Thomas Kuhn's influential ideas on scientific progress offer a framework for reconsidering the widely contested issue of style in architectural history and theory.

Kuhn on architectural style

David Wang

By any measure Thomas Kuhn's *The Structure of Scientific Revolutions* is a landmark in recent influential ideas. The very term 'paradigm shift', now common parlance, derives from this 1962 work. *Structure* redirected its own domain, the philosophy of science, from a logical positivist orientation in its evaluation of scientific progress to one that accommodates a complex mix of sociological, linguistic and psychological factors. Perhaps because of this interdisciplinary inclusiveness, Kuhn's insights have informed theory in many disciplines. A survey of the recent literature includes works in anthropology,[1] comparative literature,[2] criminal justice,[3] art history,[4] education[5] and feminist studies.[6]

Here I suggest that Kuhn's theory can also inform evaluations of architectural style. This appraisal of Kuhn's relevance for architecture is useful for two reasons. First, it revisits the notion of style itself. Post-Modernist and Post-Structuralist discourses reject the very notion of style on the grounds that holistic referents ('self', 'history', or in our case, 'style') are illusory constructions enforced by institutionalised conventions. Frederic Jameson, for instance, suggests that while the Modernist aesthetic was predicated on a view of '[...] a unique self [...] which can be expected to generate its own unique vision of the world and to forge its own unique [...] style', in Post-Modernism [...] nobody has that kind of unique private world [...] there is another sense in which the writers and artists of the present day will no longer be able to invent new styles [...]'[7] But while style as a theoretical construct might be dismissed in post-critical discourse, it is harder to dismiss style in the realm of architecture, for no other reason than that buildings are unavoidably *material* manifestations of cultural ideas. Put another way, even if style in Post-Modernist discourse is at best 'style surfing',[8] the ad hoc nature of this practice still results in a consistent (albeit heterogeneous) set of visual attributes.

Certainly this phenomenon is noted in architectural theory proper. Thirty years separate Charles Jencks' *Modern Movements in Architecture* (1973) and his *New Paradigm in Architecture* (2002). The earlier work categorised six traditions under Modernism from 1920 to 1970; these traditions were further parsed into stylistic currents and eddies diagrammed in Jencks' well-known 'evolutionary tree'.[9] But Jencks opens his 2002 work with six other trends, this time for the *new* paradigm of architectural design: Post-Modernism.[10] Shifts in style, then, as a result of social percolations shifting in the *sensus communis* of a culture over time, are a reality of architectural expression despite post-critical rejections of this phenomenon. And in what follows, the similarities between these shifts and shifts in scientific paradigms will be outlined. Indeed, without Kuhn, it is doubtful that Jencks would have even used the word 'paradigm'.

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Now, the *social* nature of style raises the second reason for looking to Kuhn: it supplies new material for mapping common ground between scientific and design activity. The received narrative of Kuhn's seminal 1965 debate with Karl Popper is that the young and recently tenured Kuhn represented a significant departure from the senior Popper's positivistic view of science.[11] Popper held that a scientific theory's validity resides not so much in its ability to predict, but rather in its capacity to be falsified, and this by the reductivist rigours of scientific method. In contrast, Kuhn took scientific theories out of the laboratory, as it were, and placed them into the push-and-pull world of human relations. In short, Kuhn's view of paradigm shifts in science is not unlike – in fact it is quite resonant with – the eddies and currents of Jencks' diagrams for stylistic trends. Later in this paper a difference between architectural style and Kuhnian science will be noted; but in the main, Kuhn's theory reveals much more common ground between science and

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design than does Popper's positivist framework. The point is that appraising architectural styles through a Kuhnian lens reveals that design and scientific inquiry, far from being opposing domains of endeavour, derive from a single deeper structure in the human project of comprehending the cosmos.

Below I first provide an overview of Kuhn's theory. I then define 'architectural style', and delineate seven ways it behaves similarly to scientific paradigms, supported by examples from the Modernist/Post-Modernist shift as well as from earlier eras. I conclude with thoughts on how paradigms may be *different* from styles (largely related to Kuhn's observations about 'progress'), followed by suggestions for further inquiry.

Scientific paradigms and revolutions

Kuhn proposes that 'normal science' occurs when a scientific community coalesces under a systemic but largely unreflective understanding of how nature behaves and consequently how research is to be conducted in accord with that understanding. For instance, in the eighteenth century, light was theorised as comprised of corpuscles; hence scientific research looked for evidence of those corpuscles impinging on solid bodies.[12] On a larger scale, at one time the heavens revolving around the earth was the received view of planetary behaviour; therefore, this Ptolemaic model 'was admirably successful in predicting the changing positions of both stars and planets'.[13]

Light as corpuscles and a geocentric solar system are examples of what Kuhn calls *paradigms*. Those working within a paradigm do not question it, and it is their research activities that Kuhn calls normal science. Normal science research seeks to re-affirm the dominant paradigm; there is no effort to refute it. For instance, it would not occur to those working in the Ptolemaic paradigm to question the underlying assumption of a stationary earth; they simply work *from* that assumption to interpret evidence. As a matter of fact, researchers working within a paradigm tend to reject evidence conflicting with it; at best any such evidence is seen as an *anomaly*. Those who do entertain competing views are often marginalised, or even put in mortal danger: Galileo, for example, feared for his life because of his commitment to a heliocentric solar system.

But a paradigm eventually destabilises. More and more anomalies crop up such that, after a transitory period of crisis, a new paradigm emerges.[14] This is scientific revolution, on Kuhn's view. So radical are these revolutions that researchers working in the old paradigm and those working in the new operate in two different worlds.[15] *Structure* provides many examples of this, but the Copernican revolution – the paradigm shift from a geocentric to a heliocentric view of the solar system – suffices not only to illustrate Kuhn's theory, but also to underline the differences in worldview pre and post a paradigm shift. This is Kuhn's thesis in broad outline. In what follows, I take a closer look at seven aspects of his model and relate them to architectural style.

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Kuhn on architectural style

By architectural style I mean the following:

> For architectural works of a given cultural period, a set of recurring visual attributes compositionally related to each other such that, when the works are considered as a whole, a visual and emotional 'family resemblance' is evident that can be regarded as the aesthetic signature of that cultural period.[16]

The shifts noted by Jencks from Modernism to Post-Modernism are characteristic. An earlier example is Heinrich Wölfflin's comparison of Renaissance and Baroque styles. While the former emphasised fixed proportions, the latter emphasised movement. While Renaissance compositions are symmetrical, the Baroque favoured the asymmetrical. While Renaissance style is planar, highlighting particulars, Baroque style is spatial, highlighting energy and grandeur: 'there is less perception and more atmosphere'.[17] All of this adds up to a different *mood* for Baroque architecture when compared with the mood of the previous style ('every style imparts a more or less definite mood').[18] In the following, I suggest seven similarities between architectural style, *qua* style, and Kuhn's paradigms. These are:

1. A style in architecture resembles a paradigm.
2. The establishment of a style is preceded and followed by competing points of view.
3. A style renders design activity akin to puzzle-solving.
4. Designing in a style does not require following rules.
5. Designing in a style follows *exemplars* rather than rules.
6. Kuhn's disciplinary matrix is relevant for architectural style as well.
7. Normal science and design activity both emerge out of cultural-*aesthetic* percolations.

1. A style in architecture resembles a paradigm.

Architectural history is usually narrated as a progression of styles: Gothic, Renaissance, Baroque, etc. Terms such as 'High Gothic' or 'High Renaissance' denote times when the stylistic attributes of those periods exercised hegemony. Consider this from Janson's *History of Art*: 'One of the strangest aspects of the High Renaissance [...] is the fact that its key monuments were all produced between 1495 and 1520'.[19] What Janson found strange was that the key architects of this period varied in age, but all produced works with similar stylistic features.[20] Additionally, Michael Levy has noted that Renaissance *practice* also shared common features, driven by the new view of the artist as autonomous

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genius rather than as hired craftsman.[21] More recently, Jencks' diagnosis of Adhocism is in the same vein, and he even draws from the Hegelian roots of Wölfflin's logic by using the phrase 'the Spirit of Adhocism'. Like Janson, Jencks' logic for Adhocism as a style is a list of common visual attributes and practices: hybrid forms, contrived spontaneity, 'the pleasure of unexpected recognition', and so on.[22]

Now, Kuhn holds that there are three kinds of normal science activity:[23] 1) Researchers affirm key principles. For example, simply standing in one place while heavenly bodies appear to move overhead is received as affirmation of the Ptolemaic paradigm. 2) Researchers make connections between theory and nature. For example, while relativity theory is now well-established, research is still conducted to demonstrate its accuracy in nature because of instrumental difficulties in measuring the speed of light. And 3) researchers apply their principles to new domains. Kuhn documents the application of caloric theory (an eighteenth-century paradigm of heat as a substance, later replaced by thermodynamics) being applied in chemistry research, or in the behaviour of friction, or of vacuums, and so on. All three types of activity unreflectively accept the guiding paradigm; none tries to contradict it.

We can overlay these same three traits to activity during periods of a dominant style. For example, 1) During the Renaissance, architects uniformly looked to antiquity for guiding principles, so much so that Vitruvius' *Ten Books on Architecture* (first century BC) is older sibling to Alberti's *On the Art of Building in Ten Books* (1440s).[24] And 2) Because the Classical Orders provided design principles based on human proportions rather than on medieval symbolism, Renaissance theory anchored design in nature as it is, and not as symbol. Alberti justified architectural ornamentation because nature is wildly ornamental,[25] and columns are even-numbered because animals do not have odd-numbered legs.[26] As for 3), Leonardo da Vinci's sketchbooks are filled with sketches of nature not only as source material for his paintings, *but also as guiding light for designs of flying machines and such*.[27]

These parallels for activity in research paradigms and architectural styles show that participation in a paradigm is not mere cognitive agreement on things. Rather, it is immersion in a way of seeing that transcends particular acts of decision-making by rooting those decisions in a pre-cognitive, and hence phenomenological, commonality of being. Common traits between an aesthetic style and research under a scientific paradigm arise out of this commonality of being.

2. The establishment of a style is preceded and followed by competing points of view.

Normal science emerges out of pre-paradigmatic stages characterised by facts often at odds with each other. For example, Kuhn says this of Francis Bacon, predecessor in ideas to Descartes: 'Baconian "histories" of heat, color, wind, mining, and so on, are filled with information, some of it recondite [...] they juxtapose facts that will later prove revealing [...] with others that will for some time remain too complex to be integrated with theory at all.'[28] But Bacon's naturalistic philosophy paved the way for Cartesian scientific method. Kuhn's point is that, embedded in the 'inchoate pool of information' typical of pre-paradigmatic stages are elements that survive as the material of paradigmatic theories.

Transitional diversity preceding architectural styles – and the mannerism that typically follows those styles – is well-documented in the literature; here we only need to note the similarity of this phenomenon to Kuhn's pre- and post-paradigm stages. The fifth edition of *The Language of Post-Modern Architecture* (1986) is a previous version of the already-cited *New Paradigm in Architecture* of 2002. In the earlier edition, Jencks writes tellingly as follows: 'Indeed this book is also strange [...] because it has been written and rewritten over a period of ten years as an architecture movement has taken shape. Such movements are rather like military campaigns. Advances on one front are balanced by retreats on another and *general confusion everywhere*'.[29] And yet by 2002, the confusion had coalesced into a paradigm, itself a Kuhnian word. Clearly on Jencks' analysis over time, a distillation of the earlier confusion had taken place.

We see this confusion-to-resolution rhythm in history. Prior to the Renaissance, medieval Christian views overlapped with revived Platonism and Aristotelianism, so that the religious subjects of a painting by Rogier van der Weyden or Andrea Mantegna were nevertheless *naturally* depicted.[30] Giotto's early (and awkward) perspectives also attest to a shift to a preoccupation with the present world rather than with the next, a transition completed in the Renaissance. This was followed by mannerist tendencies (for example, in late Michelangelo) which led to the next resolution in the Baroque, typified by Bernini. Or, previous to Modernism, a rash of competing schools vied for stylistic dominance. For example, J. N. L. Durand, influenced by the rise of the machine, conceived of buildings not as organic wholes but as kits-of-parts.[31] This conflicted with the anti-industrialism of a John Ruskin, or a William Morris. Ruskin held that ornament *is* architecture,[32] while later, Adolf Loos averred that ornament is a crime.[33] One can easily argue that these conflicts were resolved in Le Corbusier, and in Mies van der Rohe's 'less is more', only later to give way to Venturi's 'less is a bore'. Due to space limitations, this is certainly a simplistic overview of complicated progressions in architectural style, but parallels to Kuhn's theory should be clear.

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	Concepts	Theories	Instruments	Methods
Renaissance	Human body as epiphore; Man as measure of all things	Beauty, proportion, ideal cities Theories based on metaphysical considerations	Hand tools and models for production Master and production team model	Models for construction; Artisan work ethic Apprenticeships for propagation
Modernist	The machine as epiphore; Nature replaced by a mechanical world	Utility efficiency, intermixedwith utopianist visons of community (CIAM architecture as social art, etc) The Machine as both utilitarian and utopian instrument	Machines for *convenience*: mass production, the automobile, the elevator, the train, the airplane, etc Centralised office; architect-as-maker model	Representaions for construction; Industrial work ethic; division of labour, mass production Schools and manifestos for propagation
Cybernetic (current)	Computer as epiphore; Nature replaced by virtual world	Diveristy , multiplicty, simulacra, indeterminacy, etc Theories celebrate options	Computers for production Collaborative design model	Virtual reality work ethic (design from remote locations) Computer simulations for construction (e.g.: Gehry) Virtual networks for propagation

1

1 Kuhn's four categories in puzzle-solving overlaid on three periods of stylistic activity

3. A style renders design activity akin to puzzle-solving.
One of Kuhn's most memorable claims is that normal science research is similar to solving jigsaw or crossword puzzles.[34] Since the paradigm is not questioned, what remains is the task of affirming the paradigm in new ways. 'The man who succeeds proves himself an expert puzzle-solver, and the challenge of the puzzle is an important part of what usually drives him on.'[35] Whether the paradigm is Newton's laws, Maxwell's equations, or the laws of fixed and definite proportions in chemistry, each gives the normal science researcher cues for puzzle-solving in four key ways: in concepts entertained, in theories further developed, in instruments used, and in methodologies deployed.[36] In all four areas, the normal science researcher does not attempt to 'think out of the box'. Refer now to Figure 1, which overlays Kuhn's four categories in puzzle-solving over the contents and activities under three architectural styles: *[1]*.

The chart maps the contents of each style to the bounds set by Kuhn's four categories. In turn, problems within each category become solvable puzzles, because each draws from recognised material in its category, in concert with material across the four categories for a given style. The chart is largely self-explanatory, but perhaps the word 'epiphore' under the Concepts column needs clarification. It is from Alexander Tzonis and Liane Lefaivre, who define it this way:

> *Epiphoric objects impose in a non-explicit manner the limits of the conceptual framework within which design argumentation can take place meaningfully. They are everyday objects which, by entering into the argumentation, present in a 'stenographic' way the framework in use. Thus the complex of logical rules, epistemological and deontic statements as well as simple data are all condensed in simple form.*[37]

As epiphoric objects, the human body and the machine regulated design during the Classical period and the industrial age, respectively.[38] Thus epiphores resemble Kuhn's paradigms. Both 'impose in a non-explicit manner the limits of the conceptual framework within which [...] argumentation can take place meaningfully'. (Tzonis and Lefaivre actually invoke Kuhn, but do not develop the connection.)[39] Once accepted, the guiding principles of a paradigm/epiphore bound a discourse such that problems arising for the practitioner amount to solvable puzzles.

A testimonial underlines this point: John Summerson cites this from Edwin Lutyens on designing in the Doric Order:

> *That time-worn Doric order* [...] *You cannot copy it* [...] *You alter one feature* [...] *then every other feature has to sympathize and undergo some care and invention. Therefore it is no mean game, nor is it a game you can play lightheartedly* [...] You cannot play originality with the Orders.[40]

For Lutyens, designing with the Orders was indeed a game, albeit not a lighthearted one. So the challenge of solving problems within the bounds of a paradigmatic style is not only similar to puzzle-solving in normal science, one must assume that similar thrills of success also accompany the solutions. But it is not original work, simply puzzle-solving. In kind, each of Jencks' six editions of *The Language of Post-Modernist Architecture* – prior to changing the name to *New Paradigm* for the seventh edition – sets forth a certain 'pattern' (Jencks' term). These patterns (e.g., supergraphics for the first edition, double-coded hybridisation for the fourth, etc.)[41] act as stylistic meets-and-bounds within which design activity amounts to puzzle-solving.

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4. Designing in a style does not require following rules.
Kuhn holds that normal science research does not depend on transmission of rules but on transmission of models of practice.

> *As the student proceeds from his freshman course to and through his doctoral dissertation, the problems assigned him* [...] *continue to be closely modeled on previous achievements as are the problems that normally occupy him during his subsequent independent scientific career.*[42]

The institutions – schools, research centres, journals – that propagate scientific paradigms play their part in rendering normal science normal. In these venues puzzles are solved because methodological patterns regulate research in its various manifestations.

But the behaviour of institutions only suggests deeper epistemological implications. It is not so much that normal science researchers know the rules, but just do not use them. Instead, Kuhn observes that established scientists themselves 'are little better than laymen at characterising the established bases of their field'.[43] This suggests that research, like design, is essentially a creative activity, or at least rooted in a pre-cognitive way of knowing that defies propositional definitions. An experienced researcher, then, is one who has cultivated that creativity in the context of his professional environment; he is *not* one who can necessarily list the rules of his work when asked. Here Thomas Nickles looks to artificial intelligence to affirm Kuhn's position: the precise difficulty in replicating human intelligence in computers is the latter's need to have everything programmed as rules. The result? 'General rules provided only weak problem-solving power [...] Artificial Reason was surprisingly limited in its problem-solving ability [...] Kuhn's "prediction" came true.'[44]

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The equivalent construct in architecture is not so much model as *type*, or typology. It is now commonly received that design problems are 'wicked' in that they usually involve neither fixed parameters nor fixed (ideal) solutions.[45] Bryan Lawson notes that good design solutions can be had from unclear initial briefs, that briefs are themselves by nature incomplete, but that there is every confidence that good alternate designs are possible for every brief.[46] It goes right to the heart of the mystery of design knowledge and process – and why typology plays such a large role in that process. Introduced in the early nineteenth century by Quatremère de Quincy, type is very like the Kuhnian notion of model:

> *The word type represents not so much the image of a thing to be copied as the idea of an element that must itself serve as a rule for the model* [...] *Everything is precise and given in the model; everything is more or less vague in the type. Thus we see that the imitation of types involves nothing that feelings or spirit cannot recognise.*[47]

Type, then, is something like an abiding general sense of the appropriateness of a form for a function without resort to a formula for a *particular* form or function – hence architects do not follow rules. Kuhn's reference that seasoned scientists 'are little better than laymen at characterising the established bases of their field' is also an apt description of seasoned designers as well. This raises the related matter of exemplars.

5. Designing in a style follows exemplars rather than rules.
Kuhn introduced the word 'exemplar' in his 1969 'Postcript' to *Structure*:

> *By it I mean* [...] *the concrete problem-solutions that students encounter from the start of their scientific education, whether in laboratories, on examinations, or at the ends of chapters in science texts. To these shared examples should* [...] *be added at least some of the technical problem-solutions found in the periodical literature that scientists encounter during their post-educational research careers and that also show them by example how their job is to be done.*[48]

Parallels to design and style are again clear. Architectural education relies heavily on shared examples. This is due in part to the inherent difficulty of making design processes rule-based, so students are shown likenesses of what their designs should look like – from the Parthenon to Gehry's Guggenheim Museum in Bilbao. These exemplars, then, are emulated again and again in design projects in the studio, in practice, by journals, office culture and professional meetings. What is acquired is not propositional knowledge, but *tacit* knowledge, a term used by Michael Polanyi, whom Kuhn cites.[49] For his part, Polanyi holds that art of all kinds is generated by maxims, which he significantly describes as follows: 'Maxims cannot be understood, still less applied by anyone not already possessing a good practical knowledge of the art [...]'[50]

The use of exemplars (shared examples) can be seen in recent efforts by the American Institute of Architects to identify a host of 'Best Practices', ranging from Understanding Clients, to Firm Planning, to Risk Management, to Resources for the Public.[51] These best practices are *cases*, and this jibes with some current work being done in Kuhnian studies that assess exemplars from the standpoint of case-based reasoning (CBR). CBR solves a conundrum in Kuhn's theory: if normal science rejects anomalies, how do anomalies also stir innovation on the way towards revolution? The CBR answer is as follows. Rather than starting from rules, CBR 'selects from memory and adapts one or more nearby problem solutions [...] thus, it locates innovation *within a kind of history or tradition of previous efforts*'.[52] This approach suggests that normal science research and design activity are not all that different in their dependence on exemplars – now understood as cases with both historical as well as normative dimensions – as a means to move practice along. In this process, there is both the stability of the paradigm (or the style) in that the exemplary cases enforce normalcy.

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But instability is also embedded, because if knowledge-formation accommodates 'nearby problem solutions', those slight shifts from the exemplary standard can eventually result in revolutions – or stylistic change.[53]

6. Kuhn's disciplinary matrix is relevant for architectural style as well.

The above comparisons draw scientific paradigms and architectural styles ever closer together by suggesting that both domains spring from common sources, first in cognitive processes, but also as cultural practices (of which more below). Thus it is not surprising that Kuhn's disciplinary matrix for normal science can also be applied to style. A disciplinary matrix consists of: 1) symbolic generalisations, 2) shared commitments, 3) values, and 4) exemplars.[54] I now briefly relate the first three to style, exemplars having already been addressed:

Symbolic generalisations. These are 'expressions deployed without question or dissent by group members, which can readily be cast in a logical form'. In the sciences these expressions are often equations (e.g.: *f=ma*); but they do not have to be (e.g.: 'elements combine in constant proportion by weight'). Without these generalisations, researchers cannot engage 'in their puzzle-solving enterprise'. Now, in relation to architecture, I have shown elsewhere that 'logical argumentation' is the very nature of architectural theory-building – and that this kind of argumentation ranges from the quantitative (Mathematical-Formal, such as shape grammar) to the highly qualitative (Cultural/Discursive, such as polemical utterances).[55] The symbols used to convey these frameworks are the symbolic generalisations of design. Mies van der Rohe's 'less is more', for example, is a symbolic generalisation that guided the puzzle-solving activity of architects designing in the Modernist style.

Shared commitments. In normal science, shared commitments are the unreflective understandings of what nature is and how it works; from these the group frames 'permissible analogies and metaphors'. As example, 'sustainable design' certainly has the look of a current design paradigm guiding normative practice. It fosters commitments ranging from pedestrianism in neighbourhoods, to off-grid living, to hybrid automobiles, and so on. Organisations stimulate cultivation of these commitments – UNESCO's 'Sustainable Priorities' come to mind,[56] or in the United States, LEED certification is now *de rigueur* for environmentally conscious designers.[57]

Values. Different from commitments, shared values in normal science drive *expectations*, such as a theory should be simple, have predictive powers, and be socially useful. Another important value is consistency: a theory should be consistent with other theories and activities in the domain. To clarify consistency, Kuhn uses an example, significantly, *from the plastic arts*: 'Men did not all paint alike during the periods when representation was a primary value, but the developmental pattern of the plastic arts changed drastically when that value was abandoned'.[58] Values, then, enable practitioners in a paradigm (read: style) to place individual stamps on their puzzle-making and puzzle-solving while still keeping the overall collection of puzzles looking similar. For example, Mies' Barcelona Pavilion would simply not come out of the values of sustainable design; it would not be energy-conscious.

7. Normal science and design activity both emerge out of cultural-aesthetic percolations.

All of the above leads to this seventh similarity. In the preface to *Structure*, Kuhn recalls his early experiences that ultimately led to his mature insights. In sum, he came to realise that those insights only made sense when set in context of 'the sociology of the scientific community'.[59] Here I expand on what this means, for science as well as style. Neither a paradigm nor a style can attain hegemony unless and until a community agrees to it, and then promotes it. Significantly, in the case of paradigms, Kuhn appeals to *aesthetic considerations* to explain how a sanctioning community emerges:

> *Something must make at least a few scientists feel that the new proposal is on the right track, and sometimes it is only personal and inarticulate aesthetic considerations that can do that. Men have been converted by them at times when most of the articulate technical arguments pointed the other way. When first introduced, neither Copernicus' astronomical theory nor De Broglie's theory of matter had many other significant grounds of appeal. Even today Einstein's general theory attracts men principally on aesthetic grounds* [...].[60]

By aesthetic Kuhn does not mean anything overtly art-related, but the generally inarticulate manner in which group consensus usually forms. Something in the body politic stirs a shift in focus and *sentiment*. Wölfflin's theory of how Renaissance style morphed to Baroque is an example: he suggests that a communal *sense* about how material forms reflect the corporality of the human body started the shift, reflected in the work of transitional architects, in ways already noted earlier in this article – Giacomo della Porta's design of Il Gesu is one example.[61] Similarly, Jencks' analysis of the underlying motivation for the Post-Modern highlights sensual preoccupation with linguistic equivalents for architectural forms: syntax, words, semiotic groups, signifiers, etc.[62]

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After communal acceptance, Kuhn looks to textbooks as evidence of the sociological aspect of paradigm propagation. They are the 'inevitable concomitant of the emergence of a first paradigm in any field of science', and their mission is to perpetuate normal practice.[63] Textbooks smooth out the bumps and bruises of pre-paradigmatic periods by reporting just the exemplary cases, so much so that this is one reason why revolutions are rendered 'invisible'. In the architectural realm, survey history books fit this mould – Janson's, for one, or Jencks' for another. Another parallel to Kuhn's textbooks are treatises. Venturi's *Complexity and Contradiction in Architecture* is probably more pivotal than any of his built works because it is a treatise – a textbook in the Kuhnian sense – that informed the normal design activities of a generation of Post-Modernist architects.

Do architectural styles progress?

Although *Structure* often draws parallels to other domains, Kuhn held that science research is characterised by one unique distinction: progress. Kuhn supplies no definition for the word, but rather parameters for what progress might look like. More salient for us is Kuhn's implicit, and hence general, assumption throughout *Structure* that science deals with an empirical reality external to human subjective constructions, and that this reality disciplines science researchers in formulating problems and solutions. I suggest that it is this assertion that can better inform a Kuhnian notion of progress. Kuhn notes:

> *The scientist must* [...] *be concerned to understand the world and to extend the precision and scope with which it has been ordered. That commitment must, in turn, lead him to scrutinise, either for himself or through colleagues, some aspect of nature in great empirical detail. And, if that scrutiny displays pockets of apparent disorder, then these must challenge him to a new refinement of his observational techniques or to a further articulation of his theories* [...].[64]

It is this characteristic of the sciences within which a definition of progress can be framed and, because of this, a *difference* between scientific paradigms and design styles must be identified. Although architecture clearly relates to an external world – theorists from Vitruvius to Tschumi have tried to situate their frameworks in larger empirical domains – *there is much greater liberty to re-define nature in terms of the work of design* than in cases of scientific research. Nature in Vitruvius is not the nature in J. N. L. Durand at the dawn of the industrial age. In turn, Durand's nature is certainly not the nature of a van Doesburg or a Mondrian. Here, for instance, is Mondrian in 1917: '[...] the life of contemporary cultivated man is turning gradually away from nature [...] it becomes more and more abstract life'.[65] Science research has little to no leeway to re-define empirical nature in this way. Yes, the nature that Einstein understood is different from nature as Newton saw it, but that difference is rooted in the explanatory theories of the two, not in nature itself. Einstein's theory represents progress because it was an advance – or to use Kuhn's term, a 'new refinement' – of knowledge of nature in comparison to Newton's theory.

'In architecture and in the arts in general, this reference to the constancy of empirical nature is generally absent. Design productions are essentially additions to, or reinterpretations of, that nature by way of plastic forms that largely come out of the creative imagination.'

In architecture and in the arts in general, this reference to the constancy of empirical nature is generally absent. Design productions are essentially additions to, or reinterpretations of, that nature by way of plastic forms that largely come out of the creative imagination. Each in this sense is a stand-alone work. Subsequent stand-alone works can be said to be improvements of previous ones for any number of reasons. But considered as a body of work, and as bodies of work through time, these 'improvements' (refinements) do not add up to what can be regarded as progress in the scientific sense.

But two additional observations can be made. First, architects commonly justify their works in the name of progress, and since the Industrial Revolution these justifications have been indexed to *scientific* developments. For instance, when Le Corbusier stated that a new era had dawned and called for a new architecture to match, his points of reference were the technological novelties of the day: aeroplanes, steamships, automobiles.[66] Houses and cities were to be machines for living in – and this was regarded as progress. Second, insofar as progress *can* be used to describe architecture through history, *it is only in how buildings incorporate the productions of science and technology that such a term is understandable*. For example, for today's buildings to have mechanical heating and cooling is certainly progress compared with their counterparts in centuries past. And when we marvel that Roman baths piped hot water for interior heating, it is only because such a design was 'ahead of its time' from a technological point of view – which is to say, from the point of view of progress.

Does this difference in progress void the similarities between paradigms and architectural styles? On the weight of the evidence above, it probably does not. But it is a theme that surely calls for additional contemplation, and it is one of several such themes that I now summarise to conclude.

Themes for additional inquiry

1 Differences between science and art are often argued from the standpoint of *utility of outcomes*. Science, informing technology, yields useful ways by which nature can be harnessed (this attitude from Bacon and Descartes). Art does not. In fact, since Kant, productions of fine art are such precisely because they are *non*-utilitarian, and so their beauty can only be a disinterested one. But

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the above comparisons suggest that science inquiry and design activity are strikingly similar *at the level of creative generation*. Kuhn repeatedly uses the words 'creative' and 'creativity' to describe the research endeavours of science researchers. There might be fruit in framing a single conceptual model for science and art, not in terms of object-oriented outcomes and their utility, but rather in terms of their origins within the creative imagination.[67]

2 A limitation of the definition of style provided here is that it only addresses the temporal aspect. But dominant styles have reach not only temporally but also spatially, and with the spatial dimension come such realities as regional or national styles (e.g., Chinese architectural style, Gothic in the British Isles as opposed to Gothic on the Continent, etc.). A. W. N. Pugin's call for a 'pointed architecture' for England, for example, comes to mind. Jencks' 'evolutionary trees', diagramming the stylistic eddies and flows of Modernist architecture through most of the decades of the twentieth century, can benefit from a re-distribution of its contents geographically.[68]

3 A third theme for further inquiry concerns the question of *scale*. When his 1962 text and his 1969 'Postscript' are taken as a whole, there is some confusion in Kuhn's use of 'paradigm', 'worldview', 'exemplar' and 'disciplinary matrix'. At times one term seems synonymous with another; at other times one is under the umbrella of another. I am not suggesting that design research sort these concepts out; that task can be left for Kuhn experts. But at the core of the confusion is the question of scale – and this is relevant for design inquiry. My view that style itself is still an operative reality has been explained. But how small of a reach, both temporally and spatially, must sets of visual attributes have before they can be regarded as styles? Despite my critique of the post-critical position on the legitimacy of style as such, it is certainly true that the trajectory of ideas has splayed into many trajectories. This cannot be said, for example, of the Renaissance. As we have seen, the Kuhnian account of paradigm shifts recognises heterogeneity pre and post an established paradigm, but not during one. On the strength of the argument of this essay, I suggest that assessment of a hierarchy of scales, or a branching of stylistic trajectories under a general 'umbrella' of shared attributes (and perhaps this is where spatial considerations become relevant), may be more fruitful for architectural theory than an outright rejection of the possibility of style as such.

Notes

1. John Tresch, 'On Going Native: Thomas Kuhn and Anthropological Method', *Philosophy of the Social Sciences,* 31.3 (2001), 302–322.
2. Robert Weninger, 'Comparative Literature at a Crossroads? An Introduction', *Comparative Critical Studies,* 3.1–2 (2004), xi–xix.
3. Alexander W. Pisciotta, 'Theoretical Perspectives for Historical Analyses: A Selective Review of the Juvenile Justice Literature', *Criminology* 19.1 (1981), 115–130.
4. Caroline Jones, 'The Modernist Paradigm: The Artworld and Thomas Kuhn', *Critical Inquiry*, 26.3 (2000), 488–528, and 'Response' to Michael Fried commentary in subsequent issue of *Critical Inquiry*, 27.4 (2001).
5. Michael R. Matthews, 'Thomas Kuhn's impact on science education: What lessons can be learned?', *Science Education*, 88.1 (2004), 90–118.
6. Helen E. Longino, 'Does The Structure of Scientific Revolutions Permit a Feminist Revolution in Science?', in *Thomas Kuhn,* ed. by Thomas Nickles (Cambridge and New York: Cambridge University Press, 2003), pp. 261–281.
7. Frederic Jameson, 'Postmodernism and Consumer Society' in *The Anti-Aesthetic: Essays on Postmodern Culture,* ed. by Hal Foster (New York: The New Press, 1998), pp. 131–132.
8. A term coined by the anthropologist Ted Polhemus, *Style Surfing: What to Wear in the 3rd Millennium* (London: Thames and Hudson, 1996).
9. Charles Jencks, *Modern Movements in Architecture* (Garden City, N.Y.: Anchor Press/Doubleday, 1973), pp. 28–94.
10. Charles Jencks, *The New Paradigm in Architecture* (New Haven and London: Yale University Press, 2002), p. 9.
11. Steve Fuller, *Kuhn vs Popper* (Duxford, Cambridge: Icon Books, 2003).
12. Thomas Kuhn, *Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962), p. 12.
13. Kuhn, p. 68.
14. *How* anomalies accrue to the tipping point of a revolution is a point of debate in Kuhnian studies. If anomalies are by definition rejected, why would more of them matter? Or, at what point would they begin to matter, and why? What turns on this question is whether or not Kuhn's thesis of revolution is accurate at all. If anomalies 'accrue' to the point of paradigm change, as Thomas Nickles points out, then the case may be more one of evolution than revolution. See Thomas Nickles, 'Normal Science', in *Thomas Kuhn*, pp. 152–153.
15. 'Revolutions as Changes in World View', in Kuhn, pp. 111–135.
16. The limitation to this definition is that it only considers style in time, not in space, and I address this in the Conclusion.
17. Heinrich Wölfflin, *Renaissance and Baroque*, trans. by Kathrin Simon (Ithaca, N.Y.: Cornell University Press, 1968), p. 85. See also pp. 29–37.
18. Wölfflin, p. 77.
19. H. W. Janson, *History of Art* (Englewood Cliffs, N. J.: Prentice-Hall, 1969), pp. 348–349.
20. Bramante, Raphael, Titian, da Vinci; Janson, p. 349. Wölfflin's list includes the same names, adding Michelangelo, Vignola (but does not mention Leonardo); Wölfflin, pp. 17–22.
21. Michael Levy, *Early Renaissance* (London: Penguin, 1967), see for instance his treatment of Ghiberti, pp. 23–25.
22. Charles Jencks and Nathan Silver, 'Adhocism' in *Theories and Manifestoes of Contemporary Architecture,* ed. by Charles Jencks and Karl Kropf (New York: Wiley-Academic, 2006), pp. 49–51. The article is comprised of excerpts from Jencks and Silver, *Adhocism* (London: Secker and Warburg, 1972).
23. Kuhn, pp. 23–34.
24. For example, Bramante's *Tempietto* in Rome is often cited as the epitome of application of these principles during the Renaissance: 'in the three-step platform, and the

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severe Doric order of the colonnade, Classical temple architecture is more directly recalled than in any fifteenth-century structure'. Janson, p. 353.
25. Leon Battista Alberti, *On the Art of Building in Ten Books*, trans. by J. Rykwert, Neil Leach, Robert Tavernor (Cambridge, Mass.: MIT Press, 1994), Book VI, pp. 155–156.
26. Alberti, Book IX, p. 303.
27. See for example Carroll Gray, 'Leonardo da Vinci' <http://www.flyingmachines.org/davi.html> [accessed 18 November, 2008]. 'Leonardo, born in Vinci, Italy, possessed a genius which went far beyond simply being a remarkable artist. He was, perhaps, the first European interested in a practical solution to flight.' Etc.
28. Kuhn, p. 16.
29. Charles Jencks, *The Language of Post-Modern Architecture* (New York: Rizzoli, 1987), p. 6. Italics added.
30. Levy, pp. 16, 39–40.
31. J. N. L. Durand, *Precis of the Lectures on Architecture* (Los Angeles: Getty Research Institute Publications Program, 2000).
32. John Ruskin, 'The Lamp of Sacrifice' in *The Seven Lamps of Architecture* (New York: Dover Publications, 1989). 'But if to the stone facing of that bastion be added an unnecessary feature, as a cable moulding, *that* is Architecture [...]', p. 9. Italics in text.
33. Adolf Loos, 'Ornament and Crime' in *Programmes and Manifestoes on 20th Century Architecture*, ed. by Ulrich Conrads (London: Lund Humphries Publishers, 1970), pp. 19–24.
34. 'Puzzles are, in the entirely standard meaning here employed, that special category of problems that can serve to test ingenuity or skill in solution. Dictionary illustrations are "jigsaw puzzle" and "crossword puzzle", and it is the characteristics that these share with the problems of normal science that we now need to isolate [...]', Kuhn, p. 36.
35. Kuhn, p. 36.
36. Kuhn, p. 42.
37. Alexander Tzonis and Liane Lefaivre, 'The Mechanical Body versus the Divine Body: The Rise of Modern Design Theory', *Journal of Architectural Education*, 29 (1975), 4–7.
38. In the above-referenced article Tzonis and Lefaivre analyse only the shift from the Renaissance epiphore (or what they call the Classical, or Antique period) to the Machine epiphore. The computer epiphore is my extrapolation of their analysis for the present day.
39. Tzonis and Lefaivre, p. 7.
40. John Summerson, *The Classical Language of Architecture* (London: Thames and Hudson, 1980), p. 27. Summerson is here citing Edwin Lutyens; he does not provide a reference. Italics added.
41. Jencks, *New Paradigm in Architecture*, p. 7.
42. Kuhn, p. 47.
43. Kuhn, p. 47.
44. Nickles, 'Normal Science', in *Thomas Kuhn*, pp. 159–160.
45. Horst Rittel, 'Second Generation Design Methods' (1972). Reprinted in *Developments in Design Methodology*, ed. by N. Cross (Chichester: John Wiley & Sons, 1984), pp. 317–327.
46. Bryan Lawson, *What Designers Know* (Oxford, UK, and Burlington, MA.: Architectural Press/Elsevier, 2004), pp. 10–26.
47. Translated in Aldo Rossi, *The Architecture of the City* (Cambridge, MA.: MIT Press, 1994), p. 40.
48. Kuhn, p. 187.
49. Kuhn, pp. 191, 196. Tacit knowledge informs '[...] skills that cannot be fully accounted for in terms of their particulars' – riding a bicycle is one example Polanyi gives. Michael Polanyi, *Personal Knowledge* (Chicago: University of Chicago Press, 1958), p. 50. We can say it is the *art* of bicycle riding because tacit knowledge characterises art-production.
50. Polanyi, p. 31.
51. The American Institute of Architects, 'Best Practices: How Can I Share My Knowledge?', <http://www.aia.org/bestpractices> [accessed 18 November 2008].
52. Nickles, 'Normal Science', in *Thomas Kuhn*, p. 161. Italics added.
53. I am grateful to my doctoral students; it was during a class discussion with them on Kuhn and Nickles when the insights in this paragraph became clear. They are: Ali Ilhan, Isil Oygur, Vinay Kantharia, Maryam Afshar, Amber Joplin, and Monica Stenzel.
54. Kuhn, pp. 182–187.
55. David Wang, 'Logical Argumentation', in Linda Groat and David Wang, *Architectural Research Methods* (New York: John Wiley & Sons, 2002), p. 307, see pp. 301–340 for context.
56. UNESCO, 'Developing Ethical Principles and Guidelines for Sustainable Development', <http://portal.unesco.org/en/ev.php-URL_ID=1218&URL_DO=DO_TOPIC&URL_SECTION=201.html> [accessed 18 November 2008].
57. US Green Building Council, Leadership in Energy and Environmental Design <http://www.usgbc.org/DisplayPage.aspx?CategoryID=19> [accessed 18 November 2008].
58. Kuhn, p. 186.
59. Kuhn, p. vii.
60. Kuhn, p. 158.
61. Wölfflin, pp. 103–106.
62. Jencks, *New Paradigm in Architecture*, pp. 25–49.
63. Kuhn, p. 137.
64. Kuhn, p. 41.
65. Piet Mondrian, De Stijl. Quoted from Hanno-Walter Kruft, *History of Architectural Theory From Vitruvius to the Present* (New York: Princeton Architectural Press, 1994), p. 379.
66. Le Corbusier, *Towards a New Architecture*, trans. by Frederick Etchells (New York: Dover, 1986). This theme permeates the text, but I have pp. 89–148 specifically in mind.
67. The present author offers one attempt of this in David Wang and Amber Joplin, 'The Design Substrate: The Phenomenological Unity Enabling Howard Gardner's Theory of Multiple Intelligences', *Environmental and Architectural Phenomenology Newsletter*, 20.1, 10–15.
68. One version of this tree is found in the Fifth edition of Jencks, *The Language of Post-Modern Architecture*, p. 80. Another is found in Jencks, *Modern Movements in Architecture*, see note 9.

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David Wang is professor of architecture at the Interdisciplinary Design Institute of Washington State University Spokane. He teaches theory and research methods courses in the graduate design programmes housed at the Institute (DDes, MS.Arch, MLA, MID, M.Arch).

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