BALANCE IN CONTROL:  
The Case of an Urban Design Studio at the University of Arizona

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Abstract  
For the first time, in history, the majority of human beings live in urban regions. Although cities are among the most complex human-made systems, they are unfortunately environmentally, economically and socially unsustainable. How can we change this? This paper discusses an undergraduate architectural design studio, Future Cities, which pushed for an environmentally holistic design process, moving past the idea of single, object-like buildings. The studio taught various digital and research methodologies to aid in the complex issue of urban form. Emphasis was placed on balancing the huge amounts of data and information that is available in our technological age, with the need to retain the human perspective and experience.

Keywords: Carrying capacity; computational design; ecological design; sustainability; urban design.

INTRODUCTION  
The Future Cities studio took place at the University of Arizona, in Tucson, Arizona, USA during the Spring Semester of 2011. The studio consisted of 9 different teams comprising of 13 fourth year undergraduate architecture students. Students could work individually or in teams of up to three people. We also had input from one of our Planning Professors, Dr. Ryan Perkl and two additional masters students from the School of Landscape Architecture and Planning. Students were also encouraged to consult with other departments outside of our college, most notably with material science and biochemistry.

Our current environmental crisis led to a studio premise that it is not okay to maintain the status quo, but that we needed to fundamentally rethink the direction we are moving in as a design profession. This re-calibrating related to the structure of the design studio and the design proposals themselves. The speculation was whether city planning should continue to impose its will upon the land, or should it become yet another organism imbedded within a homeostatic ecosystem, like an emergent system which has been correlated with the concept of giving up control? Part of this process was determining how much should be designed and controlled in this potentially more dynamic, ecological model for humans and the environment (bottom-up versus top-down approaches).

The studio’s intent was to find ways of form-finding verses form-making; using natural and built infrastructure, systems and flows to create new planning strategies, relationships and building typologies. Projects needed to emphasize cycles and inter connectivity. Pedagogical methods were a crucial part of the studio’s make-up, emphasizing digital agility and collaborative team-work. Recent advances in digital technology have helped us understand our environment at another level then we previously had known. Design proposals were critiqued against the move towards superficial formalism to an understanding of the systems and performative aspects of ecological systems. Speculating on whether this understanding can help us to develop a non-plan that allows for more adaptability, livability and change in our built environment. Ecological, inter-connected systems in the natural world have no separation of form, structure and material: they all act on one another and cannot be predicted by the analysis of any one separately or in a different context. Isn’t this how the design of our built environment should be, critically sensitive to...
its region and holistic? With the increasing specialization of professions and the academy it is imperative to get input from other areas of knowledge and experience to develop a more holistic design strategy.

ECOLOGICAL BACKGROUND

Inspiration from the natural world has been an important force in humanity's design history. Charles Darwin’s theories in the late nineteenth century had a strong influence on Art Nouveau and the Arts and Crafts Movement. The concept of the organic was also central in the 20th century. Louis Sullivan, Frank Lloyd Wright and Le Corbusier all employed biological analogies. Generally the connection was fairly superficial, although Wright spoke of adaptability and several other core ecological concepts. In other fields Aldo Leopold, in the early twentieth century was a proponent of inter-disciplinary ecological design and author of the Land Ethic. He wrote,

“...When we see land as a community to which we belong, we may begin to see it with love and respect. There is no other way for land to survive the impact of mechanized man, nor for us to reap from it the esthetic harvest it is capable, under science, of contributing to culture. That land is a community is the basic concept of ecology, but that land is to be loved and respected is an extension of ethics.” (Leopold, 1949, p. viii).

Some scholars see his work as one of the first modern philosophies of sustainability. Developments in cybernetics, computation and science later in the century led prominent architectural theorists like Reyner Banham and Charles Jenks to predict that biologically-related architecture would be the next major movement. Jencks wrote in 1971, “When biology becomes the major metaphor of the 1990’s, the intuitive tradition will explode in a burst of biomorphic images suited to the individual and organic development” (Jencks, 1971, p. 99).

Hopefully we have learnt from the modernist tradition of ‘form follows function’ that making design too cut and dry tends to lead to alienating and cold environments. Most ecological systems are completely bottom-up systems, i.e. they are ‘designed’ through the balance of self-organized internal and external environmental forces. Humans, being among the most complex natural organisms, have the ability to think and plan ahead, so one would assume that their built environments need to be a balance between top down (planned control) and these more natural, bottom up (self-organization) systems. Therefore designing for them should not be reductive, but should acknowledge that humans are different from plants and animals.

Most contemporary designed environments have emphasized the top down approach too much. In order for us to become more civilized we need to be less controlling of others and our environment (softer), realizing that in this time of rapid change we cannot plan for permanence or predictability in a way that past cultures have.

“Power itself must be abolished – and not solely in the refusal to be dominated, which is at the heart of all traditional struggles – but also, just as violently, in the refusal to dominate...Intelligence cannot, can never be in power because intelligence consists of this double refusal.” (Baudrillard, 2010, p. 47-8).

If we are to be at balance with natural systems we need to have less of a hierarchical attitude and focus more on a system of ethical, mutual respect for the entire environment. This ultimately leads to changes beyond traditional architecture's scope, which would have to happen on multiple levels of society, including economics and politics. Trying to solve all of these issues are beyond the scope of this paper of course, but it is imperative to at least open the door to these larger ideas, particularly in an educational environment.
The Arts and Crafts Movement was in part a reaction against industrialization and the technological development of the world. However, the recent interest in natural systems is paralleling the development of technology and computation specifically. The need for computation to study and model this complexity is paramount. John Frazer, a pioneer in the use of computers in architecture has written that,

“The modeling of these complex natural processes requires computers, and it is no coincidence that the development of computing has been significantly shaped by the building of computer models for simulating natural processes. Alan Turing, who played a key role in the development of the concept of the computer (the Turing Machine) was interested in morphology and the simulation of morphological processes by computer-based mathematical models…Von Neumann, the other key figure in the development of computing, set out explicitly to create a theory which would encompass both natural and artificial biologies, starting with the premise that the basis of life was information.” (Frazer, 1995, p.13).

Generally technology today is not seen with the negative connotations that went along with the industrial revolution. Nicholas Negroponte, founder of MIT’s Media Lab, is a computer technology proponent and has stated,

“I believe that computers have the potential for assuring a responsiveness, individuality, and excitement in all aspects of living, to a degree hitherto unseen…the computer sciences, generally associated with elite and often oppressive authorities, can provide to everyone a quality of architecture approximated in indigenous architecture (architecture without architects).” (Negroponte, 1975, preface).

PEDAGOGICAL CONTENT

Even with the implications of our transforming world, much of our pedagogical methods for architectural design have remained unchanged since the introduction of studio culture in the Beaux Arts tradition. Nikos Salingaros, known for his work on urban theory has written that,

“Architectural studios today are dominated by subjective, elitist, ideological, and master-apprentice models that aggrandize invention over innovation, and radical individualism over collaborative processes.” (Preface in Salama, 2009, p. 13).

It is important to remember that studios are not a neutral environment so every attempt should be made to create as creative and interactive an environment as possible. John Dewey, an early protagonist for experiential learning, wrote about the need for a democratic education where it was imperative for students to help shape their own program and context. As a result the program for the Future Cities studio was developed by the students, relating to the particular ethics and strategies of the groups research endeavors. For this particular studio emphasis was put on a collaborative process rather than on individuals working in a competitive environment. The trans-disciplinary element was added in an attempt to make the students look more holistically at the complex subject of urban form and to encourage work patterns that reflect the current realities of the profession more accurately.

Traditionally the studio instructor has the central position of power in a very top down, hierarchical approach. In order to empower student creativity and activism it is necessary for there to be a marked reduction in the power of the instructor in order to facilitate more bottom-up action. Tomas Dutton developed a Hidden Curriculum Model in 1987, which strove for equality between instructors and students. This model was not followed completely in this particular...
paper’s example, in reality the studio was more of a hybrid approach where students were encouraged to develop their schemes and be part of the group critique process, but at times it was necessary to assert the traditional power of the instructor, mainly due to time constraints.

It was also imperative to create more research components than those that exist in the traditional studio. It is imperative that these nurture exploration and critical thinking and develop into the design element rather than being a detached precursor to the problem. This is particularly important in an area, which is attempting to be cutting edge with regards to latest technologies and theories. It is imperative to get input from everyone in the studio to share the work load and get a diverse set of perspectives. In fact defining the problems were often more important than developing solutions. In the book, Changing Architectural Education, it states that,

“Students typically come to understand analysis in an oppositional relationship to design. Perceiving design to be the most valued element of the course, they equate spending more time on analysis with spending less time on design. The result is a narrowness and lack of depth in analysis coupled with overreliance on traditional analytical, supposedly objective, methods of analysis.” (Morrow, 2000, p. 45).

SPECIFIC METHODOLOGY

The student’s first assignment was to research the various relevant issues/problems in a general way; this was followed by workshops and assignments that focused on increasing their digital skills. The architecture students involved, generally embraced the issues addressed in the studio, although many had not had a previous education in these specific areas or scale. Ultimately they were given a four square mile site in the Sonoran Desert to develop their hypothetical design strategy. The site was at the base of a mountain range, adjacent to the city of Tucson, Arizona with a major transportation link running across one edge.

Many initial decisions were based on determining the appropriate density for the project. The extreme climate in the desert was an obvious opportunity for students to address the idea of an ecological footprint and carry capacity. Density (the supportable population) became directly proportional to the amount of water and other available necessities in their given ecosystem. Students began by calculating the available resources in their given site (figure 1).

They also evaluated standard norms of per-capita consumption evaluating these against potential (per-capita) improvements based on designs that encouraged less automobile usage and more developed attitudes to resource consumption generally.

In all cases there was a desire to increase density where appropriate and to protect the natural landscape from urban sprawl as much as possible, which is predominant in the Tucson area. They also needed to balance the obvious desire for density and collective experience, with the sense of individuality and freedom for which the desert southwest has become a symbol. Land use strategies were developed which generally related to the existing topographical and environmental conditions, in many cases pushing for more decentralized network strategies rather than the centralized schemes we have historically seen. These related in part to Yona Friedman’s plurality of utopias,

“In this spirit, I propose to think of our autonomous and non-communicating Utopias – which can range from wandering tribes and settled villages all the way to great city states or regional ecologies – as so many islands: a Utopian archipelago, islands in the net, a constellation of discontinuous centers, themselves internally decentered.” (Jameson, 2005, p. 221).
The positioning of main transportation routes and nodes became networks and attractor points that encouraged transit-oriented development. These attractor points/routes were created relatively easily in the digital parametric model. Most students worked in Grasshopper, the parametric plug-in for the 3-dimensional modeling tool Rhino, by Robert McNeel and Associates. Grasshopper is not just a stripped down version of Building Information Modeling (BIM), but allows a parametric design dialogue that is not the emphasis of all BIM tools. It also has a relatively graphic interface, which is generally useful to architecture students without a prior scripting background.

Parametric, geometrical, networks were also developed which linked programmatic distances with various transportation modes and systems, always encouraging more sustainable options. Students began to see these systems as inter-connected metabolic networks. They were also encouraged to see their system analyses as a series of dynamic flows and feed-back loops rather than as static consumable objects. These dynamic systems by their very nature also needed the ability to adapt and change, bringing in 1970’s system theories of autopoiesis, the capacity of a system to self-regulate (figure 2).
FINDINGS - EXAMPLES

Obviously to use computational, morphological processes is a complex task indeed. There is a negotiation between the seen and unseen forces which need to be parameterized and added to the equation, hopefully in real time. Particular attention was given to what may be considered an arid regions most precious resource, water. Teams hypothesized in different ways about how future community boundaries, form and infrastructure could follow those of existing water sub-basins and flows within the larger existing watershed. Many groups clustered development around water run-off and catchment areas whereas others saved the areas where water naturally flowed for natural ecosystems and wildlife corridors, slowly gradating to urban density with zones of agriculture or other non-built environments (figure 3). Through integrating water conservation systems at various scales (within the home, community gardens, and landscape), it was envisioned that citizens will embrace more sustainable water management practices in their everyday life, stimulating an educational paradigm shift, from the wasteful use of resources to using them in a more thoughtful way.
The following two student team examples show in more detail about how this was tackled to various levels of success. These groups were of particular interest as they also developed their schemes one step further than an urban plan, proposing specific materiality for dwellings which would rise out of advances in material systems related to their cycles and processes. Many of the common building materials used today are non-renewable and use an exorbitant amount of energy in their manufacturing processes. Michael Weinstock, Founder and Director of the Emergent Technologies Masters Programme at The Architectural Association has stated that, “form cannot be treated independently of material, even when the strongest architectural interest is in form-finding” (Kotnik and Weinstock, 2012, p. 106).

The first scheme, Reconvergence, an emergent city was an immediate response to specific desert conditions but could also be a prototype for any city faced with disappearing natural resources. In this emergent city, water is used and reused as a direct response to a disintegrating water table (figure 4).

The population within the emergent city is provided economic homeostasis through the emancipation of imported goods and services. As natural systems become a part of the community ritual, they provide energy and consumable goods, and can change according to the
immediate demand of social implementations both actively and passively. The scheme proposed a relationship to desert calcification: where the contemporary means of groundwater desalination could help ‘grow’ the city form. Through the process of homogenous nucleation over time, the solids found in groundwater brine aggregate and solidify creating minimal surfaced limestone structures and habitable voids (figure 5 and 6).

Dynamic differences in the aggregation of the metabolic dwelling machines [MDMs] provide for such human functions such as living, working, playing, learning and socializing. Therefore, programmatic elements that nurture these types of sociological behaviors differ and disperse based upon the density of the clusters. Each individual MDM unit is adaptable and can become any number of spaces to meet individual and community needs. By allowing amenities to fit within the clusters, each area of density will begin to have its own social identity. The porosity of each module also allows for access to exterior spaces linked to public areas and richer riparian landscapes shaped by the Filter Organism Homeostatic Landscape System [FOHLS] (figure 7).

The openness of cultural, community and economic areas allow for rich social interactions, where the community would manage socio-economic programs, thus fully engaging in all aspects of sustainability. Nature is introduced into the daily lives of citizens creating a strong ecological relationship amongst the people, the natural environment, and the systems facilitating this interaction. Positive ecological affect, is the product of people in the community caring for the environment due to an added understanding of ecology and the benefits that can be achieved by
designing for interaction amongst humans, habitation, and the environment. Author Richard Louv continually stresses this natural need especially in our increasingly informational age, “but electronic immersion without a force to balance it, creates the hole in the boat – draining our ability to pay attention, to think clearly, to be productive and creative. The best antidote to negative electronic information immersion will be an increase in the amount of natural information we receive. The more high-tech we become, the more nature we need.” (Louv, 2011, p.24).

The second group, team Arid Systemics based their scheme on the principle that in nature form and force are simply manifestations of material and energy flow, fundamental to its ability to capacitate life. The urban homeostasis was imagined as a literal manifestation of this human metabolic network that mediates between complex environmental biological processes and the indeterminate physical organizations of urban life. A series of rules were established based on precedents seen in nature. The basis for the management of energy in this system came from the precedent of the living machine, a system which effectively cycles waste through a series of anoxic, anaerobic and aerobic microbial and microbiological processes in order to extract clean water and support processes which produce various forms of energy; biofuel, agriculture and hydroponics (figure 8).

Figure 8: Arid Systemics team site diagrams and growth over time. (Source: Cruz Crawford and Sheehan Wachter, B.Arch Graduates 2012).
The main system that organizes the layout on the site is its water cycles. The system is shaped in order to catch rainfall and water runoff from the surface. The water is then cycled through the overall system flowing out from the center to the edges and back to the center in a series of feedback loops which also organize the water treatment processes. The appeal of this organization is the redundancy of scale and the repetition of feedback loops which organizes a series of dispersals of energy production and waste management processes within the overall system. The larger organization is driven by a series of cores, which extend out along major arterials into the landscape. These cores represent different scales within the organization of the system, and are the centroids of the potential expansion and contraction of the overall system. The scale and mode of lifestyle at these cores also produce a varying degree of regularity of program within clusters and also a varying degree of cluster type aggregations. The essential concept was that the volume of energy in the overall structure is consistent between the innermost and outermost rings.

They also developed a conceptual system of bonding specific molecules to plant roots, generating the growth of *Biofilm*, a polymeric conglomeration composed of extracellular DNA, proteins, and polysaccharides. The biofilm grows intelligently to begin to form a filament within a system of hydrostatic structuring (figure 9).
CONCLUSION

It was apparent that the balance of many issues became a key theme of the studio. This manifested itself on several levels, from the bottom-up verses top down planning principles, use of environmental resources and the reality of working methodologies in a quasi-hierarchical studio structure. The optimum result was usually a hybrid approach that acknowledged the complexity of the situation and was not too reductive. Obviously architecture itself cannot solve all of society’s problems, but as the eminent philosopher Michel Foucault has stated, “it can and does produce positive effects when the liberating intentions of the architect coincide with the real practice of people in the exercise of their freedom” (Rabinov, 1984, p. 246). We need to be engaged as educators to be part of the process of the future shaping of the world. Staying flexible and dynamic to changes in our profession and world, more akin to nature and natural models. It is imperative to start getting students to think and work this way too. Whether this is changing up the traditional solo-based designer methodologies or introducing them to other fields and disciples.

Technically there are always developments to be made. It is imperative for architects to start using information and data in a smart way, and in multiple dimensions - the 4th dimension using time and energy. Simulation and analysis tools are developing daily, even though their interface (especially in a live way) is sometimes a digital challenge. This interface is crucial if we are to move beyond the green-washing that is the current general state of affairs and incorporate these principles in the earlier design stages. The studio started to address many key ecological concepts, but what is needed is a paradigm shift in thinking. William McDonough and Michael Braungart, authors of *Cradle to Cradle*, which gives an ecological approach to design, have written,

“When one takes seriously that the concept of waste can be eliminated in the worlds of architecture, commerce, manufacturing, and transportation – indeed in every sector of society-the purview of design shifts radically. Not only are we required to include the entire material world in our design considerations, we are asked to imagine materials in a whole new way.” (McDonough and Braungart, 2003).

At the end of the semester, feedback from students and peers indicated that the enormity of the design challenge was seen as a positive that was an engaging experience for all. (i.e. selecting and developing their own program on an urban scale). Part of the challenge pedagogically was the need to control and lead the studio, but not to the extent where I became dominating and stifled the students’ creativity. In our globalized world it is crucial to stimulate students to make further connections between themes and concepts like ecology, sustainability and parametric design, always encouraging them to work smarter, not harder. It is imperative to engage students in projects of this scale and complexity while they are in an educational environment, allowing them to be visionary and forward-thinking. These ways of thinking beyond the traditional box are becoming increasingly needed in our rapidly changing professional environment. Buckminster Fuller has eloquently stated,

“Because politicians will not dare to stop politicking, and because income-supported individuals will not risk loss of their incomes, and because the wage-earning world will not dare to drop its income-producing activity to promulgate the design-science achievement, it can only be undertaken by the more or less freewheeling student world.” (Fuller,1969, p. 291).

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