A New Paradigm for Design Studio Education

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Abstract

There is a feeling among many design educators today that the discipline has reached a crisis in its development, and that change is needed immediately in the way that design educators articulate their epistemology and their methodology. The architectural studio can be seen as the model for design education, and its culture is exemplary. Donald Schön has often argued that the professional education of architectural students – and other design students – should be aimed at making them into 'reflective practitioners'. At the core of his argument is the idea that design education must sacrifice intellectual rigour in order to achieve social relevance, yet critics have argued that this trade-off has caused design education to be marginalised in relation to the university model of education. Design is focused on subjective creativity, but the positivist university paradigm is focused on objective rationality. In order for design education to become more rigorous – and more academically respectable – it must either become more rational or it must embrace a new paradigm that values creative experience. This article argues that the emerging paradigm of complexity offers design education the rigour it has been lacking, for this paradigm constructs studio projects not as problems with rational solutions but as systems that need to be explored in order to discover their relational meanings and values – precisely what creativity, balanced with rationality, can accomplish in both Western nations and rapidly developing East Asian nations such as China.

Even a cursory survey of the literature relating to the education of design professionals reveals pervasive feelings of uneasiness among many of the practitioners in the field. For some this uneasiness amounts to a sense of imminent crisis. Melissa Niederhelman, reporting on a design education conference in Perth, Australia, in 2000, sums up this anxiety precisely:

The need for design to articulate what it is, and how it can contribute, is more critical than ever. Without a more rigorous definition of the discipline, it will be that much harder to involve design in the bigger picture which includes research, collaboration, and learning about the world. (Niederhelman 2001, 87)

Niederhelman also identifies the principal reason many design educators believe that change is needed: 'Design must be brought closer to the centre of the university education model' (2001, 87). It seems, from reading the literature that many teachers of design believe that their discipline is marginalised, and they appear to yearn for greater academic respectability. Indeed, the prominent educational theorist Donald Schön said as much for years as he advanced his argument for teaching architectural students to become 'reflective practitioners' (Schön 1988, 4). According to Schön, a trade-off inevitably occurs in design education as academic rigour is sacrificed for social relevance, because a strong grasp of pragmatics is what is deemed important for design professionals to carry into their careers (Schön 1984, 3). This exchange of intellectual rigour for professional relevance did not bother Schön – in fact, he advocated it – but such an exchange does bother many others in the discipline today.

Two questions spring to mind: What kind of changes might be made to the discipline of design education? And would these changes bring about the desired effect of establishing design education more firmly within the university model? To answer these questions this paper will first limit the investigation by examining the architectural design studio as a prototype for design education in general. Gross & Do (1997)

have already used such an assumption, pointing out that 'In architecture, design is the primary focus of university education; therefore, architecture is a model for design education in other disciplines.' In this article, then, the architectural design studio will be regarded as the norm or status quo for design education practice. It is, of course, recognised that architectural education also involves classes in specific domains of knowledge in addition to studio work. 'But', as Mark Gross and Ellen Do (1997, 2) observe, 'in architecture, the studio is king: it is where the knowledge about buildings is applied, and it is where the act of designing – generalizing, evaluating, and developing alternatives – is learned and practised'.

With this in mind, the possibility for change to design education will be considered according to a proposed paradigm shift for the discipline, replacing the currently dominant positivist paradigm with a newer paradigm based on the recent development of complexity theory. This would amount to a pedagogical and sociocultural 'complexification' – to borrow a phrase from Alain Findeli (2001, 11) – of the theory and practice of designing. Such changes would include rethinking the epistemology of design, becoming more aware of the systematic processes of design, and incorporating multidisciplinary approaches to design projects and activities.

Lesley Kuhn defines and discusses a new alternative paradigm to replace the scientific paradigm of positivism that still characterises the university education model in general and the design education model in particular. Arguing that the increased complexity of contemporary social experience requires an appropriately new way of thinking, Kuhn writes:

Complexity as I use the term refers to a style of thinking or a paradigmatic approach. Others have labelled this as the 'complexity sciences' or 'Complexity Theory'. I do not think, however, that complexity has been systematically articulated in such a way that it could be termed a single 'theory'. Thus … complexity constitutes an umbrella description under which researchers have grouped a set of new scientific theories

[such as Chaos Theory and Fuzzy Logic] sharing the idea that while certain phenomena appear to be chaotic or random, they are actually a part of a larger coherent process. (Kuhn 2008, 178)

According to this author, research is never neutral, for it involves the ontological, epistemological and axiomatic assumptions of the researcher. Thus research is an attempt to find meaning within complexity more than it is an attempt to reduce complexity to foundational truths. (Kuhn 2008, 179) Moreover, complexity narratives provide 'alternative habits of explanation to those deriving from linear, objective, positivist accounts of the natural and social world', and complexity as a paradigm recognises 'a tightly bound, mutually inducing pairing of cause and effect' (182). One of the most interesting features of complexity as a paradigm is that it is not, like the critical paradigm that is so strongly established in sociocultural studies, prescriptive (186). In this respect complexity shares positivism's respect for description and its emphases on *what is*, not *what ought to be*. This means that although complexity values subjectivity and creativity, it does not totally disregard objectivity and rationality. In fact, as a paradigm complexity maintains a fine intellectual balance between the claims of the two contrasting elements of design education.

This article will offer university design instructors various speculations about a possible paradigm shift to complexity theory, considering both its advantages and its possible problems. Some attention will be given to the increased implementation of human–computer interactions (HCI) for designing in radically new ways, and all the proposed changes will be related to the culture and the practice of the architectural design studio. This article is directed toward discovering the possible effects of a shift of paradigms from positivism to complexity theory on the articulation of design education at the present time. Specifically, the discussion will attempt to speculate whether or not such a paradigm shift would serve to bring design education closer to the centre of the university education model. The short answer is positive and hopeful, but it is not unaware of the great difficulty to be overcome.

The culture of the architectural studio

Schön defines the architectural studio as 'a reflective practicum in designing' (1988, 4). The author's central pedagogical concept of 'reflection-in action' (1984, 3) is evident in this definition. According to this concept, students learn not by assimilation but by trial-and-error practice. Thus, design is not problem solving but 'a reflective conversation with the materials of the situation' (1988, 4). Schön repeatedly uses the term 'reflective' to characterise the kind of active learning and tacit knowledge that happens in the architectural studio, but he also returns, again and again, to the concept of reflective education as a 'conversation' in which the students and coaching instructors gradually come to understand each other so well that they can 'finish each other's sentences'. This calls to mind the insistence of John Dewey (1938) that learning is experiential, more a matter of exploration than of attainment, but it should be remembered that the tradition of the architectural studio is derived from an even earlier source than Dewey, namely, the *atelier* system of the education of architects at the École des Beaux-Arts in nineteenth-century France (Kuhn 2001, 349). In fact, the design studio has provided the normal method for training architects at universities for approximately one hundred years now, but it still seems to be somewhat revolutionary to some people within the academic community, probably because it is not based on the positivist paradigm that is so firmly established at the core of the university education model.

Nevertheless, a kind of method does seem to exist within the apparent madness of the architectural studio, because there is – or at least there can be – a 'culture of systems, in the words of Senturer & Istek (2001), that is given shape and force under the direction of the architect-educator who is responsible for the operation of the studio. The term 'systems' here implies complex interactivities involving multiple variables and agents – the apparent chaos of the architectural studio to those viewing it from outside. What, then, are the characteristics of this culture? Here, again, Schön is instructive. He identifies creativity as the essential activity of the architectural studio, in sharp contrast to analysis and criticism, the

two principal intellectual activities of the university education model as a whole (Schön 1984, 3; 1988, 5). Instead of careful empiricism and strict rationality, imaginative intuition of knowledge relevant to the problem at hand is what is most valuable in the architectural studio. This is not to say that creativity is not important to the university education model in general, nor is it to say that rationality has no place in the design studio. But there is an undeniable difference in emphasis in the smaller culture of the design studio and the larger culture of the university as a whole.

Sarah Kuhn (2001) offers a succinct summary of the activities architectural students typically experience in a design studio. Each student spends an entire semester working on a project based on an open-ended problem. During the course of the semester the student's understanding of the problem becomes more and more complex, so their response to the problem is adjusted accordingly, usually several times. Critiques of each student's project are ongoing, and they are provided by instructors, peers and visiting experts. During the course of the critiques heterogeneous materials are frequently introduced, adding further dimensions of complexity to each project. Throughout the semester instructors use a variety of media to acquaint students with relevant past designs, and they provide practical constraints on all the projects. According to Kuhn, collaboration and reflection are optional, but this is highly questionable. Students in architectural studios work in close proximity and the environment is intensively socialised. Therefore, collaboration – at least in informal ways – almost always happens. Besides, collaboration is generally assumed to be fundamental to design practice (Gross & Du 1997), so it is often incorporated as a requirement for the course. Similarly, as we have seen in Schön, reflection is also integral to the normal operation of architectural studios, based as they currently are upon the constructivist model of pedagogy advanced by Jean Piaget (1954), Lev Vygotsky (1978) and Ernst Von Glaserfeld (1989).

Eli Blevis *et al.* present a thoroughly detailed description of the architectural studio, stressing the amount and complexity of physical symbolisations and representations surrounding the students to such an extent that these students are in danger of being overwhelmed or overloaded by data and communications relating to the daily operation of the studio. 'A design studio', say these authors, '… is creative, collaborative, and most of all *highly* material' (2007, 2821). The notes, diagrams, models and so on serve as a collective memory and cross-contextual stimuli for the ongoing activities of the students. The milieu of the design studio is anything but austere, and its socially interactive operation encourages what might appear to visitors to be randomness and disorder – the perfect setting for what Schön calls reflection-in-action.

Besides creativity, three other characteristics are often mentioned in descriptions of the culture of the design studio: collaboration, rapid communication and broad social relevance (Valkenburg 2001). Needless to say, these characteristics are typical of architecture and other design professions outside the university, so it is only natural that these characteristics would be valued and inculcated in university design programmes. Moreover, as Micklethwaite (2005, 86) indicates, design students tend to exhibit strongly personal feelings about their studies, the kind of emotional profile that is typical of artists in general who often believe that they have something important to 'express' in their work. All things considered, the culture of the design studio might be described as a vital complex of material representation, social collaboration, creativity, emotionality and a tolerance for uncertainty – if not outright confusion – balanced with a faith that meaningful designs eventually will emerge.

Not everyone in the design education is content with the culture of the design studio. Donald Glasser (2000), for example, argues that over his long career as an architectural educator he has found studio education to encourage more of a cult than a culture. That is, the architect-educator – Glasser gives the example of Louis Kahn at the University of Pennsylvania – tends to promote his own style of design and studio students tend to slavishly imitate the master's style. The truth of this criticism seems to be self-evident and virtually inescapable, suggesting,

perhaps, that the less individualistic (or fashionable, or egotistical) the architect-educator in charge of the studio is, the greater the likelihood that a genuine culture, instead of a mere cult, will emerge. This criticism sharply differentiates the culture of the design studio from the culture of the university as a whole, because it suggests that design studio culture tends to be so subjective, in both instruction and learning, that it must always fail to meet the intellectual safeguard of rational objectivity that is central to the university education model. Gross & Do (1997) point out that creativity may be emphasised too much in the design studio, at the expense of practicality and social responsibility, encouraging students to concentrate more on self-expression than on learning the profession of architecture in relation to its full complexity, especially its usability and its ethical implications.

Once again, we must return to Schön:

In order to be credible a reflective practicum must become a world with its own culture, including its own language, norms, and rituals. Otherwise, it risks being overwhelmed by the academic or professional cultures that surround it. But if it succeeds too well in establishing its own culture, isolated from the larger worlds of university and practice, then it may become, in Hermann Hesse's phrase, 'a mere glass bead game'. (1988, 6)

It is significant to note that even Schön, perhaps the strongest critic of the overriding 'technical rationality' model of university education, and certainly the greatest champion of educating students of design to become 'reflective practitioners', admits the danger of limiting the culture of the design studio – or, indeed, the culture of design education – to the point of isolation. At the very least, a fine balance must be struck between the expectations of the university and the practice of the design studio.

Schön was perhaps the first to point out that intellectual rigour is often conspicuously absent in the design studio, and such a lack is very problematic for any attempt to integrate design education with the general model of university education. Attempts to provide such rigour have not

been successful so far. Stefani Ledewitz, for example, argues that the architectural studio has three clearly defined pedagogical objectives: to teach new skills, to teach a new language and to teach students to 'think architecturally' (Ledewitz 1985, 2). Ledewitz then observes that the methodology of design is theoretically positivistic, being organised linearly as a rational, systematized 'analysis' (problem-defining) stage and a creative, intuitive 'synthesis' (problem-solving) stage (1985, 3). Nonetheless, this author admits that there is a serious gap between the analysis stage and the synthesis stage, and this is precisely where the problem of rigour in the design studio emerges. To move from the rational analytical stage to the creative synthetic stage the student must make 'a leap in the dark', an act of intuition and faith that is only complicated, not made easier, by the accumulation of information in the analytical stage of the process (1985, 4). Ledewitz's suggestion for improvement is a different methodology. She would replace the analysis–synthesis model with what she calls the concept–test model in which the student would begin with a possible solution to the proposed problem and then test the validity of this solution by examining and critically examining relevant data (1985, 4). In other words, Ledewitz would exchange inductive thinking for adductive thinking – that is, the scientific formulation of a hypothesis, followed by an experimental testing of it.

Critics such as Findeli would be quick to point out that Ledewitz's proposal is still fundamentally positivistic in that it assumes both a problem and a solution as the internal nature of the design project. What actually happens in the design studio – the essentially inexplicable creative act of envisioning – suggests that making design education more academically rigorous is not a matter of aligning design education practice more closely with the requirements of the positivist paradigm as it is a matter of establishing a different paradigm altogether, one that might be acceptable to both the university as a whole and design education in particular. Ledewitz's argument improves on the rigour of design studio education, but it does not adequately account for the creative 'leap in the dark' that still exists at the

core of designing. Only an entirely new paradigm can make sense of that.

A new paradigm?

Alain Findeli (2001, 5) asserts that design education is currently undergoing a paradigm shift that promises to revolutionise the field by articulating both a new methodology and a new end for realising design projects. According to this author, design education is still conducted under the epistemological paradigm of positivism that is central to the university model of education. Thus, a project in a design studio is presented as a problem that needs to be solved. The solution is identified and the project becomes the rational or causal link. Findeli believes that the entire design project needs to be conceived in a different way. Instead of a problem and a solution, there would be a system as it now exists and a system as it might exist in the future. The design would not be an application of art or science but an introduction of art or science to the system, resulting in a mutual change in both the art or science and the system. The role of the designer would be to understand the system and to work with it, not against it, for change (2001, 8). Moreover, Findeli argues that design education needs to develop a systems theory that would allow an understanding not only of planned artefacts but also of invisible relations among the inner worlds of designer and the client(s) and the outer worlds of society and the biosphere. Under such a paradigm the end of design would become an open horizon of values and possibilities – not a solution to a problem. To put it another way, both the methodology and the end of design education would be made more complex – and anti-rational – than it already is. The name that is commonly given to this new paradigm is complexity theory.

As Brent Davis points out, complexity theory challenges Cartesian dualism, breaking down the coincidental dyads of mind and body, self and other, and so on into co-implicated simultaneities (2008, 51). According to complexity theory, there is no distinct separation between knower and knowledge. A learner does not assimilate objective truth; instead, he or she creates subjective meanings and values from the educational experience. Moreover, the learning experience leads to insights suggested by a multiplicity of often disregarded phenomena and taken from a wide variety of intellectual disciplines. Similarly, Deborah Osberg et al. observe that complexity theory rejects the standard epistemology of spatial representation of open reality by closed models of knowledge, urging instead a temporal epistemology in which reality and knowledge are not separated but are regarded as an ongoing emergent system (2008, 214). In much the same spirit William Doll states that complexity theory questions the standard Tyler model of the curriculum whereby goals are set and achievement is measured quantitatively by reference to these goals (2008, 190). Instead, complexity theory suggests that education should not be regarded as problem solving in order to find the truth and control behaviour, but as an open-ended process of discovery yielded by assuming the educational process as a whole is a self-organising system with creatively emergent potentialities.

There are two fundamental assumptions of complexity theory. First, based on relativity theory, quantum theory and evolutionary theory – like postmodernism in general – complexity theory rejects the 'Archimedean point' of classical physics. In other words, neither objective methodology nor predictable objective truth is possible. Instead, as Juval Portugali explains, systems are open, fluid and complex. They exchange matter, energy and information with the environment surrounding them, but the parts of the system are so numerous that causes and effects are uncertain. Instead, there are constant feedbacks and feed forwards, and the meanings of the interactions depend on the receiver, not just the system (2006, 651–2). Moreover, complex systems are self-organising. This means they interpret the information in the system and project 'emergent properties' that could not have been predicted from the component parts, and these emergent properties feed back into the system and influence behaviour (Thrift 1999, 34). This brings us to the second defining feature of complexity theory: the whole of a system is greater than the sum of its parts (Reitsma 2003, 13). Because properties emerge from systems in

unpredictable ways, something new is always being generated. In effect, these emergent properties are actually created by the internal interactivities of the system. To sum up briefly, complexity theory is concerned with the internal operation of systems – that is, relations, not objects – and it is limited to an investigation of processes, not products. Complexity theory does not make predictions of truth that can be verified by replication, and it does not provide explanations based on descriptions of its constituent parts. The emergent properties of the whole of the system are what matters, and these are unique.

According to Hans Poser, self-organisation, or *auto poiesis*, always happens at the core of complex systems. 'So the cornerstone of the theory consists in modelling spontaneously formed, ordered macroscopic structures as an outcome of the self-reinforcement of microscopic fluctuations together with selections depending on the constraints' (Poser 2007, 428). This model began with the theory of cybernetics in the 1960s and has since that time become a standard transdisciplinary concept that Hermann Haken in 1977 called *synergetics*. Of special interest to design educators is the fact that complexity theory permits creation or invention in the self-organising emergence of properties. In fact, as Poser (2007, 434) states, 'the occurrence of the new is a constituent part of the process ontology', and this new is not possible to predict or explain. As we have already noted in this article, the creative 'leap in the dark' is the core experience of design studio education. The current positivist paradigm does not adequately account for irrational creativity, but the new complexity paradigm would incorporate spontaneous invention as a natural feature of the process of design education. In fact, complexity theory suggests that the automatic and unpredictable generation of new properties is what *should* happen within complex systems. Thus complexity theory as a paradigm promises to unite science and art and thereby bestow intellectual rigour upon the activity of the design studio.

To propose such a paradigm shift for design education is itself a leap in the dark. Complexity theory is still emergent, and it is certainly not robust yet. As Thrift (1999, 34) observes, this theory represents 'a structure of feeling in Euro-American societies which frames the world as complex, irreducible, anti-closural, and, in doing so, is producing a greater sense of openness and possibility about the future'. Poser points out that complexity theory is much more than a shift in paradigms, in the tradition of Thomas Kuhn's argument (1962). Complexity theory is actually a new worldview that replaces Aristotelian and Newtonian causality (Poser 2007, 428). 'In some respects,' says Manson & O'Sullivan (2006, 678), 'complexity theory is the grand theory to end all grand theories.' As we have seen, complexity theory as a paradigm explains but does not predict, so in effect it is not really scientific at all, even though it is firmly based on mathematics. Therefore, if complexity really could unite science and art, it would do so by making science more artistic instead of by making art more scientific. This would be precisely what Schön always advocated for design studio education: the recognition of tacit knowledge, reflection-in-action and creativity as legitimate forms of university epistemology. Be that as it may, there is no doubt that complexity theory is still questioned by many faculty members working within the university model of education.

As with many new cultural and intellectual trends, there are certainly good reasons to be cautious about the proposal to replace positivism with complexity theory as the paradigm for design education. In the first place, complexity theory derives mainly from physics and biology, and its application to disciplines in the humanities and social sciences is therefore questionable. Perhaps its principal attraction for design educators is its apparent hostility to positivism and its obvious compatibility with John Dewey, Michel Foucault and Jürgen Habermas in its emphasis on experience, openness and diversity of interpretation. Indeed, complexity theory's reliance on qualitative research and individualistic hermeneutics fits well with many educators in the humanities and social sciences. Nevertheless, the very thing that makes complexity theory attractive to many educators in the physical sciences also makes it problematic to educators in the social sciences. We have already

noted that one of the essential features of complexity theory is that it is purely descriptive, not prescriptive. In this sense complexity theory is basically rational and therefore similar to positivism, explaining why complexity theory has a strong following among some physical scientists – despite its lack of precision and its emphasis on personal hermeneutics. As both Lesley Kuhn (2008) and Keith Morrison (2008) point out, however, education in the social sciences is usually regarded as normative by definition. The transmission of values and ethics is a core feature of such education. All things considered, because complexity theory is not normative, does not make verifiable predictions and is not concerned with either truth or control, it probably will not achieve the status of a university paradigm in the foreseeable future, either for the physical sciences or the social sciences.

But what if complexity theory *could* become a paradigm for design education? We must return to our abiding problem of making design studio education more academically rigorous and respectable. Recall that accounting for creativity – the leap in the dark – is the main issue here. As long as positivism is assumed as the paradigm for design education, the subjective and irrational and ultimately mysterious and ineffable nature of design creativity can never be defined and explicated. If this is so, the full glory of academic respectability will always elude design education. If, however, complexity theory were to be established as the paradigm for design education, creativity *could* be articulated as the fluid and unique emergence of new properties from complex self-organising systems of learning.

So far, the adoption of complexity theory as a paradigm appears to be the best hope for the discipline of design education achieving intellectual rigour and complete academic respectability. To a certain extent, the social sciences have already rejected positivism as a paradigm, though they still cling to the normative possibilities that complexity theory lacks. Perhaps design educators could be so bold as to declare that complexity theory should be assumed as their particular educational paradigm. The functioning of the design studio, with its emphasis on the constantly changing intricacy of information and the importance of rapid communication, is already perfectly compatible with complexity theory. All that needs to be done is to formally articulate this fact. Design education cannot be made more rational, but perhaps the university as a whole can be persuaded to recognise a paradigm that promises to be a legitimate alternative to positivism.

A note on HCI and complexity in the design studio

The possible new paradigm offered by complexity theory not only promises to make the pedagogical methodology of design studio education more academically respectable, but it also promises to provide a new model of understanding how human–computer interactions (HCI) can become indispensable to design education. For the past two decades much has been written and debated about the pedagogical effects of using information and communication technologies (ICTs) in university classrooms. Great expectations have been expressed by many university administrators and faculty members, but little empirical evidence has been forthcoming to demonstrate the validity of claims that the advent of ICTs would radically 'transform' educational practice for both teachers and students. As Nora & Snyder (2008/2009, 3) puts it, there has been a missing link of evidence in the argument for the benefits of implementing greater HCI in university classrooms.

Perhaps researchers have been looking for evidence in the wrong place. Mostly, they have studied the effects of ICTs on student performance, but these effects have been typically stated in terms of quantitative measurements of student achievement. A shift to the paradigm of complexity, however, would likely produce different results, because under this paradigm research is mainly concerned with qualitative understanding of the relationship among all the parts of the system. In other words, such research is sociocultural instead of scientific. HCI might not result in students achieving higher performance scores, but it might positively – or negatively – affect their experiences of the educational process in the design studio. Such research promises to be both meaningful and productive.

In fact, Stephen Petrina (2003) argues for the end of 'technical education' in the manner that this concept, sometimes called 'applied' arts and sciences, has been used to identify design education. As Schön (1988, 5) has frequently observed, architecture is a hybrid discipline, spanning both artistic creativity and scientific rationality. Petrina points out that this dichotomy is inherent in C. P. Snow's classic definition of technical education, given at Cambridge University in 1959:

He argued that on one hand, there had developed a culture of engineering and science types – people with a logical, rational, quantitative worldview and a disdain for messiness, politics, and subjectivity. The other culture that had developed was made up of arts and humanities types – people who work qualitatively and merely tolerate, rather than celebrate, objectivity and precision. In one, culture is a protection of humanity from politics, in the other, a protection of humanity from rationality, science, and technology. Both cultures consist of people aspiring to be 'design' and 'technology' educators. Design and technology educators aspire to fit into both cultures and to build bridges, often stretching their imaginations and senses to maintain relations in both. (Petrina 2003, 47)

Petrina argues for a dismantling and reintegration of Snow's two cultures, thereby putting an end to design education as it is commonly understood, while at the same time redefining it and reinventing it with much greater complexity. In Petrina's view, 'sociotechnical knowledge' should be the focus of design education in general and its HCI manifestation in particular. He argues that computer-assisted design (CAD) should not be regarded neutrally as a tool, but should instead, be conceptualised in regard to its technical relations to human, cultural and social concerns.

The ways that CAD fit with the ethical-personal and socio-political dimensions of design education need to be formally articulated. If this were done, the long-standing gap between the artistic and the rational halves of design education would be closed, and the new paradigm of complexity would confer more intellectual respectability on the discipline. The creative 'leap in the dark' at the core of designing would be normalised within the paradigm and would no longer seem to be an unaccountable anomaly. In short, HCI would become a principal feature in the complexification of the culture of design studio education.

Conclusions

The status of design education in general and the design studio in particular appears to have reached a crisis at the present time. Many writers on the topic agree that radical change must occur. The evidence suggests that, compared to the university education model in general, design education has frequently suffered from a lack of intellectual rigour. This has been caused by the fact that tacit subjective knowledge and irrational creativity have always existed at the core of the designing process as it is embodied in the design studio. The result has been that, viewed under the positivist paradigm, the artistic dimension of designing has often been thought to be somewhat lacking in academic respectability. Champions of the design studio – notably Donald Schön with his argument that architectural and other design students should be regarded as 'reflective practitioners' – have argued that the loss of intellectual rigour has been more than compensated by the gain of cultural relevance, but many design educators have felt somewhat uneasy about this argument.

During the past few years, however, a possible shift in the dominant paradigm to design education from positivism to complexity theory has offered a way for design educators to regard their work as being intellectually rigorous after all. This new paradigm is still being articulated at the present time, but it already promises to replace the positivist emphasis on viewing design projects as problems having rational solutions – or, in design education, irrational 'leaps in the dark' – with a complexity emphasis on viewing design projects as intricate systems having many possible relations and meanings that might be defined through both rationality and creativity. Both a new articulation of design education and a greater academic respect for the discipline appear to be possible with a properly careful and thoughtful acceptance of the paradigm of complexity.

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