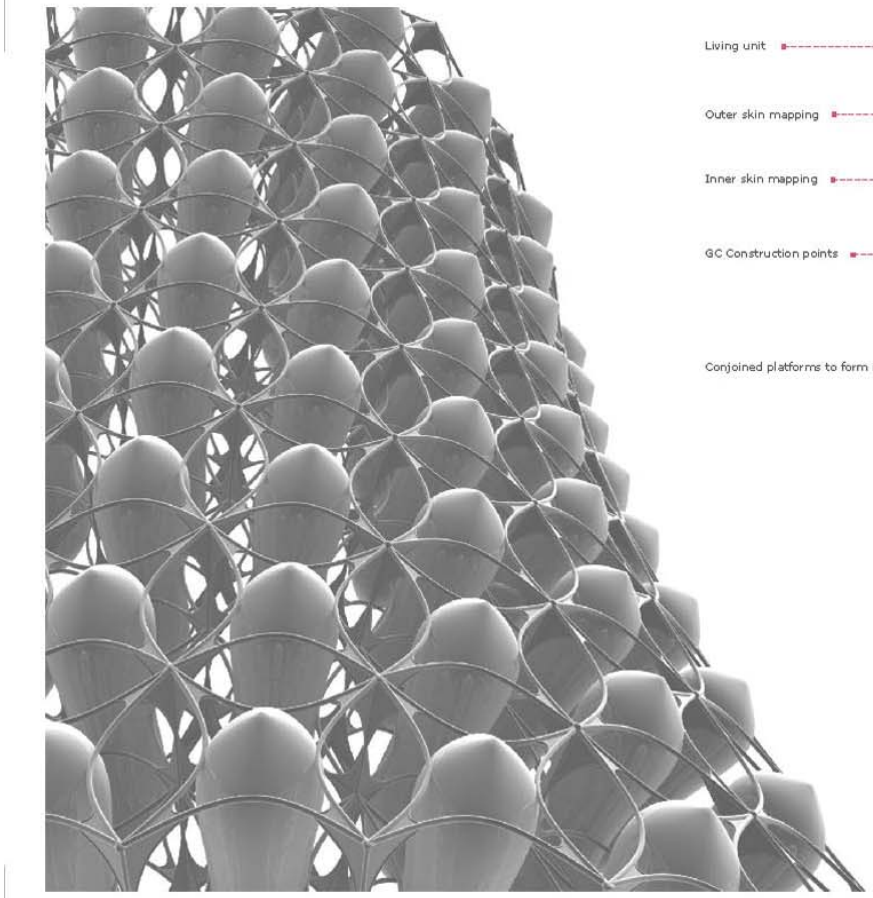
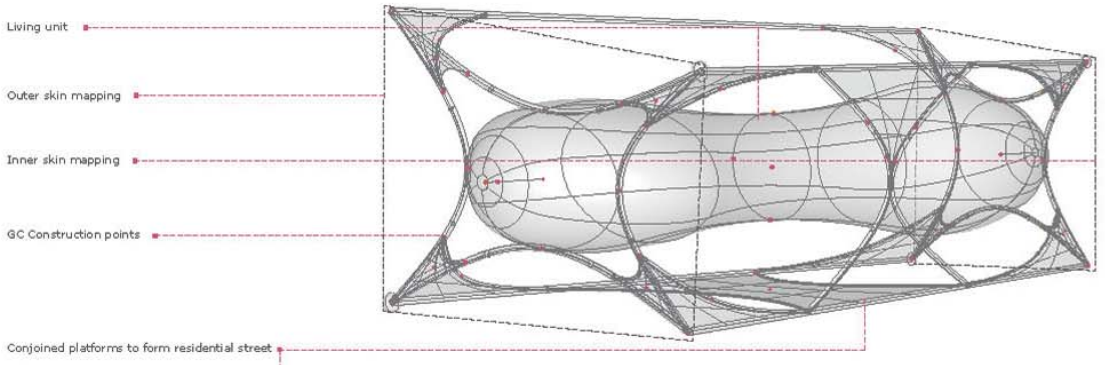
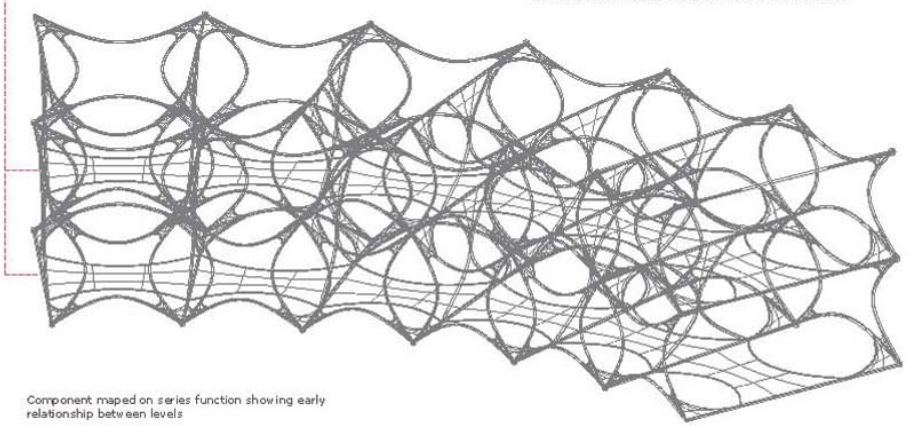


Image 19: Parametric iterations of twisting skyscrapers using GC (Paresh Chandegra)





Initial structural frame study of residential component



Component maped on series function showing early relationship between levels

Component for residential living pod development

Image 20: GC-generation of twisted skyscraper frame and inserted components (Paresh Chandegra)