TRIALOG 106

Zeitschrift für
das Planen und Bauen
in der Dritten Welt

3 / 2010

Designing for People

PAR Amos Rapoport

Editorial

This special issue of TRIALOG is dedicated to **Amos Rapoport**, the architect who became famous for his writings on vernacular architecture in the 1960s and 1970s. Unlike other authors of that time, he went beyond just phenomenologically describing traditional architectures of the world, and also presented a theory explaining a genesis of their forms.

His essay 'Designing for People – Some Implications', presented in this issue of TRIALOG, is an original text based on a conference held in Darmstadt on the occasion of TRIALOG's 25th jubilee in January, 2010. In this text he turns to contemporary architecture and its frequent shortcomings in design, which he blames on the widespread refusal of the architectural profession to conduct and apply serious research as a basis of their work.

Rapoport is returning to Darmstadt again for the presentation of this publication in September, 2011. This will occur within the framework of another symposium organised by PAR, the Department of Planning and Building in Non-European Regions at Darmstadt University of Technology. This event, 'Taming the Megacity', will also commemorate the 31 year history of PAR, which has also been the home of TRIALOG since day one. PAR will be closing down this year following the retirement of its director, Professor Dr. Kosta Mathéy. However, Kosta Mathéy, a member of the TRIALOG steering committee, will continue his engagement with the TRIALOG association and journal from his new base elsewhere.

Apart from Amos Rapoport's essay, there are only two other and shorter papers included in this issue of TRIALOG. They are both inspired by Amos Rapoport's earlier publications – among which the book 'House Form and Culture' (1969) probably is most widely known. **Franco Frescura**, another authority on the documentation and critical analysis of rural and vernacular architecture in Southern Africa, expands in his article 'From Vernacular to High Design' on Rapoport's references to architectural form and social formation.

The paper 'Cultural Identities, Social Cohesion, and the Built Environment', by **Kosta Mathéy**, documents a lecture given by the author in Brazil, 2010. It, too, is inspired by Rapoport's 'House Form and Culture', but takes it to the urban scale. Mathéy argues that in order to overcome the uniformity of the built environment in the age of globalization, the lost cultural identity of place can and must be recovered by consciously incorporating the combination of various design factors that are unique to each particular place.

Last but not least, we want to draw our readers' attention to Amos Rapoport's vernacular design image archive; it contains over 25,000 slides taken by Prof. Rapoport himself since the 1950s and includes depictions of vernacular settings from over 70 countries. It can be accessed under <www.sadp.ku.edu/rapoport>. A bibliography of Rapoport's publications up to 1970 can be found under <www.archive.org/details/bibliographyofwr331mill>.

Silvia Matuk *Kosta Mathéy*

TRIALOG 106

**A Journal for
Planning and Building
in the Third World**

3 / 2010

Designing for People

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Volume editors: Kosta Mathéy, Silvia Matuk

Designing for People—Some Implications

Amos Rapoport*

Entwerfen für die Nutzer – einige Schlussfolgerungen

Wenn wir die Forderung 'Designing for People' bzw. „nutzergerechtes Entwerfen“ ernst nehmen, bedeutet dies in der letzten Konsequenz eine komplette Umorientierung in der Praxis von Architektur und Städtebau – und dementsprechend auch der Ausbildung in diesen Fächern. Gemeint ist damit, dass sich Architekten und Umweltplaner/innen von der Vorstellung trennen müssen, zu den künstlerischen Berufsgruppen zu zählen mit einem sozial sanktionierten Ausmaß an Narrenfreiheit und Autozentrismus. Es ist an der Zeit, auch die räumlichen Planungsberufe auf eine wissenschaftliche Basis zu stellen.

Der künftige Entwerfer wird seine Erfüllung darin finden, Probleme und Aufgaben folgerichtig zu identifizieren (statt lediglich zu definieren) und Lösungen auf der Grundlage explizit wissenschaftlicher Kriterien zu entwickeln, statt allein das persönliche Gefallen am Erscheinungsbild eines räumlichen Entwurfs als Bewertungsmaßstab heranzuziehen. Entscheidungen mit langem Verfallsdatum müssen den besten verfügbaren Prüfkriterien standhalten können: der wissenschaftlichen Nachweisbarkeit. Zukunftsrelevanter räumlicher Entwurf, Praxis und Ausbildung berücksichtigen gleichermaßen ein durch empirische Forschung gestütztes Wissen, ebenso wie ein stabiles Theoriegerüst. Doch da ein solcher Ansatz bislang von den klassischen Architekturdisziplinen wie auch den progressiveren 'Environmental Behaviour Studies' (EBS) vernachlässigt worden ist, müssen Theoriebildung wie empirische Beweisführung noch den Erfordernissen der Umweltplanung angepasst werden. Verschiedene Forschungsansätze (Grundlagenforschung, ‚übertragende' Forschung, angewandte Forschung sowie die vom Autor als ‚informell' bezeichnete) müssen fester Bestandteil der Curricula für Architekten und Umweltplaner werden – andernfalls gehören diese Disziplinen nicht an eine Universität.

Noch bleibt die Umsetzung solcher Forderungen Utopie und die einschlägigen Ausbildungsstätten sind weit davon entfernt, eine nutzergerechte Planung der gebauten Umwelt zu unterrichten. Um diese Situation zu ändern, sollte man zuerst mit den Grundlagen beginnen: die richtigen (Lebens-) Erwartungen fördern, eine praktische Ausrichtung sowie einen besseren Zugang zu und systematische Auswertung von Information.

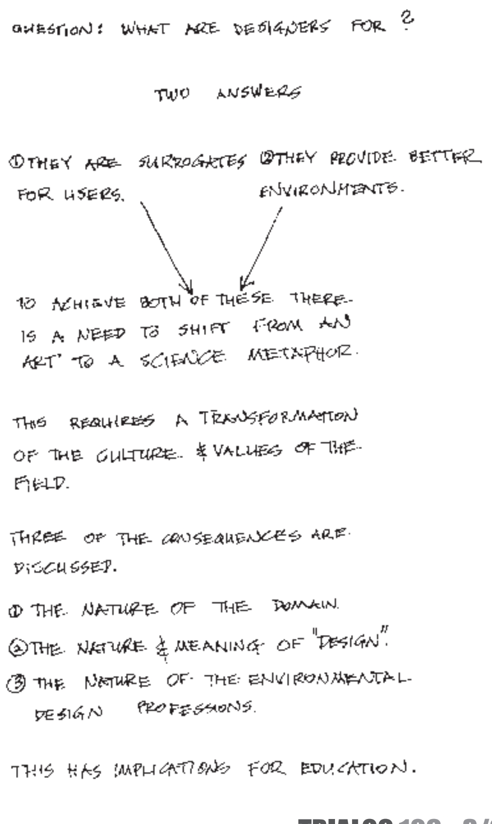
Introduction

I begin by asking an apparently simple question: Why do we have professional designers, what are they for? From my perspective two answers are possible. The first is that designers are surrogates for users, doing what users cannot do, or do not wish to do themselves. The second answer is that designers are supposedly able to provide better environments than others are able to do.

These two answers lead to a single conclusion: The primary reason for having designers is to provide the “best,” i.e. most supportive possible environments for those people called “users.” If they do not do that, and largely they do not, they are not needed, they become exterior decorators and, in many (if not most) cases, the public is not too happy with the results (Rapoport 1987[a]). (Fig. 1)

This is reflected in the low public esteem of architects (Glancey 1985). The result (in the same issue of the RIBA Journal, p. 9) is that the “latest survey reveals earning [of architects] are now lower than ten years ago.”[1] In a report by the Board of Architects of Queensland [Australia] on the ’85 Workshop, the synopsis by S. Ryan, Chapter President of the RAIA, says : “If the profession at large continues on its present course, unless it accepts the challenge of rethinking and redirecting its role, it will face decline and risk oblivion. If the impact of the architect…

Figure 1: Structure of the argument



* This paper is based on verbal presentations at Oxford in 2009 and Grenoble and Darmstadt in 2010. Although the references may appear rather extensive they are, in fact, highly selective; also they stop arbitrarily with material at hand on July 31, 2010.

1
I have not looked at more recent figures, or in other countries, but I believe architects are still grossly underpaid relative to other professionals.

2
As used here environmental design includes urban design, landscape architecture, architecture, interior design and hence, possibly also product design. Note, however that most of what I say is particularly relevant to architecture.

3
I did not deal with “contradiction” since there is no scientific research on it nor, currently, is its meaning clear.

is restricted to the visual effect of a building, frequently determined by a questionable preoccupation with trends and fashions, the architectural profession will become largely irrelevant….to the built environment." (Architecture Australia (Institute publication) vol. 75, no. 1., Jan., 1986, p. 72).

This paper proposes one way of rethinking and redirecting the environmental design[2] professions.

Designing for People

On the face of it, this seems both obvious and straight forward. If taken seriously, however, it has extensive implications and leads to different views of the nature of the domain, of design, of the environmental design professions, and hence, also of environmental design education.

In order to design for people one needs to know about people. Neither guessing nor using oneself as a guide will do. The latter is particularly dangerous because designers are very different to users, as a large research literature shows. One result is that preferences vary greatly, at scales ranging from cities to interiors, and products and furnishings (e.g. Rapoport 1977, 1990f; Brower 1988, Nasar 1998, Bishop 1983, Groat 1979, 1982, Groat and Canter 1979, Gifford et al. 2000, 2002, Hunt Thompson Associates 1988, Norman 1988, Kron 1983, Goldberger 1981, among many others). A Study of 15 manufactured objects based on actual choice (purchases from J.C. Penney) showed 11 were evaluated in completely different ways by designers and users (Hanna 1986, cf. discussion in Rapoport 1995g). Designers and users had entirely different environmental quality profiles (Rapoport 1995e (1989) discussed later).

The result of using oneself as a guide for design leads to what Ellis and Cuff have called "architects' people" and Brower has called "planners' people." It is significant that, as will be discussed later, the equivalent in economics "homo economicus" is being replaced by more realistic, research-based knowledge about human behavior. Thus both designing for mythical people or for oneself are both unacceptable. What is required is knowledge about people.

Consider an example of the latter. Venturi (1966 p. 21) begins: "I like complexity and contradiction in architecture…." as a basis for design that is quite irrelevant (except in a designers' own environment). Contrast that with my own work on complexity[3] (starting in 1967). Only research, both ethological (starting with planarians!), and psychological, can be used to justify a need for complexity as well as revealed preferences for different levels of complexity in different contexts.

Moreover, to be useful a number of questions need to be answered: What is complexity? How is it measured? How much is needed where and when (and how does one know?) Are there group variations in this need or preference? And so on. These, in turn, all require research-based knowledge. Based on such research I hypothesized that design of paths need to be related to the speed of movement relative to certain rates of information input (Rapoport 1977, esp. pp. 207-2477, Rapoport 1990c, esp. pp. 261-287). That hypothesis is empirically testable and has been tested. In an unpublished re-analysis of earlier work (Thiel and Nitzschke 1968), Thiel (April 28, 2001) compared movement on an expressway, a street and in a garden. He found the respective rates to be 0.380, 0.375 and 0.40 events/sec. This rate of movement is selected by users to maintain preferred rates of stimulation (between over arousal and boredom) which is complexity. Taken together with other evidence scattered in many fields this shows the beginning of cumulativeness. Note also how long this information has been available with no apparent impact on design.

In this discussion I raised the possibility of differences among groups. This is a most important issue. Users need to be identified and designers are often faced with the problem of the "unknown user." In this connection it needs to be emphasized that user groups are rather small and numerous and one needs to understand both constant and variable factors (discussed later) (Rapoport 1998, 2000c, 2000e, 2005[a], 2008c). There are also differences and potential conflicts among users, clients, investors, passers-by (users of the city) and so on. Which of these, if any, are the "primary" users?

For example, in a hospital are the users doctors, nurses, patients and their families, visitors or cleaners? (LeCompte and Willems 1970, LeCompte 1972; cf. the new journal World Health Design). Is it in terms of the criticality of tasks, time spent in settings, for patients—the disease? In programming a hydraulic engineering building for a new university in Australia (before any faculty has been appointed) I interviewed a number of senior academics in the field. There were major, sometimes contradictory differences in what they regarded as good or bad, acceptable or unacceptable, and I had not even considered junior faculty, support staff, undergraduate and graduate students, etc. (Rapoport 1990e, p. 85-86). A complicating factor is time and change—there are culture and lifestyle changes among users, generational change, ecological succession in cities etc[4].

In a word, users are not a homogeneous group—as already pointed out there are very many groups, which tend to be small and variable—not least by culture. Since much of my work has been on the role of culture, I will use it as an example of how ongoing research in a variety of fields can further develop a hypothesis. Starting in 1990, I proposed, on the basis of research in various fields that cultural variability may be constrained by major constancies—human nature (Rapoport 1990c, 1998, 2000c, 2001, 2005[a], esp. pp. 79-81, 2008c). This, of course, helps to simplify the problem of culture-environment relations.

There has since been increasing research evidence (some of which I read years after publication!) that strengthens and clarifies this proposal and may be able further to constrain cultural variability and further reduce apparent complexity (an important aspect of science as will be discussed later) (e.g. Cronk 1999 (cf. Hauser 2009), Betzig 1997, Clark and Grunstein 2004, Hardcastle 1999, Russell 1993, Miller 2000, Alcock 2001, Cartwright 2001, special section "From Genes to Social Behavior," Science, 322/5903, 7 Nov. 2008, p. 891-914, De Dreu et al. 2010, Mulder 2008, Hsu et al. 2008, Pinker 2002, among many others).

Amos Rapoport

Amos Rapoport is Distinguished Professor Emeritus in the School of Architecture and Urban Planning at the University of Wisconsin-Milwaukee, where he was previously Professor of Architecture and Anthropology. He received his Bachelor's degree in Architecture from Melbourne University (Australia), his Master's in Architecture from Rice University as a Fulbright student, and his Post Graduate Diploma of Town and Country Planning from the University of Melbourne.

He has taught at the Universities of Melbourne and Sydney (Australia), the University of California at Berkeley, and University College London. He has held visiting appointments in Israel, Turkey, Britain, Argentina, Brazil, Canada, Puerto Rico, India, and Switzerland, among others, and has lectured by invitation all over the world.

He is a Registered Architect in two states in Australia, a Fellow of the Royal Australian Institute of Architects, and an Associate of the Royal Institute of British Architects. As one of the founders of the new field of Environment-Behavior Studies, Rapoport's work has mainly focused on the role of cultural variables, cross cultural studies, theory development and synthesis.

He is the editor or co-editor of four books and several monographs and the author of over 200 papers, chapters, and the like as well as six books. Most notable work are 'House Form and Culture' (1969), 'Human Aspects of Urban Form' (1975), 'The Meaning of the Built Environment' (1990) and 'Culture, Architecture, and Design' (2005). His work has been translated into a number of languages, including French, Spanish, German, Greek, Japanese, Chinese, and Korean.

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All photographs of Amos Rapoport , except the one on page 34, were taken by Silvia Matuk during the Darmstadt conference 2010; the sketches in between the references (p 39 - 45) are overhead transparencies drawn by Mr. Rapoport during his Darmstadt lecture.

4
This brings up the topic of open-endedness to be discussed later (Rapoport 1995f (1990/91)). Open-endedness also allows for individual difference which cannot otherwise be considered in design the way others can.

5
As discussed later in terms of the domain, i.e. as cultural landscapes, systems of setting, fixed and semi-fixed elements, etc. (Rapoport 1992a, 2005a, Fig. 45, p. 98).

6
Note that these effects can be direct or indirect (Rapoport 1990f).

7
Note, for example, references to weekly developments in a variety of fields in the bibliography (which continue as I write this).

These findings are still rejected by a number of social scientists on what I think are ideological grounds (e.g. Lopreato and Crippen 1999, McIntyre 2006). These findings, however, have important implications for environmental design for people. Together with work on the origins of culture and its components and expressions, in humans vs. other animals (e.g. on the evolution of language (Hauser and Bever 2008, Kenneally 2007), on the genetic, neural and biochemical mechanisms involved etc., this has major implications for understanding people.

It is also becoming clear that culture is not only about learning. There are species-specific genetic origins of at least some aspects of cultural diversity. Thus male zebra finches (a model system (see later)) normally learn their song from tutors. However, when deprived of tutors they are able to develop their typical song de novo (Feher et al. 2009, Fitch 2009). This is related to the well-known case of the development of sign language among Nicaraguan deaf children with grammatical similarities to spoken language (cf. the development of creoles, e.g. Bickerton 2008).

The discussion of culture raises an important question. Since most EBS research so far has been done in Western countries: is it generalizable to other cultures? These questions about the transferability of EBS research arise as EBS expands globally (not only EDRA, but IAPS, PAPER, MERA and EBRA). There is a need to consider how research done in one context can be applied in other locales and cultures, whether it can be transferred and from where to where, to what extent, in what specific contexts and scales, with what modifications, etc. (Rapoport 2002b). These are researchable questions which, with further research on constancies, will enable us to deal with all these issues and any limits to generalization.

The fact that the variability of culture may be less than thought, or feared, does not mean that there is no variability. There is variability between users as a whole and designers and among different groups of users. This is why culture is becoming important in a range of fields—business, medicine, technology, the military, etc. (Rapoport 2005a, 2008c). Groups do have different characteristics, preferences, wants, meanings, reactions which vary for different activities, and in different roles, they make different choices. It is also the case that there are different views about the constancy/variability question; only research will gradually clarify it (e.g. Nisbett 2003, Heinrich et al. 2010a, Dahaene et al. 2008).

Regarding the general utility of scientific research, it is highly significant that this does not apply to scientific thinking. The same approaches, models, simulations, experiments and theoretical thinking are evident wherever scientific research is done. This has major implications for my argument about adopting a scientific metaphor and hence about research, practice and teaching. Research makes possible to clarify and understand the nature of group differences, reasons for them, their importance and also areas of commonality, and to derive ways of dealing with them. Each of these, in turn requires the use of the best available research-based evidence.

To know about people for design purposes means to understand their various characteristics, behaviors, wants, preferences and choices, lifestyles, ideals, images, social organization and so forth. Also important is knowing the constraints which can make identifying wants difficult. All of these require research-based knowledge. One also needs to know how environments affect people, positively (supportive) or negatively (inhibiting) as well as the mechanisms involved. To do and use research on all these aspects of people-environment relations (EBR) is what environment behavior studies (EBS) set out to do, starting about 40 years ago. The field can best be understood in terms of what I call the three basic questions of EBS (c.f. Rapoport 2005a, Ch 1).

1. What bio-social, psychological and cultural characteristics of human beings (as members of a species, as individuals and as members of various groups) influence, or in design should influence, which characteristics of the built environment?[5]

2. What effects do which aspects of which environments, have on which groups of people, under what circumstances (i.e. in what contexts) when, why and how?[6]

3. Given this two-way interaction between people and environments, there must be mechanisms that link them; what are the mechanisms? (c.f. Rapoport 2005a, p. 12-14).

All this, and more, requires knowledge based on research from a wide range of disciplines (e.g. Rapoport 2005a, p. 15). Also new disciplines are constantly becoming relevant (as this paper tries to show). All of these disciplines are advancing rapidly. Unfortunately EBS has not kept up with either of these developments (Rapoport 1990e, 1997a, 2000d, 2008c). There is, therefore, a need to be able to keep with both sets of developments,[7] the many implications of which I will discuss later.

It should be emphasized that the relevance of many of these fields and their findings only becomes apparent at some level of abstraction, and within conceptual frameworks and theories, and requires certain ways of thinking—the main argument of this paper.

A personal example. My hypothesis about how settings elicit appropriate behavior has received support from research in cognitive science and artificial intelligence—frame-script theory (Rapoport 1990f, epilogue). More generally consider the potential relevance of apparently unrelated fields. Dealing with intelligence analysis, Heuer (1991) argues that intelligence analysis deals with vague and often conflicting information (an argument also used about design by Horst Rittel and others). In order to improve such analysis, it is necessary to understand how the mind works. Heuer applies findings from cognitive psychology to intelligence analysis. Most of the 4 parts and 14 chapters are also highly relevant for the view of design, for which I am arguing (see later).

The potential relevance of apparently unrelated fields is also found in other fields. Consider just two examples (others will be given later). A recent study of the evolution of proteins uses a model derived from cosmology—a most "unlikely" example of relevance. (Povolotskaya and Kondrashov 2010). Similarly striking is the application of a model from linguistics in the rational design of antimicrobial peptides. (Loose et al. 2006), or applying studies of amoebas to the understanding and design of infrastructure and other networks (Marwan 2010, Tero et al. 2010).

Consider one subarea of EBS, environmental cognition, especially way-finding and orientation, on which there is any extensive literature (e.g. Rapoport 1977, Passini 1984, Golledge 1999, Silva 2001 among many others, e.g. in preceding of EDRA, IAPS, MERA, etc., and Environment and Behavior and JAPR). Recent research in neuroscience, in addition to relevant work on perception, preference, etc., both links orientation and wayfinding at different scales (from rooms to cities) and also, most importantly, identifies the brain mechanisms involved, what are called "space cells," which encode spatial information in animals (including humans).[8] (e.g. Hasselmo 2008, Kjelstrup et al. 2008, Bartsch et al. 2010, Nature, 461/7266, 15 Oct. 2009, p. 843 "Place cells know their place;" Nitz 2009, Harvey et al. 2009).

There are three types of space cells with different spatial coding characteristics: direction cells, place cells and grid cells (e.g. Doeller 2010). In animals, it appears that two of these cells types (direction and place cells) work without experience and learning. There is disagreement about the need for learning, and its effects, in grid cells (Palmer and Lynch 2010, Mills et al. 2010).

New methods of study are being developed and research is ongoing. Whatever the outcomes of such research, it is clearly highly relevant for both EBS and environmental design. Keeping up with it (and all other research relevant for designing for people) is clearly most important.

Admittedly, and as will be discussed later, so far that knowledge is difficult to access (Rapoport 2008[a]). It is also difficult to use not only because of the art orientation of designers, but also because even EBS research is often uninformed by previous work. In the absence of adequate theory it is a "pile" not a system, and a pile of empirical studies is most difficult to interpret and use. For example there are very many studies of housing, so many that even academics, let alone practitioners are overwhelmed. As we will see later, in other fields there are analytic reviews (not lists of papers that pass for reviews in environmental design), meta-analyses, syntheses providing reliable information, as well as theory development. Scientific research is not just empirical work on a specific topic—conceptual unification is a major part of it—and should be in environmental design (Rapoport 1997[a], 2000d, 2008b). This is a more general problem and it has been argued that too much empirical work uninformed by theory may make theory development more difficult (Bunge 1998).

The problem is similar in biology (but handled much better). Bray (2009, p. 89) points that biology is a mass of details so that it is difficult to derive general principles, which need to be derived from special cases. It is then useful to follow a single thread, an exemplar that most clearly reveals basic mechanisms [i.e. to follow a specific question across many cases, i.e. comparative work, as discussed later].

Bray (p. 98) agrees with Bunge (1998) that above a certain level, the more data, the more difficult it is to put them together into a coherent account. He suggests that simulation should be used (p. 100-101). That is a way of knowing, a symbolic representation that enables phenomena to be understood and can do many things otherwise impossible. As usual, one needs to be careful (p. 102), simulation can lead to "reality distortion," when one sees a model of the world as the world itself. However, judging by the many simulations increasingly used in many diverse fields (and discussed later) this problem is clearly being overcome.

Conceptual unification in EBS and environmental design has been made more difficult by another major problem in the development of EBS—the lack of replication. That is a sine-qua-non of research. There are many very suggestive studies, never replicated to see whether the findings stand up, nor tested in other contexts, other populations and so on. Hence, the importance of comparative studies more generally, i.e. not just cross-cultural studies. All these—replication, conceptual unification and theory development have been neglected even in EBS in favor of ever more empirical studies. Hence conceptual unification and theory development are a primary research objective in order to be able properly to design for people.

The importance and advantage of theory is that it helps to clarify relations among data and also what data mean. Frequently data only make sense within a theory.[9] Most importantly, theory leads to "compressibility." One only needs to deal with principles which incorporate much data—all the pieces of earlier work can be pulled together and new work incorporated. The principles are succinct, manageable and since only theoretical statements need to be remembered they are easy to remember. Specifics can be "plugged in" when needed (Rapoport 1997[a], 2000d). This is well captured by a statement by a physicist "I have the arrogance that physicists have. Everything is understandable [which I will elaborate later]. I learned the laws of physics—I just need to apply them to this [specific] situation."[10] (Ananthaswamy 2010 p. 114 quoting Jerry Nelson).

For the purposes of this paper, and in grossly oversimplified terms, theory development begins with putting

8
These have been known in neuroscience for some time but not, to my knowledge, ever referred to in EBS.

9
As Sir Arthur Eddington famously said: "Never trust data until confirmed by theory."

10
Note that the role of, or need for, laws in science is not universally accepted (e.g. Giere 1999, his later papers and the semantic view of theories generally).

research results (old and new) in order, structuring them, evaluating their quality, and synthesizing them through systematic review, metanalyses and other techniques, i.e. developing conceptual frameworks to see how the results relate, what they mean and their implications (Rapoport 1990e, 1997[a], 2000d). Judson (2006) describes this process well. He says that Crick was a theorist, which meant putting other scientists' thoughts in order. He looked at other people's data and saw beyond them, to their meaning and implications and was very skillful at generalizing. In this way he helped rule out large areas of speculation.

Theories, and the models which are part of them, make it possible to cope with the flood of data which is becoming a major problem in many fields (and will be discussed later). In addition, in science many details are left out in models, simulations, etc.—complexity is reduced by trying to discover the minimum that will work. In this way one can know what is necessary for understanding and what is not (Batterman 2002, cf. Science 310/5747, 21 Oct. 2005, p. 449 ff, and 496 ff, Plenlo 2009). This is something designers tend to reject—because of the lack of "realism."

With all these problems of EBS it is still a major advance on the design fields as they currently are. Enough is already known although (as discussed later) difficult to find at present, to make at least a start at the evidence-based design which designing for people requires.

To conclude this section, here is an example of what I believe our approach should be: This on advertisement by the U.S. Navy for a program officer for research psychology and human factors (Science 320/5876, 2 May 2008). It refers to both basic and applied research and seeks "… knowledge and experience in the fundamental theories, concepts and current state-of-the-art research in the broad areas of engineering, psychology and human factors, including but not limited to cognitive and social neuroscience, human decision-making, methods for assessing individual cognitive workload, models for human-computer interaction and simulation technology."

With a very few minor changes this should be a model of an advertisement for some environmental design professionals and schools of environmental design faculty.

Designing "Better" Environments

Just to say that designers are meant to provide "better" environments is quite inadequate. A series of questions follow immediately:

- *What is better, i.e. what does "better" mean?*
- *Why is it better?*
- *How is it better?*
- *Better for whom?*
- *How do we know (or judge) that it is better? (Rapoport 1995 (1983), 1995 (1990))*

In order to be able to answer such questions one needs to know what the "thing" designed is supposed to do. It is only possible to judge whether something does something well or badly if one knows what it is supposed to do—in the case of environmental design being maximally supportive of users. It follows that it is essential to set explicit goals or objectives to be achieved which, in turn, are explicitly justified by research-based evidence. Also, "better," like many (if not most) terms used is too broad and general. It needs to be dismantled—a general and essential approach. I have already addressed it when discussing "people" or "users" and have used it to define and clarify culture, environment, tradition and vernacular design (see also later) (e.g. Rapoport 1989, 1990d, 1990f, 1990g, 1995e (1990), 1998, 1999[a], 2000c, 2005[a]).[11]

This is a persisting problem, so that even a journal dedicated to evidence-based hospital design (World Health Design) uses terms that are not useful without dismantling, for example "serene," "empowering," "healing," etc. (e.g. April 2008, p. 41).

This is also the case with "better" which can be analyzed in terms of the many components of environmental quality. These components can be identified (e.g. Rapoport 1977, p. 65-80, 1990f, Brower 1996). They can vary in four ways: The components describing environments can be completely different (unlikely), they may vary in relative importance, their importance vis-à-vis other things can differ and, finally, the same components can be seen as positive or negative (Rapoport 1995e (1990), 2005[a]). They can be represented graphically by profiles condensing much information, which can then be used to compare environmental quality among different user groups, different environments, at different times (e.g. Sastrosasmita and Nurul Amin 1996). They can also be used to compare notions of environmental quality of different "actors" in the environmental design process—potential and actual users, designers, clients, officials, investors, aid agencies, governments, preservationists, etc. Identifying such profiles would help to identify potential conflicts among them, and reasons for these. They could then be addressed (although not always solved). They could also be used to clarify the differences among designers and the public discussed earlier. Note that in my work I have used linear profiles; in the one application I know polar profiles proved more useful (Khattab 1993). Other forms or methods of representation and comparison could, no doubt, be developed. (Fig. 2)

Profiles can also be used in design, by specifying the specific environmental quality sought, explicitly using the many components involved—physical, perceptual, cognitive, social, cultural, affective, regarding meaning and so on (the list is open-ended). They would also need to be justified on the basis of research-based evidence. Only then can one evaluate whether one has succeeded or failed. It follows that the first and most important step in design is to decide and specify what needs to be done, and why (i.e. providing justifying evidence).[12] This, in turn, depends on knowing for whom one is designing.

Here the two lines of argument lead to the same conclusion—environmental design needs to be evidence-based and the evidence, in turn, must be based on the best available research.

The Major Shift

Although such research-based knowledge is essential it is not enough—it is necessary but not sufficient. For one thing, and most important, one must want and be able to use research; this I will discuss later. One must also

11
Note, that Charles Hackett, in 1960, used 13 categories that define language and used these to compare human language to animal communication (Allen 2009, p. 239-240, cf. my polythetic definition of vernacular design) (Rapoport 1990d)).

12
Note that the full environmental design process also requires specifying how this is to be implemented. This is a separate topic and follows specifying what and how. However, in current practice, "criticism" and studio education, it receives almost all emphasis. That essential aspect of the overall process in not addressed in this paper.

be able to have access to research. Also, the question is often which findings or facts one considers, emphasizes and uses and the justified basis for selecting those as relevant. All these require a particular way of looking at the world, which also determines how already known facts are seen and fit in. All three of these requirements lead to the need for the major shift in world view being proposed.

It seems clear that specific facts, while required, can be less important than the approach, the process of obtaining them and seeing their implications.[13] As a personal example, I can read almost any paper on any topic weekly in Science and Nature and, while not too concerned with the specific findings, find the reasoning, approach, argument (and sometimes methods in principle) relevant. As already discussed that is all at a sufficient level of abstraction that makes it applicable for very different purposes. It is the underlying world view, attitude and approach that are relevant, not the specifics. After all, environmental design is not physics, chemistry, molecular biology or material science.

It is often the case that new discoveries in science come not only from new facts but from a re-examination of known facts from a different point of view. This will certainly be the case in environmental design once the paradigm is changed. Involved are what have been called "major epistemic shifts" (Zerubavel 2003). That involves looking at existing knowledge in new ways (in addition to) obtaining new knowledge through research. What is required is a new world view, in the case of environmental design replacing the current art metaphor with a science metaphor.

Many scientific advances have been due to such shifts in how things already known are reinterpreted—shifting one's perspective reveals new knowledge. Frequently this shift, the epistemological breakthrough, is itself the result of new knowledge and further advances it makes possible. In David Bohm's words, "The ability to perceive or think differently is more important [I would say may be more or as important] as the knowledge gained." (quoted in Shimadzu advertisement, Nature, 440/7087, 19 Oct. 2006). Similarly Carl Sagan "Science is a way of thinking much more than it is a body of knowledge (Shimadzu advertisement, Nature, 443/7113, 19 Oct. 2006) although it is also, of course, very much a body of knowledge.

Consider an example of such a proposed shift "caught in the act," as it were. This proposes a new framework, based on epigenetics, for identifying complex traits and diseases (Petronis 2010). This may also help resolve aspects of the nature/nurture debate and is an "interpretation that cuts through several Gordian Knots that are impeding progress…" (p. 721). It is based on recent findings: The discovery of epigenetics and its mechanisms as an important field. There is also the beginning of subfields—all within 2 decades. One of these subfields is "behavioral epigenetics." Miller (2010) refers to an explosion of interest in so-called "behavioral epigenetic mechanisms." That is new (starting in 2004) although previously used by developmental and cancer biologists. It is also still controversial. Thus, this example is only meant to show a potential epistemic shift underway, whether it succeeds or not. Also, should it be accepted, the implications for understanding human behavior and for EBS (including both direct and indirect effects of environments (Rapoport 1990f)) make it another field worth keeping up with.

The new ways of looking at knowledge lead to seeing new aspects of familiar things. The choice of these aspects, i.e. knowing what is significant also requires knowledge in addition to the new perspective.

For example, although perseverance is critical in research, it is important to know what to persevere with, a need to focus on the important issues and not get carried away with the peripheral ones (interview with Dr. Jeremy Henson, of the Ludwig Institute, The Australian, June 3, 2010). It also needs agreement on concepts, terms, the form of data and also theory or, at least, strong conceptual frameworks.

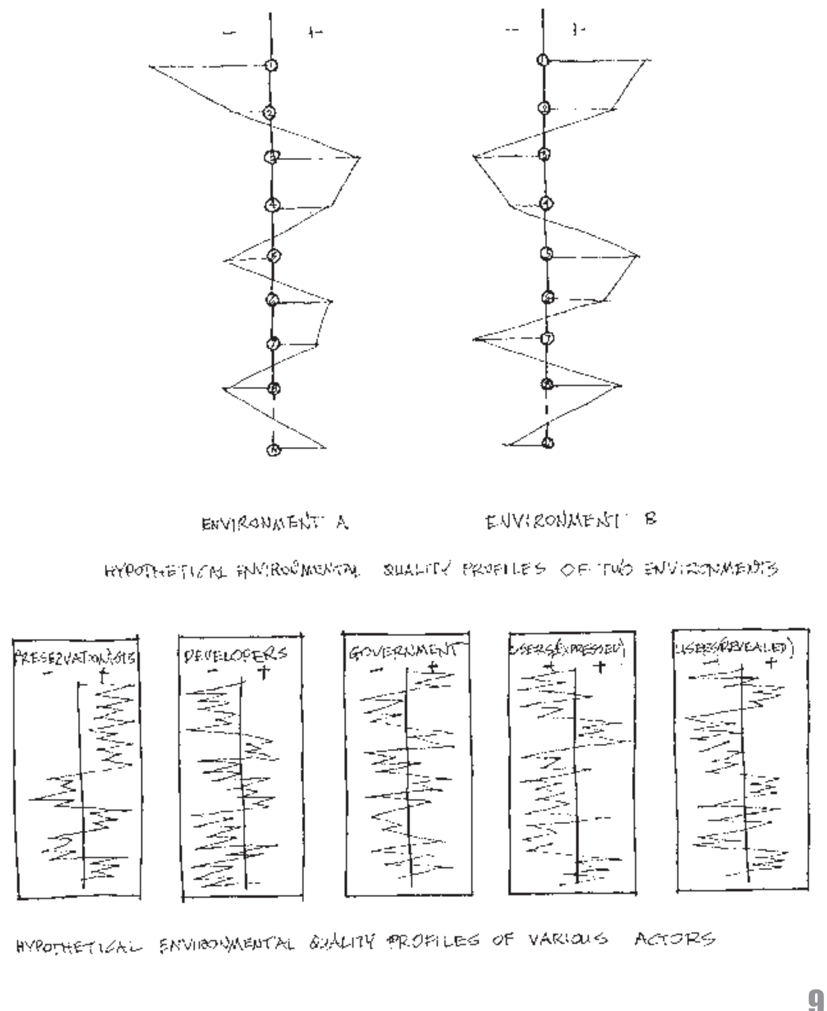
Environmental designers have much anecdotal, personal knowledge that can only become useful, if seen in a different light, shared, tested and made part of a cumulative body of knowledge through theory. This also applies to published material.

The scientific way of thinking has been there for a long time and, in Jacob Bronowski's terms "the most wonderful discovery made by scientists is science itself" (quoted in Shimadzu advertisement, Nature, 447/7142, 17 May 2009).

It is that way of thinking that has led to the rapid progress of science and the science based professions (often described as "breathtaking"). Consider one example. From the first experiments on designed genetic codes (in 2000)

13
These facts must, of course be known, i.e. one must both know the research literature and be able to access it—both highly problematic in environmental design.

Figure 2: Environmental quality profiles (based partly on Rapoport 1983a, 1995e (1990), 2005 a)



14
Contrast this with the obfuscation and reveling in mystery and (often unreal) complexity of environmental designers (especially architects) (cf. Rapoport 1990e). It is laughable to insist on the complexity of environmental design in comparison with the brain, the universe, the proteome and other really complex topics studied by scientists.

it took less than a year for undergraduates (at MIT) to be doing synthetic biology, to be building novel biological circuits (Bray 2009, p. 192, cf. Rapoport 1990e, p. 89). By 2004 it was becoming possible to do synthetic biology using "building blocks" ordered commercially (Regis 2008, p. 130-132). Synthetic biology is an emergent field based on a fusion of disciplines that continues to develop rapidly. It uses synthesis to create new types of biology, through function-oriented design and control of molecules and molecular systems that go far beyond any natural system and is only limited by what can be imagined (Wender and Miller 2009). I will be discussing this later when I address the meaning of "design."

Science turns "mysteries" into problems (Chomsky, cited in Pinker 1997, p. ix) and problems can be solved. Science then proceeds to solve them. It typically assumes that they can be solved, that there is an underlying simplicity behind apparent complexity.[14] Thus, Schofield (2010) ends a review of some recent experiments on certain phenomena by saying (p. 554) "…it is only a matter of time before they are fully revealed." Disney et al. (2008) conclude that "galaxies appear simpler than expected."

It is the general attitude of science that everything can be explained and that data can be compressed. Thus Wilczek (2008) (p. 140) speaks of the profoundly simple theories of physics based on data compression. The goal is to find the shortest possible statements (i.e. avoiding details) which, when unpacked (= dismantled), provide a detailed, accurate model of the physical world. To achieve this one must avoid vagueness and be specific ("avoiding hand waving") (p. 154). When one knows what one is looking for, it becomes easier to find it.

For example, Sigman et al. (2010) conclude (p. 54) "Despite the relative complexity of our narrative [it] calls for a simple explanation." One "Must…search for new paths to more general insights….mechanistic understanding" which may be counterintuitive. Similarly Geha (2010) says (p. 167) "The mark of a satisfying astrophysical solution is that it solves multiple problems with a single physical process." Chakravarty (2008) (p. 735) refers to experiments that "foreshadow a remarkable degree of simplicity in these complex materials" and concludes (p. 736) "with further experimental work we should be able to tell just what kind of animal we are dealing with," This is after 20 years.

It is often suggested that while this may apply to the physical sciences it may not apply to biology. Thus Hayden (2010) argues that biology is becoming more complicated. However, biologists keep on searching for simplicity, for general principles leading to understanding and explanation. One could argue that they are succeeding, judging by the examples of biological manipulation discussed later when I address design.

There are clearly differences among domains: Where does environmental design fit? That needs to be discovered, but with the positive, optimistic attitude of science, so that in all branches of biology there is an ongoing effort to find general laws (but see Giere 1999) or, at least, unifying principles, to develop unifying frameworks for the vast mass of detail (e.g. Bonner 1988, Okasha 2010, the development of Evo Devo, etc.).

In ecology there is also much work on finding simple principles behind the complexity of ecosystems. As just one example, the application of a simple, general model from physics clarifies prey/predator relationships by eliminating detail. This provides an attractive, abstract framework for many specific prey/predator systems. The model can be expanded [like theory] with additional features (Vicsek 2010).

It is, in fact, typical of science to search for (and eventually find) simplicity behind apparent complexity and general principles behind great variety. As an example, there is great variation in the coats of the numerous breeds of domestic dogs. These can, however, be dismantled into three simple traits—length, curl and texture. Each is found to be controlled by one gene. Thus a small number of simply interacting traits can be combined to create extraordinary phenotypic variation. A large number of varied and "seemingly complex" phenotypes can be reduced to the combinatorial effects of only a few genes (p. 150) (Cadieu et al. 2009).

I suggested earlier that environmental design covers many scales, from regions and cities to interiors and products. A question is then posed as to whether there are differences in EBR research and design depending on scale. There has been no research on this in EBS/environmental design as far as I know. I believe, but do not know, that many concepts, ideas, findings and approaches will apply across scales (cf. my "blurb" in Norman 1988), and it is a topic that needs research.

In science, the search for generality and simplicity extends to questions of scale. There is increasing evidence that many diverse systems of different scales are similar at the level of "scaling laws," i.e. they are universal across scales (and often domains). For example Kim et al. (2009) find that many different systems in nature exhibit very similar behavior at the level of scaling laws, e.g. earthquakes, stock markets and vortices in superconductors—disregarding details (cf. "scaling down" Nature, 458/7239, 9 April, 2009, p. 675). The same point is made by Strogatz (2009) who discusses otherwise hidden patterns that mathematics can reveal, so that the law of collective organization links urban studies to zoology, and shows that Manhattan and a mouse are variations on a single theme. This relates to Zipf's law which has been applied to cities in many different contexts for 100 years. He concludes, once again, that there is great simplicity behind apparent complexity if details are omitted. On the other hand, in some domains scale may be important (e.g. in the brain: Ohiorhenuan et al. 2010).

While in physics some laws apply at scales from a few atoms to solar systems, ecology seems to be scale-dependent and has begun to clarify which forces operate at which scales, which would help to unify the findings (e.g. McGill 2010, c.f. my earlier discussion of the importance of the small scale of cultural and other users groups).

In starting research on the topic of scale in EBS and design, a systematic search of the literature in the many relevant fields would, once again, be helpful. Some clues can already be found. For example in the important area of environmental cognition (orientation and wayfinding) already discussed, neuroscience finding show that navigation in a room and a neighborhood involves the same neural mechanisms (place-cells) although the continuum of scales in finite (Kjelstrop et al. 2008).

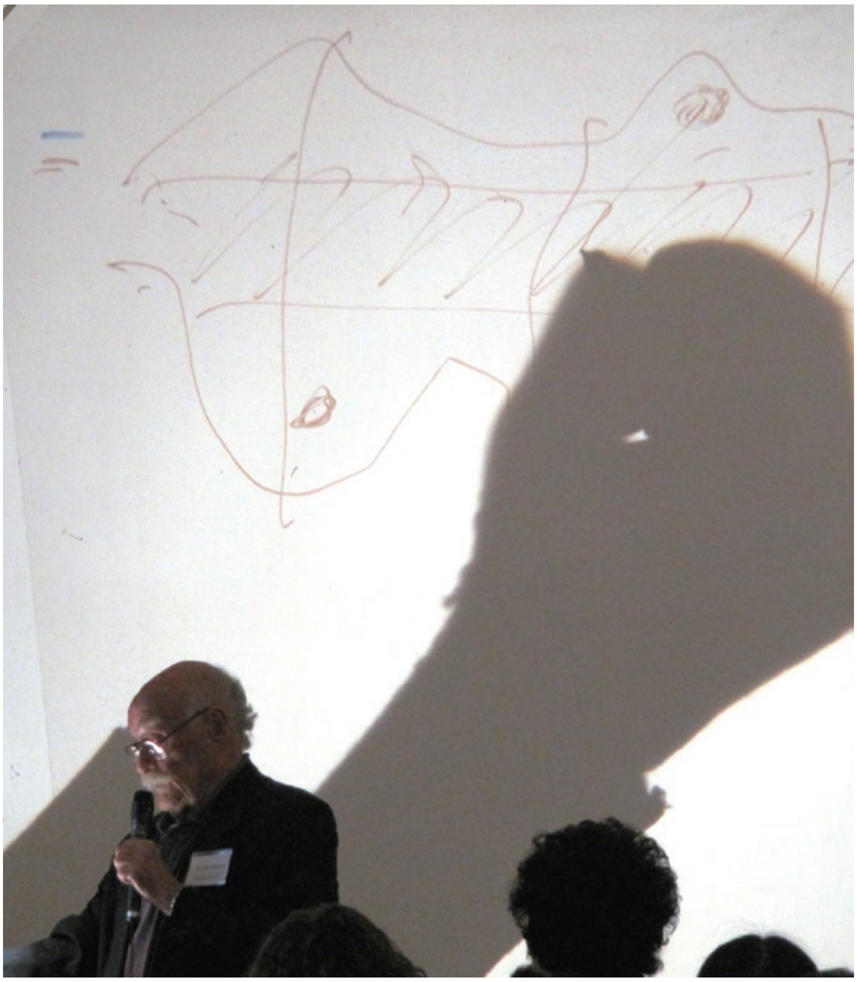
Susskind (2008, p. 263) argues that paradigm shifts in science are different to those in art or politics. The latter are just changes in opinion, whereas in science there is real progress (contra Kuhn). There is a progression of paradigms and one does not return to, for example Aristotelian mechanics or phlogiston theory, nor does one give up General Relativity for Newton's theory of gravity [although the latter is still widely used in its appropriate domain and scale]. When paradigms in science shift, there is often resistance and strong emotions (p. 264) but when these are filtered through the scientific method some kernels of truth of the old paradigms frequently survive. Successive paradigms improve and, in general, are not reversed.

In discussing a new research study on barefoot running by Liebermann et al. (2010) Jungers (2010) points out that "more studies like [these] are required to provide data instead of opinions, and testable models and scientific explanation instead of anecdotes." He also argues that "an evidence-based approach is badly needed to assess the competing claims as to what, if anything, is the best cover for a runner's foot."

Similarly, a review of planetary science (Burns 2010), says "considerations of the solar system's origin were historically often just philosophical musing….scientific facts that could constrain speculation were simply unavailable. That is no longer the case" (p. 581). "Within the last decade, the solar system's origin—like cosmology—has moved from speculation into a full-fledged science in which hypotheses now face observational testing" (p. 582). Also emphasized is the role of theoretical advances to guide observations.

In the arts and humanities, with which the design professions identify," there is typically no conclusion, in science there is typically eventual agreement about essential issues, although that is still, and always open to further research" (from Nature, July 27, 1957 cited in "50 Years Ago" column, Nature 448/7152, July 26, 2007). However, when the arts and humanities are approached scientifically, they can be extremely useful—one can learn much from anything with the proper approach (e.g. Rapoport 1990b, 1990f). An interesting attempt by the Tokyo Institute of Technology is a large-scale knowledge resources project which will study humans by re-examining many resources from the humanities from a scientific point of view. At the same time scientific research on the topic will continue (Advertising feature in Nature 446/7135, 29 March 2007).

In the philosophy of science it has proved difficult to establish a formal "demarcation criterion" between science and non-science. Yet one commonly finds phrases like "this is still more an art than a science" or [something] "has undergone a steady transformation from an art to a science" (in this case regarding the culturing of high quality crystals (Nature, 448/7154, 9 Aug. 2007, p. 658). By implication, in all these cases, the differences are explicit goals based on knowledge, rapid and continuous improvements in the understanding of the mechanisms involved and, as a result, high predictability in reaching the goals set.



Before proceeding to some more detailed discussion let me reiterate the central point. The essential need in our case is to change the way we see environmental design. This requires a shift from looking at it as a visual art (using an art metaphor) to seeing it as a science-based profession (based on the science of EBS) engaged in identifying and solving problems on the basis of research-based evidence, i.e. using a science metaphor. I also agree with Horace Judson (in The Eighth Day of Creation) that "science is the art of the 20th century" and, I would add, even more of the 21st century.

It should be emphasized that science is not something esoteric. At its simplest (and in this it has been compared to civilization as a whole) it poses questions and finds answers. While these answers are critically examined and revised, the conclusions are the most reliable on the basis of available data. Science is a way of thinking, a method for getting answers (Susskind 2008).

There is general agreement in the literature that science replaces conjectures, beliefs, prejudices, personal experience and preferences by rigorously obtained evidence. While not perfect, it is by far the best, if not only, way of getting to true, valid answers. Also, while science is open to new ideas, no matter how counterintuitive (e.g. some current cosmology) it ruthlessly tests these ideas, as well as accepted ideas. A striking example is the "standard model" in physics which, has been extraordinarily successful. Yet much effort is being expended trying to falsify it, hoping to find new physics beyond it. This is in striking contrast with the self-satisfaction of designers.

15
In my work I have cited many references on the effects of dimensionality, materials, colors, textures, light, temperature, sound and so on.

16
One example is the manual on facial expression by Paul Ekman, Friesen and colleagues.

Similarly to my argument here, there have been calls for scientific approaches in other fields, e.g. economics (Bouchaud 2010) (discussed later), clinical psychology (Editorial "Psychology—A Reality Check," Nature, 461/7266, 15 Oct., 2009, p. 847), psychiatry (Editorial "A decade for psychiatric disorders," Nature, 463/7277, 7 Jan. 2010, Abbott 2008, Singh and Rose 2009, letter by B. Schwart, Scientific American 303/2, Aug. 2010, p. 10). The latter argues that there is a need to change psychiatry "from a subjective, mental based discipline to one thoroughly grounded in neuroscience…thus allowing psychiatry to join the other medical specialties, thoroughly grounded in sound scientific practice." This is also the case with other fields, albeit sometimes indirectly through calls for evidence-based practice (discussed later).

Usually when I discuss the shift being proposed I am told that environmental design is too subtle and complex to be approached scientifically and that doing so would weaken people's responses. I will, therefore, discuss recent work in a number of other fields which strongly suggest that my proposal here, is in fact quite feasible—that anything can be approached and studied scientifically—even love! (including identifying its component parts—i.e. dismantling) (Jolly 2004, Young 2009).

Although I have argued for some time that "aesthetics" is not useful in environmental design, and should be considered as the perceptual and associational aspects of environmental quality, scientific studies of aesthetics are ongoing (e.g. Solso 2003, Zeki 1999, Olhausen and DeWeese 2010, among many others). In addition to these studies of "experimental aesthetics" the many studies that consider art as part of human evolution, behavior, wants and needs can also be considered to be part of this approach (e.g. Miller 2000, Mithen 1996). Imagery, communicating domesticity or institutionality whether of buildings (Robinson 2006) or urban areas can also be so studied (e.g. Rapoport 1977, 1990f, Nasar 1998).

In this connection it is essential to get away from the purely visual approach of environmental design and consider other senses, on which serious research is now going on and also, and most important, on how the different senses interact the need for which I have long emphasized (Rapoport 1977, 1992b) and which is finally beginning to be studied (e.g. advertisement for a symposium on "Sensory systems: smell, taste, touch, hearing and vision" Jan. 13-15, 2010 in Nature, 461/7273, 29 Oct. 2010). Once again, one needs to use the best available evidence, keep up with research and reexamine what is already known, and there are suggestive indications about people's subjective reactions, their mood, physiology, health and other effects of the different sensory modalities.[15]

The many components of environments that play a part can only be known through research, which can them inform designers about how to achieve the "I like it/I do not like it" immediate affective response among the public (Rapoport 1977), which is not adequate for designers. As discussed earlier, dismantling is the first step in establishing the components of environmental quality which could then be integrated with the large literature on preference—various buildings, spaces, materials, etc., at various scales (although these would require replication). It might then be possible to achieve an overall synthesis of the specifics possibly as a table.[16] That would then allow environmental quality profiles to be used in deciding what to do, programming in terms of behavior, lifestyle (and its profile), activity systems, affective responses, meaning, etc. (e.g. Rapoport 1977, Ch. 2, Brower 1996).

This is also the case in other domains. Consider the mystique of wine and the attempts by critics to describe its complex flavors and aromas. There is now research (at the University of California-Davis) to identify and quantify these through scientific research. This uses metabolomics to look for the chemical components of wine, using advanced and sophisticated techniques. So far 413 metabolites have been identified, and there are probably many more—the metabolite profile of wine is very complex (cf. my environmental quality profiles). This knowledge not only does not reduce the pleasure of wine but "science has the potential to bring the art of winemaking to a higher level" (Buchanan 2008).

This is also the case for food and can usefully be considered in a bit more detail (Gladwell 2005, p. 182-183). As for environments, the public can only say "I like it/I don't like" about foods. That is not adequate for experts, who are taught a very specific vocabulary to use in analysis. In fact, they produce something very much like my environmental quality profile. In the case of mayonnaise (the main example used) there are six dimensions of appearance, ten dimensions of texture, fourteen dimensions of flavor (split among three subgroups). Each of these factors is evaluated on a 15 point scale, allowing the quantitative "programming" of a good mayonnaise—and this can be done for every product in the supermarket (p. 182). As another example, among the 90 attributes of cookies there are 11 critical attributes (p. 182). A core, as it were.

This is what environmental design programmers, designers and evaluators must be able to do in their domain, and only research can make that possible. Regarding food there is now work which deals with taste perception, identifies the receptors and cells for taste and how taste is encoded in the brain (Wenner 2008; cf. Bohannon 2010). Research is also able to clarify how people perceive and react to smell, considered the most subtle, ineffable and mysterious of the senses. This understanding makes it possible not only to recreate smells found in nature, but to create new, unknown smells. This is based on designing new smell molecules to achieve predictable scents, described by the equivalent of an environmental quality profile (Burr 2008; Gilbert 2008, Firestein 2008). The latter argues that there is not enough science in Gilbert's book, that much more could be included, e.g. the specifics on olfactory receptors discovered by neuroscience. Advances in molecular biology, physiology and genetics mark the field of olfactory science. He concludes that "olfaction is not an enigma, a waft of incomprensibility manipulated by a priesthood of perfumers…" and that "recent developments in the field offer the best evidence for a rigorous, scientific approach to all olfaction "although some mysteries still remain" [to be solved] (cf. Beauchamp 2008).

Another field with a mystique is French cuisine (and cooking in general). Yet there has developed the field of "molecular gastronomy"—the science of cooking (pioneered by the French chemist Hervé This). The goal is to demystify cooking, turn it from an art into a science and the field now has other people in other countries (see Nature, 464/7287, 8 March 2010, p. 355, and reference to This' new book The Science of the Oven, New York Columbia University Press; cf. Enserink 2006).[17]

Another example is provided by recent scientific research on what attributes lead people to regard certain violins (e.g. those from 18th c. Cremona, Italy) as special, rather than considering it to be a mystery, thus turning violin-making from an art into a science ("Fiddling the numbers," Nature, 454/7200, 3 July 2008; Cho 2005, "Unsound judgment" Nature, 446/7137, 12 April 2007, Honan 1988, Revkin 2006, Oho 2010).

This also applies to recent research on music, on which there is a growing literature. For example, consider a series of nine essays in Nature starting in vol. 453, Issue 7192, 8 May 2008, p. 160-162 and ending in vol. 454, Issue 7200, 3 July 2008, p. 32-33. These essays discuss various aspects of music and human reactions to it in terms of current scientific research. It asks about the evolutionary origins of music, how its study helps understand the brain and culture, its relation to language, how its effects depend on the structure of the ear and how the brain encodes information. It studies the response of the brain to a wide variety of music, languages and musical languages [i.e. comparative research], applies statistical analysis as a way of informing the history of music and understanding the act of composition itself and differences among performers.

The last essay (Nature, vol. 454/7200, 3 July 2008, p. 32-33) argues, as I do about the built environment, that research much study music as people actually experience it, must embrace the full variety of musical experience and context [see "The nature of the domain" in the next section]. It must demystify music [i.e. move from a mystery to a problem] and avoid the attitude "that music is so complex and ineffable that it must remain shrouded in mystery" and hence "that a detailed scientific understanding of it is impossible" (p. 33). Such research must take seriously listeners' beliefs, feelings and situations. Advances already made have led to a shift from acoustics to the study of how music interacts with people, contexts, etc.

Two points need to be made about this work. The first is that the conclusions are most applicable to EBS and environmental design and offer another model to follow. The second is that it could help to link architectural science, which also needs to be in terms of the impact on people of building fabric, HVC, acoustics, etc. That would also help in linking architectural science research with EBS, Design Methods and participation into the complete synthesis needed.

I conclude with two major humanistic fields, philosophy and history, to show that even in this case there are attempts to try and make them more scientific.

Some time ago (Rapoport 1990c) I cited Himsworth's (1986) suggestion that what was called natural philosophy has become science, as has ontology, and epistemology is increasingly being "naturalized." He concludes by asking whether moral philosophy, including ethics, could be naturalized. This is now starting to happen, although it has a long way to go. It is more difficult, because it tends to be normative, but the approach is the same as it was in epistemology—using knowledge from human psychology, cognitive science, anthropology, evolution, including animals studies, etc., to constrain the possibilities (cf. Buchanan 2007, Shermer 2007). In both cases, being normative must be based on what human nature[18] makes possible, if normative demands are to be realistic and practical.

Appiah (2008) points out that philosophy used to be empirical, and needs to be so again—conceptual analysis is useful if it follows research-based evidence. He refers to many experimental studies, brain imaging, cognitive science and work on human universals, which also involves cross-cultural studies (Some cited in Rapoport 1990c, 1997ª, 2000d, 2005ª, 2008b, 2008c). He also analyzes folk psychology in line with a debate in psychology about whether folk psychology is to be modified or rejected (as folk physics has been). This is because many studies are at odds with common beliefs. As part of this work there has developed a very extensive literature on the evolution of altruism in animals and humans, its relation to conflict, kinship and group membership, race relations, evolution of generosity, religion, language, etc. (e.g. Miller 2008, Hsu et al. 2008, Hoff 2010, Henrich et al. 2010, Chakravarti 2009, Bowles 2008, West and Gordon 2010, Boyer 2008, Szatimàry and Számado 2008, Nowak 2008). This literature is much too extensive to review or cite here in any depth, but it is at odds with many common beliefs.

It is also the case that research is beginning to clarify (and possibly eventually solve?) what philosophers of mind had considered one of the most difficult questions—"qualia" and "consciousness" (e.g. Schwartzkopf and Rees 2010, Schuger et al. 2010).

Very much in line with my argument about the history of the built environment (Rapoport 1990c) are some arguments in history generally (e.g. Turchin 2003, 2007, 2008). The point made is that history must be transformed into an analytical, predictive science based on a search for patterns using comparative studies on diverse times and places (see next section). Like I do, Turchin argues that rather than trying to reform the historical profession there may be a need for a new discipline—theoretical historical social science (which he calls "cliodynamics"). History

17
I have also seen research on the chemistry of baking, but cannot find the reference.

18
Note that research on human nature involves research from archaeology, evolution, sociobiology, behavioral ecology, economics, anthropology and others. Sharing and synthesizing these data becomes essential (cf. editorial "A look within" Nature, 455/7216, 23 Oct., p. 1007-1008.).

needs to make predictions and then test these hypotheses. He concludes (2008, p. 35) that truly learn from history "we must transform it into a science."

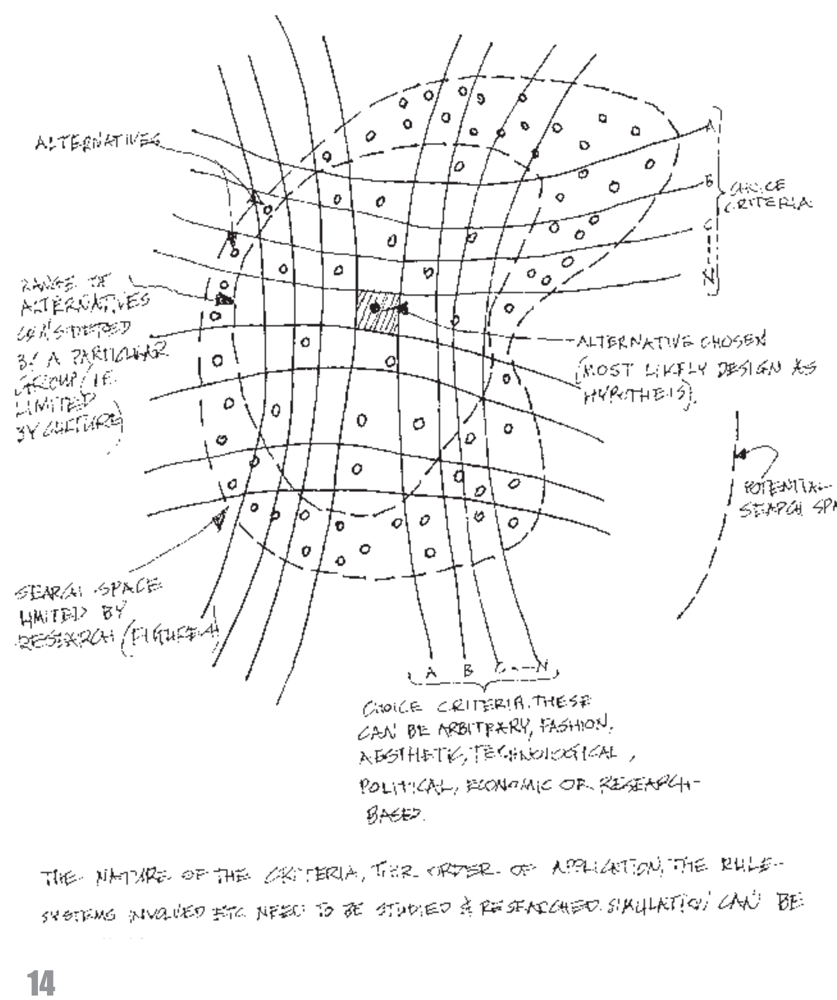
The similarity of all these proposals to mine is striking and suggests that models exist for helping transform environmental design—as will be elaborated later.

As in all scientific research, the problem of data is central. This raises a special problem with environmental design—the difficulty of finding previous work. Even in EBS previous work is rarely reexamined or replicated, there are no databases, relevant work is in many different fields hence in many specialized books and journals and in many countries. Many publications have gone extinct. There is also work in conference proceedings, theses, dissertations and also a problem with proprietary materials (such as POE's) (Rapoport 2008[a]).[19] There is also a general problem in many fields due to the sheer mass of material.

This problem is increasingly common in most fields of science. Problems include storing data, how to find them, how to retrieve them, how to analyze and use them and how to link different data. The latter requires not only agreement on terms and concepts and clear definitions (Rapoport 1997[a], 2000d) but also on classification of data, the categories used, etc. (Parsons and Wand 2008).

For example, one barrier to the development of systems biology (and possibly integrative biology) is the lack of a systematic vocabulary and uniform form of data (e.g. Cassman et al. 2005) in addition to the sheer mass of material.

Figure 3: The choice model of design on varions iterations (Rapoport 1977, 2005a)



I will later discuss simulation, which has been described as the third form of science (in addition to experimental and theoretical), and has become "a standard tool to… explore domains that are inaccessible to theory and experiment" (Bell et al. 2009). As the data deluge increases, a fourth form of science is emerging—data intensive science. There is an increasing need for specialized tools and people to develop ways to perform data intensive science in many fields and to manage retrieve and deal with data (Ibid; cf. Rapoport 2008[a]). A special section "Big data" (Nature 455/7209, 4 Sept. 2008) points out that problems of storage, retrieval and analysis are leading to a new profession in biology—"biocuration," extracting meaning from data through "data mining."

One example is a recent advertisement from Ohio State University Medical College for someone to develop electronic information systems that would help in translational research through integration across all sectors of the medical center. Others include an executive director for the new formed neuroinformatics coordinating facility at Karolinska Institute in Stockholm, and for a curator for the Zebrafish model organism database at the Institute of Neuroscience, University of Oregon.

It is important the reemphasize that included are not only data from ongoing research, but previous data which complement new findings, need to be reexamined from new points of view and play a role in synthesis and theory development. One therefore finds the use of archival material. This reexamination of archival material and its combination with new material is increasingly common in many fields of science (ecology, biology, paleontology, oceanography, astronomy, cosmology and others). An example is a project (astronometry.net) to combine all existing astronomical images, past (going back to the 1880's) and present (and, of course, future) into a single data set (Hand 2008; cf. Wynn et al. 2009).[20]

Note that one field, ecology, organized a symposium on "synthesis in ecology" (Nov. 1996 in Santa Barbara, CA). The decision was to work on synthesis, projects of integration and so on. Synthesis is defined as bringing together existing information in order to discover patterns, mechanisms and interactions that lead to new concepts and models. The meeting emphasized that one can do first-class research without collecting primary data when one already has much (as I argued earlier) (Taubes 1997; cf. Rapoport 2000d, p. 113).

Thus data not only present problems but also opportunities. For example, in oceanography a recent synthesis of phytoplankton change used data going back more than 100 years, combined with the latest satellite data, to relate these changes to climate change (Siegel and Franz 2010, Boyce et al. 2010).

In a study of population dynamics (Reynolds and Freckleton 2005) used a database on global population dynamics which contains nearly 5000 time series. They selected 1780 time series for 674 species. This is an important repository for data that often remain concealed in obscure journals and reports (cf. Rapoport 2008[a]). By being carefully screened and evaluated such data can then support powerful statistical analyses to search for broad patterns" (p. 567).

19
Although more serious in EBS, the problem is more general. In some fields, for example archaeology, proprietary information is becoming more prevalent with the rise of commercial archaeology (Ford 2010).

20
Note that verbal descriptions and visual records of astronomical events from many culture have also been used regarding novae, comets, etc.

As a final example, from palaeontology, Alroy et al. (2008) used 44,446 collections with 284, 816 fossil occurrence from 5384 sources in the literature, both filling gaps and improving sampling. This is made possible by palaeontology databases.

These few examples show that, unlike EBS and environmental design, different fields of science are tackling the data problem. It would be most valuable similarly systematically to reexamine earlier work in the fields relevant to EBS and environmental design and to make it available. This material, if worthwhile, could then be replicated, examined from new points of view and synthesized with new work.

* * *

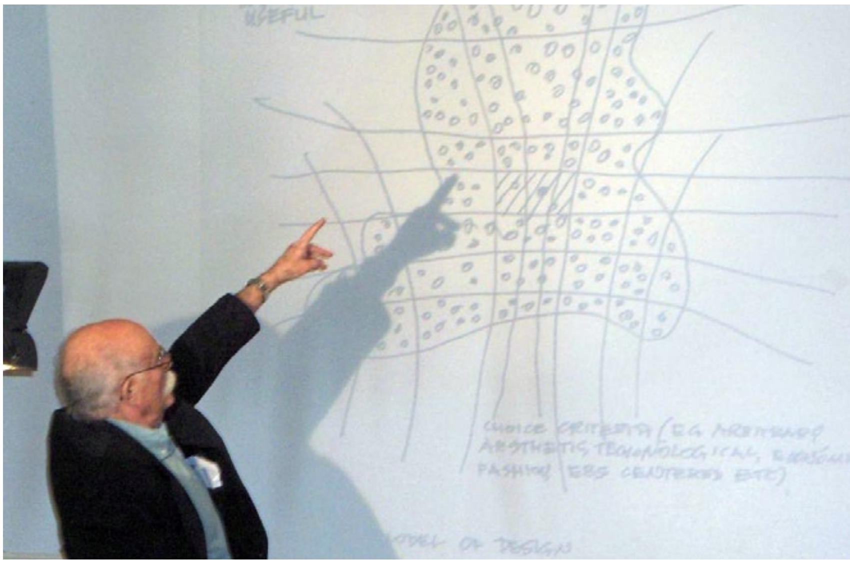
The shift that I have been advocating and discussing in this section is critical for environmental design. Although essential, it is also very difficult to achieve. In science there exists an underlying and shared world-view that has carried through quite some time—since the origins of modern science. Developing a totally new world view is a difficult task. But I have tried to show that there is no need to reinvent the wheel. As discussed, and as I will elaborate later, the various fields of science and the science-based professions provide extremely useful precedents and models from which one can learn a great deal.

Accepting that the need to shift to a science metaphor is the main implication of designing better environments for people that, in turn, radically changes everything else. I will discuss three areas: The nature of the domain, the meaning or nature of "design," and the nature of the environmental design professions. These in turn have implications for environmental design education which I will discuss briefly.

The Nature of the Domain

All research and scholarship begin with questions. These can only be posed and studied within a given domain, the body of relevant data and their interpretations of which questions are to be asked. It follows that the nature of domains and fields of study must be defined explicitly and problems and questions within that domain identified, i.e. it is critical clearly to conceptualize the domain (Rapoport 1990c, Ch. 1 and references therein; cf. McMillan 2008, p. 304).

The scientific study of any domain begins with a search for patterns and regularities because they demand explanations (asking "why"). In order to identify those, the largest and most diverse body of evidence is essential. Moreover, that body of evidence is most usefully studied comparatively. I have made this argument at length elsewhere (e.g. Rapoport 1990c) and will only point out that even today (let alone in the past), globally, most settings of people's daily lives are created by themselves or, in any case, are not designed professionally.[21] The systems of these settings which is what people inhabit, the cultural landscape, is rarely (if ever) designed professionally (Rapoport 1990ª, 1992ª, 1992b, 2000ª). In addition to fixed-features, the environment also includes semi-fixed features ("furnishing" at all scales) so that, in effect, it



effectively comprises all of material culture, and people (non-fixed features) who are, of course, central. None of these are under the control of professional designers.

Thus, although it is fair to say that the environmental design professions see design as their essence, it is the case, as I have long argued, design is any change to the physical environment.[22]

It follows that the domain to be studied needs to be expanded in four ways. First, to include all of history, including human evolution and even animal building (Von Frisch 1974, Hansell 1984, Gould and Gould 2007).[23] Second, all cultures, third, the whole environment (as a system of settings) and fourth, all types of environments—tribal, vernacular, nomad camps, outdoor and floating markets, prehistoric environments, popular design, spontaneous settlements and suburbs. Expanding the domain in this way is not only essential to discover patterns, it also makes comparative studies possible, clarifies the nature of specific environments, and any underlying commonalities, making generalizations possible.

When the domain is expanded to include the full range of environments described, and considers the settings that comprise them and how they relate to the professionally designed high-style elements (Rapoport 1992ª, 2000ª) one discovers that designers have never dealt with any of these—they have no tradition, experience or knowledge regarding these; that knowledge needs to be provided. That, and the many new types of specialized settings that never existed before, also require knowledge. This will become important when I discuss the nature of design.

I have argued elsewhere that in order to learn from the newly included 98% of the domain it needs to be seen as a model system. To be useful as such one needs to know which model system to pick, and for that questions need to be posed, based on a scientific world view and prior research (Rapoport 2006ª; cf. 1990c). Such learning, and deriving precedents, is not copying, using shape (different from form (Rapoport 1977, 2007)). It consists of learning lessons based on research. (Fig. 3)

This position is supported by recent work in other fields. For example, Forbes (2005), dealing with biomateri-

21
Architects design approximately 2% of buildings (personal communication, President of IUA, Berlin, October 2001). (See Rapoport 1990c, Figs. 1.1 and 1.2, p. 13-14).

22
There is no need to say "purposeful" change, such changes require effort and hence always have a purpose. This avoids the arguments in philosophy of biology about teleology—in our case teleology is a given.

23
At a more abstract level, research on animals and evolution makes new concepts relevant. Thus, the effect of niche construction and their effects on even primitive organisms (see references in Rapoport 2008b, 2008c) applies even more to humans whose whole environment is a self-constructed niche and has affected, and affects, their evolution (e.g. Cochran and Harpending 2009). That is also another example of the need to operate at a certain level of abstraction to make links with "unlikely" fields. I will discuss later the role of animal models to understand humans—their cognition, culture, art, behavior, language, etc.

als, argues that "bio-inspiration" is a better term than the more common "biomimetics." This is because one does not want to copy. Rather one wants to identify the mechanisms and principles abstracted from nature (p. 169, Fig 7.4). It then also becomes a model of translation (discussed later). Similarly in designing proteins the approach identifies and tests how proteins are formed in nature, and extends these to design "completely artificial" proteins (Koder et al. 2009) (see also my discussion of "design" later).

The domain, as defined here, is an unequalled (and only possible) laboratory with a vast range of human responses to an equally vast range of problems—cultural, technological, of resources (including materials), site, climate, ways of making a living, meanings attached, preferences, etc. It provides an extensive "repertoire" of both problems and (successful and unsuccessful) solutions, of processes and products, of ambience, and at scales from semi-fixed elements to cultural landscapes (all of which I have discussed at length in many publications which I cannot cite here).

I have also suggested that traditional vernacular environments and their closest contemporary equivalents, spontaneous settlements, may be especially useful (Rapoport 1988). I have also suggested that a most useful approach of learning both specific and general lessons is to consider them as model systems, which are used extensively in various areas of science, above all in biological and bio-medical research which could serve as a most useful guide—once again there is no need to start from scratch (see Rapoport 2006[a], p. 184-185 for a very brief discussion - much had to be left out due to lack of space).

A careful and systematic reading and review of the hundreds of examples and theoretical discussions of the model system literature would make its application to environmental design easier and quicker. This is particularly the case since the field continues and develop, not only in terms of the number and nature of such systems, but to what and how they can be applied.

At its most general the idea of a model system is the use of one system to study phenomena in another, seemingly very different, system (e.g. the use of animal models to try and identify consciousness in human Nature, 422/6931, 3 April 2003, p. 455). As mentioned, the use of model systems, although used in many fields, is most developed in biological and biomedical research, which I will use as a guide.

This discussion is based primarily on one study that considers model systems to address fundamental questions, in this case in behavioral ecology (Dugatkin 2001).[24] This study examines 25 model systems ranging from insects and spiders to primates. In choosing such systems it essential to know, and make explicit, the ways in which they resemble and differ from the object of study, both their limitations and strengths.

Model systems are extremely useful for addressing questions in any area of science, because they integrate conceptual, theoretical and empirical perspectives and approaches, leading to unified theories. These three approaches can be derived from a variety of fields and disciplines. In this way one need not generate new data but can use and integrate existing, sometimes previously ignored data. These help provide the large varied body of evidence required, and the variation needs to include extremes and this is where vernacular design can play a role.

A useful distinction is one between 'conceptual' and 'theoretical' approaches. The former are based on broad concepts, often synthesizing material from various sources into new frameworks (Dugatkin 2001, p. xii; cf. Rapoport 1990f). Although empirical data clearly play a role in concept formation, the latter are not directly tied to any specific observation (or experiment) (Dugatkin 2001, p. xxii). Theoretical approaches involve the generation of a conceptual model of the world, different to the specific model system being studied and, as already mentioned, different kinds are possible: physical scale models, dynamic or static conceptual models, mathematical numerical, agent-based or other simulations. In this context empirical work is essential—although it goes beyond the data, an empirical base is necessary.

Note that in using model systems, and modelling generally, many specifics need to be left out. Environmental designers often reject models for that reason. But, in fact, learning from model systems and modelling and simulation depend on identifying the principles, significant aspects and mechanisms, and avoiding details. This applies not only to biology but physics and other fields—it is a general strategy (e.g. Plenio 2009, Batterman 2002).

Historically there have been certain model systems that were widely used (e.g. the fruit fly, roundworm, mouse, zebrafish, frog, yeast and axolotl (in plants Arabidopsis)). However, the field continues to grow and develop and the number of model systems used is growing. For example, there was a special section on model systems (in Nature, 458/7239, April 2009, p. 673; 695-698), a section discussing new model systems to answer specific questions (Nature, 459/7246, 23 May 2009, p. 477, 515-527), i.e. how to select among potential models (see also Slack 2009, Cyranoski 2009, Schatten and Mitalipov 2009, Maher 2009). The latter discusses the emergence of a large number of new potential, alternative model organisms (i.e. enlarging the domain) and provides criteria for good model organisms suitable for solving specific biological problems.

There are also numerous specific examples of the ongoing use of model systems (e.g. Cyranoski 2009, Schatten and Mitalipov 2009, Sasaki 2990)—all in a single issue. The latter deals with genetically engineered [designed!—see later] monkeys which may provide a potentially valuable bridge between mouse models of disease and treatment for human disorders.

Unless approached at some level of abstraction, as discussed earlier, such studies may appear farfetched. Consider just a few examples. The sea snail Aplysia, with 20,000 neurons in nine ganglia becomes a model system to study the human mind (Kandel 2006). The fruit fly, Drosophila Melanogaster, proves to be a most useful model system for studying aging and brain disease in humans (Science, 298/5595, 1 Nov. 2002, p. 917 referring to a paper by M. Leslie "Flies like us"). The roundworm Caenorhabditis Elegans with only 302 neurons is a "superb model for

24
It is useful to note that while behavioral ecology is the same age as EBS, unlike EBS it has evolved from an "initial hodgepodge of ideas drawn from other areas…it is now a legitimate and respected discipline with the sciences" (Dugatkin 2001, p. xi). Not only does it no longer import ideas, but it exports them to a variety of fields, including EBS where, together with sociobiology and evolutionary psychology, I use it to consider constancy in humans. This development is due, at least in part, to the use of model systems.

studying behavioral neurobiology and the development of complex social behavior" (Sokolowski 2002). Slime mold is also often used for that latter purpose! (cf. Zimmer 2008) As a final example, there is the use of amoebas for ideas for optimizing dynamic technological networks, e.g. transportation (Marwan 2010, Toro et al. 2010; cf. my discussion of Turner (2007)).

More generally animal models are being used to throw light on intelligence, cognition symbolism (e.g. Mithen 1996, Marean 2010 and references therein, Lock and Peters 1999) and language (e.g. Balter 2010b). This latter has been driven partly by findings that animal communication is richer than thought. Thus prairie dogs not only use alarm calls that identify specific predators (as do monkeys) but also indicate their color (to the extent that prairie dogs can distinguish colors) (Science, 324/5928, 8 May 2009, p. 699; cf. Hauser and Bever 2008).

The study of the mental life of animals (with potential insight into humans) is relatively new (mainly post-1970). It is described (Clayton 2010) as the result of combining comparative psychology and animal behavior studies (i.e. interdisciplinary). Its findings are now being synthesized and that, in turn, is catalyzing an overarching comparative analysis of cognition. Most significantly Clayton (2010) concludes that "Shuttleworth's second edition (the first was 1998) provides considerable synthesis and greater amalgamation with other disciplines, such as child development, cognitive science and neuroscience" [note both the process and its speed, as well how similar that is to my proposals for EBS]. He concludes by saying that this work "clarifies how and why the capacities of various species can be the same yet different"—most relevant to my discussion of the domain of environmental design, cultural differences in it, etc.

It was long thought that to study higher cognition primates had to be used. However, it has recently been suggested that rats can become model organisms in that domain (Murphy et al. 2008, Abbott 2010). Showing the ongoing and continuing work on model systems, including ongoing debates, this work, being very recent, is not universally accepted, i.e. the choice of model systems is a field of study. It is also the case that birds can be used to study processes of recognition and learning (Lyon 2010) and as we have seen, bird song development throws light on the genetic component of culture (Fehér 2009, Fitch 2009). Although I will be discussing simulation in more detail later, note that it is a form of modelling (overlapping other systems) and, as an example, makes possible to use data from a large variety of fields (including archaeology) to model interactions between people and landscapes, in effect modelling the generation and development of cultural landscapes (French 2010), the importance of which in the domain I discussed earlier.

There is also a growing literature (which I will not review here) on culture (or at least protoculture) among chimpanzees, orangutans, monkeys and even meerkats (e.g. Balter 2010a, Van Schaik 2004, Haslan et al. 2009, "Meerkats have their own traditions," Science, 329/5989, 16 July 2010, p. 269). These have major implications for the understanding of culture in humans. A similarly extensive literature deals with the social complexity of animals (e.g. Maestripaeri 2007, Harcourt and Stewart 2007, the work of Frans de

25
Many other examples can be found in much of my published work.

Waal, among many others). This has implications for human evolution (Mulder 2008). It has also been suggested that it has implications for the development of intelligence (e.g. the work of Robin Dunbar). At the same time there have been many studies of monkeys and apes trying to identify the critical differences and also continuities between them and humans (e.g. Balter 2008).

It is also suggested that agent-based modelling can be of help to epidemiology by capturing irrational behavior (Epstein 2009[a], cf. Ariely 2010), complex social networks, etc.—all very relevant to environmental design (all discussed later).

I have already briefly referred to the relevance of the concept of niche construction and its potential relevance for environmental design. The idea of niches generally has become significant in various fields. For example, at a very small scale they play a critical role in the survival of stem-cells (paper by Lutoff et al. in a special section on "Biomaterials" Nature 462/7272, 26 Nov., p. 433-441 discussed earlier). This uses research to identify the attributes of these niches for the survival and correct specification of fate of stem cells in them. At a larger scale there has developed the idea of niche construction (e.g. Odling-Smee et al. 2003, cf. Rapoport 2008b, 2008c).

Animals live in constructed niches which affect not only their well-being and survival but their evolution. This is most relevant regarding humans who essentially live in a man-made environment (and have done for a long time)—the ultimate niche. As a result, even more than for animals, niches have affected human evolution (e.g. Cochran and Herpending 2009). Thinking of the environment as a system of settings (which include all of material culture) it is, in principle, possible to identify the attributes of such systems of settings (niches) that humans need (e.g. levels of complexity, appropriate meanings, colors, materials, light, etc. etc.). These then provide information (e.g. through environmental quality profiles) for the design of supportive environments that leads to evidence-base design.

Animal studies (when combined with human studies) can also greatly illuminate basic question 2 of EBS—the effect of environment on behavior. Building on numerous field studies of stress in animals, e.g. baboons (Cheney and Sayfarth 2007) work is now proceeding on considering stress in humans and the underlying mechanisms. Thus, for example, Pinholster and Han (2008) have found that long term stress has major effects on the brain. They emphasize the importance of being rigorous about and identifying, the mechanisms involved. Diaz—Ferreira et al. (2009) also provide insights into the mechanisms involved.

Since socially and economically deprived groups also live in stressful environments this may explain how such environments contribute to the effects of deprivation. It is then possible to argue that inhibiting environments are equivalent to stressful environments, linking this work, and the mechanisms discovered with the sizeable literature in EBS on the effects of degraded environments on people. These include scruffy vegetation, empty and badly maintained houses, broken windows, littered streets, graffiti, etc. (frequently via the meanings communicated (Rapoport 1990f)).

Some cities in the U.S., and public housing management, have adopted a policy of responding quickly to vandalism and damage to prevent the build-up of such indicators. Continuing research supports and reinforces such policy. It seems that disorder in the environment has generalized effects, attributed to "norm violation" (Holden 2008b, Keizer et al. 2008) confirming related earlier work in EBS. Clearly "disorder" needs to be defined and dismantled, its specific components identified and their effects, singly and in combination, studied.

New research findings are thus enriching our understanding about the effects of environment on behavior. Some studies are starting to show the effects of specific variables on people (e.g. Williams and Bargh 2008), for example, the effects of temperature on interpersonal relations. This work is also in line with my suggestion earlier that by linking environmental variables to humans, architectural science would be more easily linked with EBS, the new cognitively informed design methods and work on participation.

This discussion of how various sciences address questions to, and learn from, their domains by using model systems should serve as a guide for how the domain of environmental design (as defined above) should be approached. I conclude with two brief examples, which are related.[25]

The first thing is to be aware of the domain as a whole, and define specific sub-domains in terms of the questions being studied. This has never been the case in environmental design because nomothetic thinking is neglected, and there is an idiographic attitude (especially among architects) that each case is unique. This has also led to the neglect of knowledge already available, cumulativeness, learning from successes and failures and also the proper search for precedents. (Rapport 1990c, cf. 1986, 1987b, 1989, 2000b, 2006[a], 2006b, 2008c).

Consider "suburbia" which environmental designers have criticized for a long time, without much success. This is because, as I have argued for some time, it happens to be an ideal for many (if not most) people. As soon as resource constraints are loosened, one finds suburban developments all over the world: Africa, China, Japan, Indonesia, Turkey, Mexico, etc. The first step is to dismantle the term: "Suburb" can be defined in a least 5 ways (Rapoport 1980, p. 119-120) and it is necessary to know which of these characteristics (also dismantled) is playing a role in any given case. Second, one needs to identify the components of environmental quality of these environments.

As I have already suggested (and will discuss later), it is very useful to use advertising, the housing marketing literature, etc., which have been ignored. These provide a very good understanding of the positive and negative components of environmental quality, hence reasons for people's likes, wants and the choices made, the images that are important etc.; These I have discussed in many publications, with many references and examples (cf. Nasar 1998, Troy 1996, Bruegmann 2006).

My final example critically examines an attempt to learn from spontaneous settlements in order to suggest how that should be approached. Note that I am relying entirely on an architectural critic's description; I have neither seen the project nor the designer's actual proposal.

According to Ourousoff (2006) it seems that a California architect (Teddy Cruz) has attracted much attention by applying characteristics of a spontaneous settlement in Tijuana, Mexico to housing in San Diego, California. Judging by the description and illustration there arise a number of questions and doubts based on my account above of how one learns from such environments and generates precedents and lessons (see Fig. 3, page 14).

1. The idea of learning from such settlements is not new, although the account suggests it is. There is a very large literature, going back over 40 years, on the potential lessons of spontaneous settlements (e.g. the work of Turner, Peattie, Lobos and Payne to mention just a few). Most of this work has been about process, although product has occasionally been discussed (e.g. Rapoport 1988, 1990d, 1999ª). It would be useful to do research on the environmental quality, supportiveness, open-endedness, aesthetics and other aspects of these environments. In the present case, there seems to be no awareness of the current state of the large research literature. Rather than starting at the state-of-the-art, and as is all too common in environmental design, and even EBS, it seems that the wheel is being reinvented.

2. A single example seems to be used, yet spontaneous settlements vary enormously. I once counted 13 very different such settlements in one day's visits in one city (Saõ Paulo, Brazil). In one small settlement in Kharagpur (Bengal, India) there were two very different environments — Bengali and S. Indian.[26] The literature also makes clear that there are major differences in the way such settlements develop in different regions (e.g. Africa vs. Latin America) and among different groups in one country. It follows that any generalizations or transferability based on one case are questionable and, in this case, the transfer was also too direct.

3. On the basis of the article it appears that the "lessons" were largely visual. Given the prevalence of rules, in the U.S. and elsewhere, in condominia projects and many residential areas, many people seem to prefer uniformity to the visual quality of spontaneous settlements. In fact, personalization is often prohibited and rules and covenants are used to preserve uniformity (Rapoport 1990f, 1995 (1990/91)). Like Cruz, I also greatly admire, and like the visual character of many spontaneous settlements. However, as already discussed, "I like it" is not a valid criterion for design. Moreover, that particular visual quality is a result of participation, open-endedness, expressions of cultural identity (which vary) and the operation of particular rule systems. It is in these that any lessons are to be found and a very different kind of transferability is involved (if it is valid which needs to be established in any given case).

4. Similarly the "lesson" of mixed uses is doubtful. These are rejected by most in the U.S. and increasingly in Mexico and other places with increasing wealth (e.g. Rapoport 1977, 1990f, 1998, 2000c; cf. Baumgartner (1988) (discussed below) among many others). As discussed earlier, U.S. type "suburbs," criticized by Ourousoff (2006), seem to be an ideal in many countries. When resources permit, they and walled communities are becoming common in China, Turkey, Italy, Mexico, Japan, Indonesia, etc.[27] There are also differences among different countries and groups. There are thus researchable questions on the acceptability of mixed uses in various contexts and also the types of uses. Grocery shops may be acceptable (although there is evidence against it) whereas auto repair shops and butchers (given as examples) hardly seem what most people with choice (like those in San Diego) would want next door—although that too is researchable.[28]

5. The use of Tijuana as a "model" (not in my sense!) seems to be based on the supposed "alienation" of U.S. suburbs (which is more an alienation from "suburbs" by environmental designers and architectural critics). Users clearly choose suburbs and choice, habitat selection, is the most important aspect of the effect of environments on people (EBS basic question 2). The inhabitants of suburbs represent a distinct culture who have chosen them for the very reasons that designers and critics dislike them (Baumgartner 1988, Bishop 1983, Rapoport 1998, 2000c, 2005ª).

The question one is left with is whether this is learning or copying. One cannot just look at an environment, say "I like it" and try to reproduce it (in any case Tijuana does not have a very positive image in San Diego!). By looking at it, one can only become aware of it, and sensitize oneself to its qualities. [29] The next step must be research on it, starting with the state-of-the-art, the literature and previous work.

Regarding spontaneous settlements there is a major gap in our knowledge and, hence, ability to learn from them. This is the relative impact of constraints and wants and how to distinguish between them. I am not aware of any work on this topic (which is general—constraints always play a role). Housing games and other methods could prove useful in such research, which is needed.[30]

26
See also the variety of photographs in Caminos and Geothert (1978). Note also the uniformity of proposals (Rapoport 1979b).

27
I have brochures of new developments in Istanbul and Yogyakarta, which feature the suburban image and gating. In the case of Yogyakarta, architects from Orange County, California (the "heart" of suburbia) were commissioned.

28
Also, there really are no butchers shops in the U.S., they are typically a part of supermarkets.

29
This is important because, as in the case of vernacular, or any other environment, there are four possible responses. One can ignore it (particularly common for spontaneous settlements but also vernacular, popular, etc.), it can be rejected as having no valid lessons, it can be copied or one can try to learn from them through research.

30
In housing games one begins with unlimited resources and allows people to express their wants through design. Then, one systematically reduces the resources available, and studies the order in which elements are eliminated, This, then produces a hierarchy of the importance of various wants.

31
Although this is later than the cut-off date of July 31, I had to include it. It is the only one (of many others available).

32
I will not pursue this interesting question here, but it seems to provide a most worthwhile topic for research.

The scientific study of the domain as defined, of this great variety of environments, how they came to be (the processes involved), their characteristics, environmental quality, their supportiveness or inhibiting effects, human behavior in them, relation to culture and identity, etc., can help with the development of generalizations, conceptual frameworks and, ultimately, theory. Such research can also provide valid lessons and precedents. With all these, designing for people becomes feasible.

The above discussion has begun to address the issue of design, to which I now turn.

The Nature and Meaning of "Design"

I have pointed out elsewhere (Rapoport 1995g, cf. 1995d (1989), 1995h) that, at least in English "design" is a strange word—it has very many meanings. Dictionaries give as many as 16 meanings and refer one to "plan." The principal definition in OED is "the thing aimed at; the end in view; the final purpose (what I call the "what"). I listed close to 40 domains to which it is applied, which I need to repeat because these are central to my argument.

One can speak of having "a sense of design" or being a "creative designer." Design can be of books, jeans, shoes, fashions, perfumes, machines, cars, airplanes, rockets, robots, TVs, microphones, players and speakers. One can also design furniture, fabrics, decorations, graphics, buildings, urban areas or spaces, landscapes or interiors. Once can contrast high-style, vernacular and popular design. One designs marketing and advertising campaigns, corporate strategies, experiments, clinical trials and research programs and also artificial hearts (Jolly 2010). In this case, what is significant is that rather than basing the design on animal research the new device uses "hemodynamic modelling, regulation algorithms, simulation and computer-aided design". Similarly one designs artificial kidneys, parts of lungs (Huh et al. 2010) and lungs (Wagner and Griffith 2010, Peterson et al. 2010). They only become possible because one knows how kidneys and lungs work, how they do what they are supposed to do.

There is the design of materials, metamaterials, catalysts and catalytic processes, biomaterials and biomimetic materials (see earlier and Omenetto and Kaplan 2010), drugs and drug delivery systems, vaccines and viral vectors, genes and artificial genomes, i.e. synthetic biology (designing life) which, in one year, progressed from modifying genomes (Lartigne et al. 2009) to the design of synthetic genomes (Gibson et al. 2010).

In this case the genome was constructed from digital DNA data. When inserted into a bacterium it changed it, as predicted, into another species, which was able to replicate and form colonies. This was called a "proof of principle" for the development of synthetic biology, i.e. designing life (Pennisi 2010, Katsnelson 2010, "Life after the synthetic cell," Nature 465/7297, 27 May 2010, p. 422-424). Note that just one year earlier it was thought that this would take significantly longer (Pennisi 2009)—another example of the "breathtaking speed" of advances (special section on "small-molecule catalysis," Nature 455/7211, 18 Sept., p. 303).

Living organisms with specific characteristics (knock-out and knock-in mice and rats) have long been designed (and can be purchased commercially). Similarly there are artificial amino acids which do not exist in nature leading to designed proteins. When these proved impossible to synthesize, artificial ribosomes were designed (Neumann et al. 2010). Similarly other cell organelles, such as golgi bodies (Choi 2009) and gene oscillators (based on computational prediction (Stricker et al. 2008) have been constructed. One designs chemical reactions, molecules, atoms and even atomic nuclei (Sherill 2008). Two years after it proved possible to have monkeys move prosthetic (i.e. designed) arms by thinking (Carey 2008) it is now becoming possible also to do that with humans (Dreyfus 2010).[31] These designs show an understanding of how brain signals relate to movement.

Given this range of forms of "design" two possibilities follow. First, there may be some common core among them.[32] Second is the implication that one can choose among these numerous ways in which "design" is used. I suggest once again, given my emphasis on using science as a model for environmental design as a science-based profession, and my emphasis on clear goals and predictable outcomes, that we use the examples from science rather than art for guidance. Our model should be the design of materials, enzymes (Röthlisberger et al. 2008), proteins, living organisms, cellular and metabolic engineering and molecules (e.g. Wender and Miller 2009).

In addition to the examples already discussed, I have collected over 100 examples of this kind of design in various evidence-based specializations. I will discuss just a few; That will help to see what they have in common, and how that makes them highly relevant for designing for people.

Material science provides many examples of the design of materials with properties not found in nature, e.g. with a negative refractive index (which may provide "invisibility" in some cases (Valentine 2008, Service 2010)). More generally such materials offer unprecedented control of light and the possibility of new devices (Shekiev 2008). It also becomes possible to make materials more efficient for given purposes, e.g. by tailoring pores, either to trap and hold desired products (Service 2008, Colombo 2008), in some cases near the ultimate adsorption limit for solid materials (Furukawa et al. 2010). Alternatively it becomes possible to design perfectly dense materials (e.g. ceramics) without pores (Messing and Stevenson 2008).

One can design near-perfect 'black' materials which absorb every photon that hits them, and were thought to be only ideal (Bally 2008). Note the necessity to know what "perfect black" means and how it is defined. Many proteins are now being designed including completely artificial one (Koder et al. 2009). These "offer a clean slate on which to define and test these protein engineering principles, while recreating and extending natural functions" (p. 305). The point is made that "the ultimate test of our knowledge of how metalloproteins work is to design new metalloproteins." These can be used in biotechnology and therapeutics, and the design is based on desired functions (Yi Lu et al. 2009, p. 855).

Enzymes that do not exist in nature can also be designed, to capitalize on the ability of enzymes to catalyze reactions (Baker 2008, Ghirlanda 2008, Lutz 2010, Siegel et al. 2010).

In view of all these achievements it has been striking to observe a further change—an emphasis on what has been called "rational design," "intelligent design," "truly intelligent design" and "predictive-based design." These approaches seek to replace serendipity, and trial and error, in order to achieve desired objectives in predictable and effective ways, whether in chemical reactions, designing uses for viruses, designing artificial viruses or in drug (small molecule) design that will bind predictably to proteins (e.g. Douglas and Young 2006, special section on Virology, Science 312/5775, 12 May, 2006, Nam et al. 2006, Ball 2006, Houk and Cheong 2008, Jorgensen 2010, Superti-Furg 2008). The latter discusses how understanding of biology as a system could help rational drug discovery.

Synthetic biology can also lead to predictive-based design. Referring to a paper in Nature Chemical Biology, Nature, 465/7295, 13 May 2010, p. 138 describes how researchers have engineered a strain of the bacterium E. coli (a favorite model organism (cf. Zimmer 2008)) to move towards and degrade Atrazine (a common pesticide and environmental contaminant). Details are given about how this was done, and it is suggested that one could reprogram bacteria for other tasks (they are already used to produce antibiotics, etc.)

What is common to all of these examples is that a problem is identified—what is to be achieved and what is to be avoided (i.e. what needs to be done). Also identified is the knowledge needed to solve that problem, e.g. the mechanisms involved, without which predictable design is impossible. That knowledge includes both what is already known and what is yet to be discovered through research. Whether the desired outcomes have been achieved requires further research (i.e. evaluation) (e.g. Winther-Jensen et al. 2008 among numerous other examples).

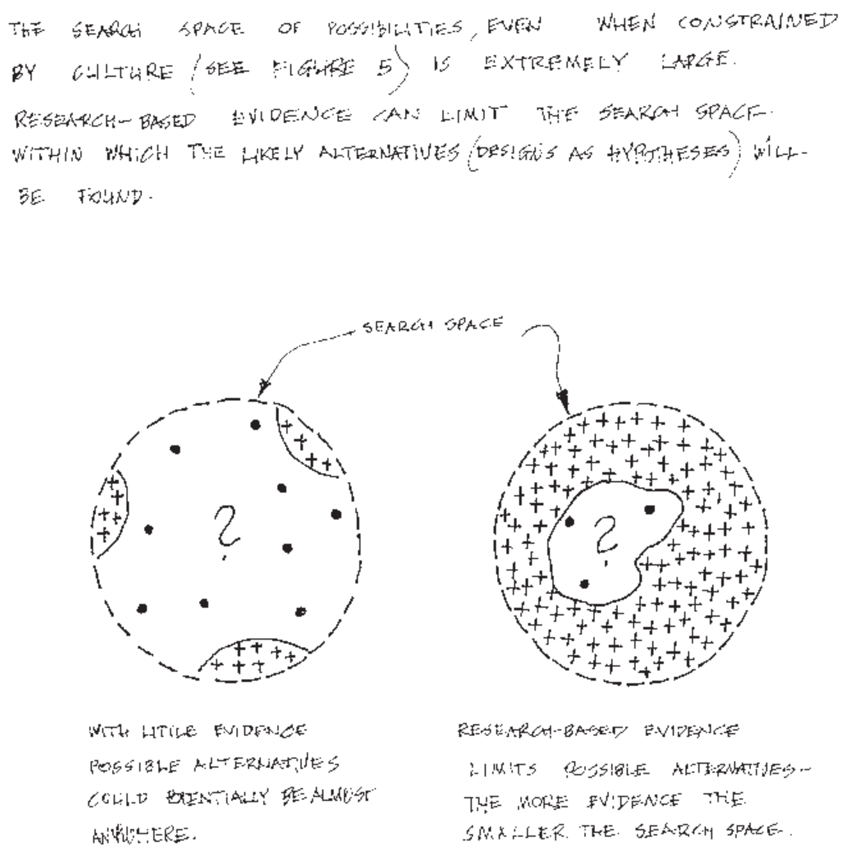
In environmental design seen as a science-based profession one would similarly want predictably and reproductively to achieve explicit behavioral, affective, sensory ("aesthetic"), social, cultural and other responses, based on knowledge—i.e. supportive environments for people and the results then evaluated.[33]

Note that intuitions, insight, imagination and even guesses, play an essential role, as they do in research and science generally. They are essential in any creative endeavor (and science is, I believe, the most creative thing humans do). However, in science these intuitions (= hypotheses) are greatly constrained by prior research—the best available knowledge. They are placed within the context of what is already known in order to avoid reinventing the wheel, to avoid unnecessary replication and to justify new studies to test these hypotheses. As Nabel (2009) points out "dense information" helps to generate likely hypotheses, as well as to test them. It follows that there is discovery-driven research to generate hypotheses as well as hypothesis-driven research to test them, and these are usefully combined—they complement each other. Exploration through discovery, e.g. studying the domain as defined with specific questions (rather than hypotheses) generates information. With more information an unknown search or decision space can be more tightly defined which helps to reduce or limit where likely hypotheses are to be found. It is also useful to think of generating scenarios, which are useful in organizing thinking and research about complex topics (Allen 2009, p. 259. (Fig. 4)

It is the case that designers today build their intuitions, the basis for which is totally unclear and based on personal preferences, ego, fashion and so on, and largely in visual terms. Furthermore, they do not consider their intuitions to be hypotheses yet, as I will discuss below, design itself is usefully seen as a series of hypotheses.

This discussion is also related to my argument earlier about dismantling. As is often the case as a term "research' is too broad. In addition to the above distinction one can distinguish among basic (empirical and theoretical) research, translational research, applied research and simulation (all developed below). In environmental design, in addition to these, there are also more "informal" research methods, which are simpler and more straightforward. Environmental design has the great advantage that one can always do this type of research. Opportunities are always present, in an aeroplane window seat, bus, train, walking or driving. One can interrogate the environment—"read" it.

However this only becomes useful if one has specific questions in mind, some concepts and particular way of thinking. As a start, just observing and finding apparent patterns that demand further work and explanation ("natural history") can be useful (Rapoport 2006[a], Endersby 2009). One can observe what people do, and do not do, and ask "why." For example, it is often noted that people, especially in the U.S. tend not to walk (except for exercise), yet much effort goes into creating pedestrian



▲ **Figure 4:** The role of research in the choice model of design (based partly on Nabel 2009)

33
R. D. Blackwell quotes Nietzsche to the effect that "man's most persistent stupidity is forgetting [or not even considering] what he is trying to do," (The National Interest, No. 84, Summer 2006, p. 22).

friendly environments which are often not used (I myself have studied those, Rapoport 1990c). The use of what I call indirect methods (using popular media, advertising, etc.), and which I and students have found useful, can help (Rapoport 1990b, 1990f, 1998, 2000c). In fact it clarifies both the U.S. phenomenon and why it is becoming more widespread as affluence goes up (like suburbs). Thus Garreau (1994) cites 18th c. visitors to the U.S. to the effect that people were even then (before cars that are often blamed) unwilling to walk. Cherruau (2010) quotes people in Senegal about walking. One woman hates to walk because she did too much of it as a child. She grew up in a village and had to walk a great deal, and fast, to complete her duties "…I have walked so much that my legs have nothing to prove to the soil" (my translation). Senegalese now hate to walk and, as soon as they can afford it, start driving. Walking reminds them too much of life in the villages "which our parents and grandparents left with joy" (my translation). Such attitudes more generally, emphasizing modernity have major effects on planning, design, preservation and learning from the past (Rapoport 1983, 1986, 1987b, 1994ª, 2002ª).

Indirect methods include using advertising, TV, films, newspapers, general magazines, novels (mysteries), poems, songs, housing developers' pamphlets, environments used as backgrounds to advertisements (e.g. fashion, cars, travel), city and regional literature and home pages: Those meant to attract businesses, residents or tourists are different—an example of the small size of groups already discussed and their different evaluations of environments (Grodach 2009). All of these identify positive and negative images and components of environmental quality. Once these methods are learned (and they should be taught and practiced) it becomes possible to use plants, gardens, fences, color, decorations, landscaping, signs, contents of shops, etc. to identify many environmental variables, e.g. meanings used to communicate identity ethnicity, etc. (Rapoport 1990b, 1990f, 1998, 2000c, 2008c and references therein).

An example of how direct observation of the cues above, including during travel, newspapers, mysteries and other "unlikely" material come together, and can be combined with more formal research (including historical) can reveal how the small size of lifestyle and other groups is reflected in the urban environment and, therefore, the continuing significance of neighborhoods.

Formal research has made clear the importance of neighborhoods, their small size, their large numbers in cities, and their subjective definition as a socio-spatial schema (see references in Rapoport 1977). This can easily be confirmed by observation during travel, and seen particularly clearly in traditional cities (in China, India, Indonesia, N. Africa, Central Asia, etc.) (see Smith 2003 on the early evidence for this). (cf. Rapoport 1993ª, 1997b, 2000ª, 2000b, 2006b). Even suburbs are differentiating into varied neighborhoods, and these are often becoming smaller, as I predicted, and judging by the proliferation of the kinds of signs I described (Rapoport 1997b). This is, of course, due to the small size of groups and confirmed by the housing marketing literature which defines 50+ lifestyle groups in the U.S. defined by where they live and able to predict their choices—what they buy, read, drink, etc. (cf. Rapoport 2005ª). As neighborhoods change, differences also emerge between remaining groups and incomers (Rotenberg and McDonogh 1993, Suchar and Rotenberg 1988 concerning Chicago).

Consider a memoir in a general interest magazine (Epstein 2009b, p. 31) that also concerns Chicago, which is said to have 237 neighborhoods [probably more judging by Milwaukee (Rapoport 1997b)]. In the past one could predict inhabitants' income, behavior, space use and institutions based where they lived. Each neighborhood was a village [as in the case in many cities, cf. Rapoport 1981] defined by ethnicity, folkways, mores, etc. People did not leave their neighborhoods which had everything they needed. This is no longer the case for many, but even as neighborhoods change Epstein points out that they remain homogeneous (cf. Rapoport 1980/81).

Such findings are also supported by novels (I use mysteries). In a recent example (Lovesey 2009) a detective in London is trying to find a Ukrainian. He asks if there is a Ukrainian community in Bath. The reply: (p. 61) "They do band together in places and keep up old customs and religion. Ukrainians have always had a strong sense of identity…they organize events and meet socially "[in London]"…"they have their own cathedral." Another question (p. 162), "Would you know the part of London where most Ukrainians hang out?" [Note the assumption that there is one]. The answer "Holland Park. It's all around that part of town. Restaurants, clubs, churches, the embassy. You could be forgiven for thinking you're in Odessa. They even have a Ukrainian Statue in Holland Park Avenue—their patron saint, St. Volodomyr. They're well dug in."

This applies to dozens of other groups in London, who can be identified through shops, restaurants, signs, etc. It also applies to many other cities and groups (e.g. Chinatowns, Little Italys, etc.). Thus, for example, it was found that the Hmong community in Milwaukee is tightly clustered and maintain many aspects of their culture (Dearborn 2006).

In another case (Mayle 2009, p. 6) a character looks out over Los Angeles, sees the airport, Beverly Hills [a neighborhood] Thai Town and Little Armenia [There is also Korea Town, Japan Town and so on]. Also in L.A. Connely (2009, p. 90) after mentioning a black area continues "Monterey Park could easily pass for a neighborhood in Hong Kong. The neon, the colors, the shops and the language on the signs [and foods and other goods sold—a useful cue] were geared toward a Chinese speaking population." I would add that while Monterey Park is horizontal, Hong Kong would be vertical. Newspapers also typically refer to neighborhoods. Thus Santos (2009) refers to Irish and Italian neighborhoods, and sections of Crown Heights, Borough Park and Williamsburg (all in Brooklyn) inhabited by Hasidic Jews and where Yiddish in spoken (cf. Rapoport 1990f, 1997b, 1998, 2000b, 2006b).

Note several things about this discussion. It combines different methods a formal research in several disciplines with informal ones using a wide variety of sources. It also combines theory and experiment (e.g. in the subjective definition of neighborhood), empirical data and observation. Finally it also leads to other disciplines and theory. For example the persistence of neighborhoods relates to the importance of what sociologists call intermediate institutions or mediating structures between individuals and macro-structures. In this case they are based on intermediate socio-spatial units (neighborhoods) between individuals/families and the larger social urban (or metropolitan, megapolitan) realm. It also then leads to the possible importance of "bottom up" approaches in environmental design and, in this particular case, another example of the relevance of apparently unrelated disciplines—international policy (Etzioni 2009).

Thus persistent patterns of human behavior (neighborhoods) go back 1000's of years (Smith 2003), social organization and other aspects of culture, choice and the resulting environments must be the point of departure for design. Starting with a blank slate, designing for one's own preferences (e.g. Le Corbusier's plan for Paris) is unacceptable. In deciding what to do, it is essential to know, and start with what is, regarding both people and environments, and to understand why it is. That helps constrain the field of possibilities (which are also hypotheses) as discussed earlier (cf. Nabel 2009 and Fig. 4, page 21).

In fact, any design can usefully be seen as a hypothesis, or rather a series of hypotheses, of the form: if such and such is done (A, B, C…Z) then so-and-so will follow or happen in terms of human responses (1, 2, 3, …N) through certain mechanisms. The outcomes, of course, need to be evaluated.

This can be seen in e.g. molecular biology. For example, if one adds a third photo pigment (human opsin) to retinal cells in monkeys (who are normally red-green colorblind) through gene therapy, they are able to distinguish three colors (Neitz and Neitz 2009, Shapley 2009, Mancuso et al. 2009). In the case of the disease retinitis pigmentosa the introduction of archaeobacterial holorodopsin ex-vivo can reactivate light-insensitive human photoreceptors, and may help restore vision (Cepko 2010, Busskamp et al. 2010). In each case the manipulations are, in fact, hypotheses.

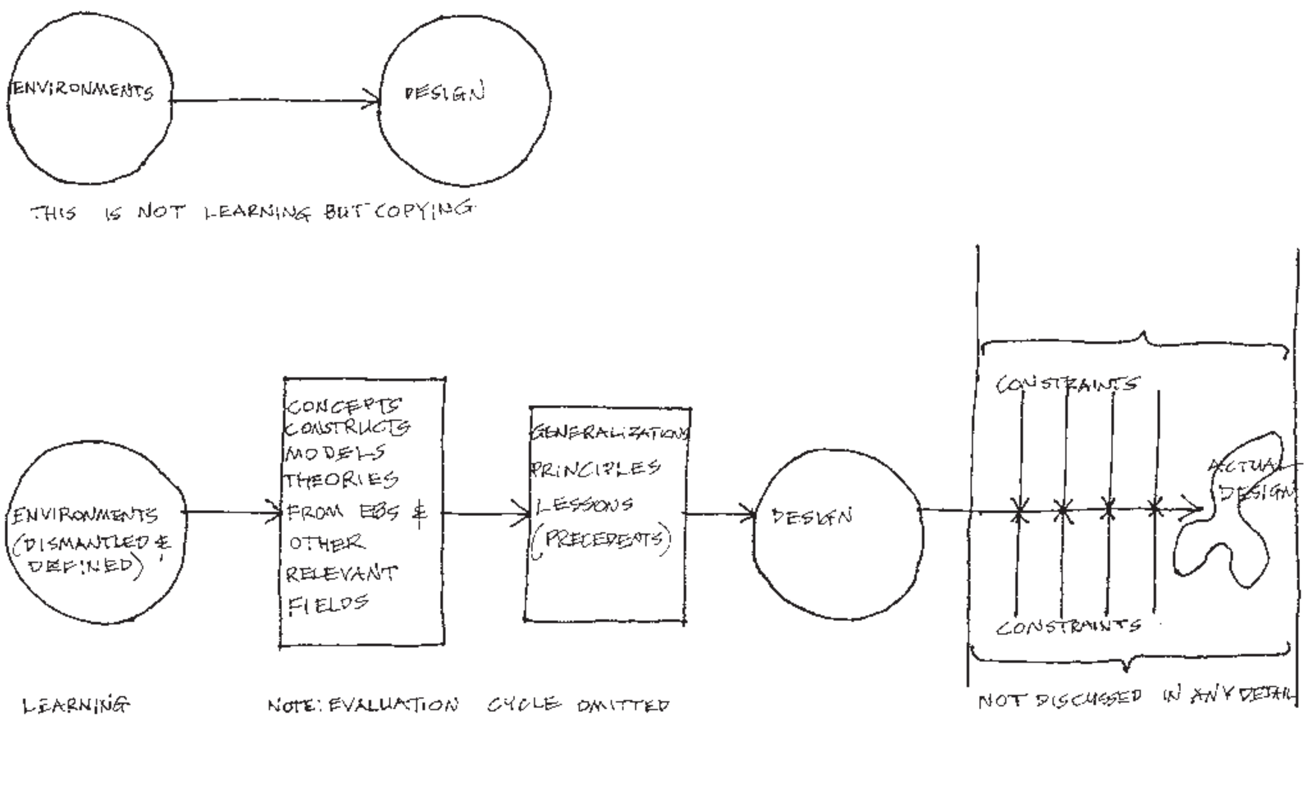
Particular manipulations of certain receptors in brain cells enhanced the cognitive abilities of mice (starting with "Doogie" in 1999). There have now been 30 further mutations that improve cognitive functioning in mice and work continues to see if it might be applicable to humans (Nature 461/7266, 15 Oct., 2009, p. 843, Lehrer 2009).

Note that these cases are all in the form described above. Although in design this may be reversed—what needs to be done (A, B, C…Z) to achieve (1, 2, 3…N), and why (what mechanisms, etc., are involved). Ultimately design, as here described, and research are very much alike (Rapoport 1990e, fn. 11, p. 99).

I suggested earlier that any change made by people to the physical environment is design. Thus cultural landscapes are designed in the sense that many people make decisions about choices among alternatives over long periods of time following systems of rules. These choices incorporate the meanings and behavioral, affective, social, cultural characteristics of the group, and also their lifestyle—a most important expression of culture useful in designing for people (cf. Rapoport 2005[a], Ch. 7). They also lead to recognizable outcomes, to style more generally (of buildings, art furnishing, etc.) and of cultural landscapes (Rapoport 1992[a], 1996, 2005[a], 2008c). The rules used vary greatly among groups and can be identified through research (Akbar 1988, Hakim 1986, 1994, 2001[a], 2001b, 2007, 2008, Hakim and Ahmed 2006).

Two things follow. First, it might be possible to think of designing rule systems, the application of which would

Figure 5: Learning from the domain (Rapoport 1990c, 1998)



result in desired outcomes rather than designing the environments themselves.[34] Second, it is necessary to study and understand others' rule systems, their role in the past and present in the full range of cultures and environments of the domain, and also the constraints at work and the tradeoffs made. This would help in designing for people, and in avoiding the problem of "architects' people" and "planners' people." Again research-based knowledge is essential.

Following this line of thought, one can suggest that all design can be seen as a process of making choices among alternative, based on the application of certain rules (rule systems). These then lead to certain desired (and predictable) outcomes to meet explicit and justified objectives. This I have represented by what I call the choice model of design (e.g. Rapoport 2005[a], p. 64-72). (Fig. 5)

This hypothetical model which I have long used has recently received support from studies in the brain sciences and decision-making (and problem solving) in general (e.g. Leighton and Sternberg 2004, special section "Decisions, decisions…" Science 318/5850, 26 Oct. 2007, p. 593-610, Resulaj et al. 2009, Nersessian 2008).

For example, Leighton and Sternberg (2004, p. 6) say: "The advantage of problem solving is that its outcome can be judged right or wrong unequivocally, by determining how well it resolves the problem…" This is highly relevant to design if it specifies what it is supposed to do, but only if the problem is correctly identified. Chapter 10 on cognitive heuristics which is particularly relevant says, (p. 273) "…finding a workable solution to a problem does not need to depend on taking all causally relevant information into account [which is often not feasible]. Simple rules or heuristics can be used." The chapter also emphasizes the relevance of intuitions if these are tested (as discussed earlier). Page 231 supports my choice model almost verbatim. It points out that when there are multiple options or choices to be made, a single criterion will not do. "Follow the simple principle of elimination. Successive cues are used to eliminate alternatives until a single option can be selected." Such rules are more effective when they rely on knowledge for judging the validity of various criteria.

Further support of my model can be found in Leighton and Sternberg (2004) on pages 282-283. Moreover the various forms of elimination-based heuristics can be described, researched and clarified, satisfyingly introduced and taught.[35] Chapter 15 "Teaching reasoning," other parts of the book and the references therein are also relevant.

The special section "Decisions, decisions…" Science, 318/5850, 20 Oct., 2007, p. 593-610, further supports the choice model. For example, Paulus (p. 602-606) describes decision making as being the selection of an action from a set of available options. On pages 606-610, Körding discusses the various ways in which the central nervous system makes decisions, which are based on "utility." That, of course, must be defined on the basis of knowledge (discussed on p. 609). Again, decision making is discussed, analyzed and research reveals how the central nervous system may represent uncertainty, e.g. on utility functions. Even inverse decision-theory is discussed which is my above definition of design in terms of "if-then."

All these, and other, sources present a most useful analysis of decision-making, theoretical, empirical and quantitative, which is most relevant to my view of design. It incorporates goals based on evidence, evaluation of evidence and goals as correct or wrong (e.g. Resulaj et al. 2009). There is much work available which would help greatly improve environmental design.

Design as problem-solving requires different ways of thinking than designers now use. After all, most artists do not use research. Using research-based evidence to solve problems requires knowledge of the relevant literature(s), the ability to abstract and generalize, to construct models and to emphasize diagrams rather than drawing (which I discuss later in "education"). It has also been pointed out that "the process of science is not an arcane intellectual practice, but a type of problem solving that we can use when we want an answer" (Science 326/5958, 4 Dec. 2009, p. 1349). If, then, environmental design is problem solving, and seeks answers, it follows that turning it into a science-based profession is highly relevant.[36]

Additionally much ongoing neuroscience and brain research can help understand and improve human problem solving, and was not previously available. As one example, Tsien (2007, p. 52) points out that to solve problems in an ever changing world one needs the ability to generate abstract concepts from events (my italics; cf. my discussion earlier). That ability is also described as the essence of intelligence and, in turn, involves a search for constancies and regularities, a search for pattern (as I have already emphasized). It also requires generalization and a way of thinking common in science and science-based professions but foreign to current environmental design professions. It also needs to be re-emphasized that problem identification (rather than "definition") is critical.

Research is also beginning to identify the role of unconscious decisions in goal seeking, which is often used to question arguments such as mine. (Custers and Aarts,

34
This relates to open-endedness and under-design and can be combined with the design of physical frameworks allowing for changes to the environment (The work of Habraken, Turner, Open House cf. Rapoport 1995f (1990/91), Tipple 2000). It is also related to participation, and another important topic for research.

35
Here is an obvious link with design methods as suggested earlier.

36
Suggestions that design may be seen as problem-solving go back quite some time (e.g. Heath 1984). This approach also offers an opportunity to link EBS and design methods research.

2010, Doya 2010). Such knowledge may help in utilizing such processes more productively.

Recently it was reported (NY Times, June 30, 2010) that the advertising community is starting research on decision-making, emphasizing ongoing work in neuroscience and behavioral economics. Increasingly brain scans are used to reveal people's reactions to various stimuli, their likes and dislikes that may not be conscious and is being successfully used in marketing (e.g. Plambeck 2010). Using neuroscience, brain scans, etc., to study preferences, wants and the like has another advantage. Given the evidence that people are greatly influenced by others, such studies may bear on my hypothesis that the public interest in certain designs is not because they are liked but because, since environments are not prominent in people's awareness, they feel they should like what 'critics' ("experts") and the "intelligencia" say they should like.[37]

Accepting my view of design has two consequences. First, design can be taught in terms of decision-making, reasoning processes, the application of rules to eliminate alternative, including making the inevitable tradeoffs (discussed later) based on cognitive science and neuroscience research. Second, it suggests once again that EBS and design methods (DM), especially cognitive science-based design methods research (e.g. Oxman et al. 1995) can begin to be integrated and synthesized with EBS[38] As a reminder, there were two responses in the 1960's to the same perceived problems with the failures of environmental design as practiced. Wheareas EBS emphasized the need for the use of new kinds of information, new data based on research on EBR, DM emphasized how information could best be used in design.[39] After that obviously complementary beginning, and a number of attempts to relate the two approaches, they diverged. It would be extremely useful to attempt once again to synthesize them particularly given the current flood of information.

A recent call to reconnect cell biology and immunology to overcome problems caused by their divergence (Science, 317/5838, 3 Aug. 2007, p. 825) is an interesting analogue and may provide guidance on the process, as may the development of systems biology and integrative biology. In the case of environmental design such a synthesis is now potentially easier because of new developments in brain research, neuroscience, cognitive and behavioral science and their possible applications to DM.[40]

If design is seen as a series of predictive hypotheses, as suggested, these need to be tested. Without such testing, and without incorporating these results into the field, there can be no cumulativeness, and learning is impossible, either from success or failure (cf. Petroski 2006). There is thus a need for a systematic study of successes and failures, of what works or does not, reasons for these and the mechanisms involved, only with explicit, justified by evidence goals, an explicit rationale for the decisions made (= design) and evaluation can one learn. Only then can "design as research" become a reality. Currently it is impossible, except on an individual personal level.

The testing of design hypotheses also benefits from the development of computers and the resultant growth of what has been called the third branch of science—simulation (in addition to theoretical and experimental). Thus Ston (2008, p. 787) says "Computer simulation has become an essential aspect of research in all areas of science…" (cf. Costi 1997). In biology it is used to study protein folding, in astronomy, planetary science, in cosmology to study the development of the systems they study (e.g. there is an Institute of Computational Cosmology). And so on and on.[41]

Note, however, that other and simpler forms of what one might consider simulation might be available (paralleling my "informal" research and indirect methods). Thus Thiel (personal communication, Sept. 2007) argues that environmental design could learn much from stage, film and TV designers, set dressers, lighting designers and camera operators. They deal with the ends-means relationships (my "design as hypotheses") in real-time, full-scale short-term simulation in which hypothetical cause and effect is quickly executed and evaluated—by the audience reaction at the box office and viewing behavior.

Simulation makes it possible to test design hypotheses, retaining those that are most promising; this could be called predictive evaluation—one could test the predicted outcomes of design hypotheses in silico, as it were. Consider rule systems discussed earlier. One could easily test these. I have long, and unsuccessfully, tried to persuade Ph.D. students to test Hakim's (1986) study of the rules supposedly underlying the Medina of Tunis (using agent-based modelling) to see if the predicted outcome, which in this case is known, would result.

The range of simulation methods and models is large and growing, and requires specialist knowledge which I lack. However it seems clear that agent-based modelling could be immediately useful. This is suggested by the examples already available. The agent-based modelling of the decline of the Anasazi in the U.S. Southwest begins with material variables—climate, hydrology, demography and agricultural technology (Gumerman 1988). A model of how these interact led to predictions, which ten needed testing. The prediction that some Anasazi should have persisted proved incorrect because they vanished. The introduction of social and cultural variables seemed to improve the predicted outcome (Kohler et al. 2005).

Later work (Gumerman and Gell-Mann 1994) begins to generalize to the U.S. Southwest more broadly. This work begins to relate explicitly to science generally, and begins to parallel some of my work (p. 163-191, cf. Rapoport 1990c, 1993b, 1997ª, 2000d) and also supports the choice model of design (p. 245-263). The work is highly interdisciplinary (as in EBS) and there is an awareness that additional variables are lacking. It is also significant that the papers lead to a single picture, as a typical in science.

Later still (Kohler and Gumerman 2000) generalizes even more to other areas and environments (including architecture and planning) and shows an even greater awareness of other variables or their lack. Many examples show close parallels with EBS and there are even places (e.g. p. 107-143) where reference to the extensive EBS literature on environmental cognition would be useful (e.g. Rapoport 1977, Silva 2001, Golledge 1999, Passini 1984 etc.)

37
I would also argue that much environmental design has become like fashion (haute couture) equally unsuitable for most people, based on superficial glitter and shock value—what a review of AIA Wisconsin State Architecture Awards called "the wow factor" (Milwaukee Journal Sentinel, May 1, 2008).

38
I am not up on recent developments in design methods (DM) and must keep the discussion general. Joint research by EBS and DM would be most useful.

39
As already briefly mentioned, and to be discussed briefly later, there was also a third response at the same time—participatory design.

40
The development of new brain techniques could make large, full-scale virtual reality walk-throughs possible, including reactions before conscious evaluation. Increasingly these fields seem useful. Behavioral economics and neuro-economics may be particularly useful since they also involve choice and tradeoffs. In fact, I have found even traditional microeconomics to be useful for some time.

41
In this connection it is significant that architects have used computers to play around with shapes rather than use it for research on EBR, testing design hypotheses, simulations or to make research information accessible, to provide an EBS database (Rapoport 2008a) and to develop expert systems. For example, Gehry is reported as saying that the Bilbao Museum was made possible by the programs used to design the Mirage fighter.

42
See the parallel attempts to relate culture to medicine, business, management, etc., by incorporating group differences, human behavior, etc.

Various hypotheses about EBR and design could be tested through agent-based modelling (and, possibly other forms of simulation). Various constraints (resources, finance, ecological, technological, social, cultural and symbolic) could be used as boundary conditions and outcomes compared to either contemporary or past environments, to see whether they match reality.

In studying the role of constraints one could also study the inevitable tradeoffs (also choices!) involved in any design (cf. Davis et al. 2006, Szigeti and Davis 2006). This work, while starting from a very different point of departure, has much overlap with the current discussion and many useful ideas and methods.

Tradeoffs are also being considered in relation to the conservation of species (Marris 2007) and the value of protected areas (Kareiva 2910, Fuller et al. 2010). All these, and others, provide guides to thinking about the inevitable tradeoffs involved in design, and provide suggestions, approaches and methods for making these explicit, and thus defendable.

The choice process whether regarding housing choice or the well-documented tendency of like people to cluster in space can also be studied through agent-based modelling. As suggested, simulations of identified rule systems (e.g. Tunis) could be a useful proof of principle. More generally cultural landscapes as a result of choices based on hypothesized rule systems could also be tested through simulations. One could see whether result in the expected environments, this is also a test of whether objectives would be achieved. This is another area for research, design and education.

Given my emphasis on values, wants, preferences and choice (and the limits set by available resources) understanding design as choice (which make advertising, house marketing, etc., useful) can benefit from micro-economics. This is especially the case due to recent developments in economics which echo my argument about EBS and environmental design by calling for economics to become more scientific and to use more data regarding humans (Bouchard 2009).

Especially significant given my emphasis on replacing architects' and planners' people by more realistic models are parallels in economics. There is a call to replace homo economicus, described as a mythical species, with more realistic models based on research (including experiments) on human nature and behavior, irrationality, meaning and culture[42] (Levitt and List 2008, List 2008). These have led to the development of evolutionary economics, behavioral economics, and neuroeconomis. They could be most useful in helping develop design as choice (e.g. Ariely 2010, Shermer 2008, Wald 2008). There are also calls for the use of agent-based modelling in economics, which could be related to such simulations in EBS and environmental design (Buchanan 2009, Farmer and Foley 2009, Wald 2008) (cf. also experimental economics, Falk and Heckman 2009).

One also finds an emphasis on synthesizing the different approaches to networks by economists and sociologists. These are said to reinforce each other and cold help network research understand human behavior. More generally in addition to these developments in the social sciences they are also increasingly relying on experiments, which are becoming a major source of knowledge, helping explanation and predictability (Ball 2010, Buchanan 2007, Behren et al. 2009). They are also using findings based on studies of brain mechanisms and genetics (see special section "From genes to social behavior," Science, 322/5903, 7 Nov., 2008, p. 891-914). All these lead to high predictability, for example the lack of variability in human travel patterns despite significant differences in individual travel behavior (Song et al. 2010).

In this process economics has also used evolutionary studies and research on human nature, has borrowed explanatory principles from theoretical biology, via game-theory, and draws on the ideas and experimental

methods of cognitive science, neuroscience, sociology and anthropology (Sugden 2010). There have also been interesting attempts to link classical economics with hedonic psychology and objective and subjective measures of well-being (e.g. Oswald and Wu 2010). These have potential relevance for evaluation.

I have already referred to the use of neuroimaging to discover unrevealed preferences that are not conscious, and hence not easily revealed in other ways (e.g. Krajuch et al. 2009). Recent research also shows that people can act on goals about which they are unconscious (Custers and Aarts 2010). Further research is clearly needed on both unconscious and conscious cognition leading from goals to actions or behavior. From my perspective, however, the significant thing is that research must make these goals explicit, and designers must use these and justify them by research-based evidence on people's goals as best understood through research (They must also avoid their own unconscious goals!). This parallels the earlier argument that the (often unconscious) affective response ("I like it/I do not like it") needs to be dismantled, analyzed and made explicit, and reasons for it understood, in programming, design and evaluation (e.g. via environmental quality profiles).

Other developments in economics can also throw light on design, for example through the new field of "mechanism design theory." That tries systematically and rigorously to pose questions, to think and to consider the realities of economic life and develop explanations of how individuals, market and institutions interact, and to use this knowledge to design systems and institutions. Mechanism design can be seen as the "reverse engineering part of economics" (Lohr 2007). The starting point is the outcome sought (the what and why) before addressing how that could be achieved, how outcomes could be improved (= design). In my terms this is a predictive hypothesis of the form, "to achieve 1, 2, 3…N, do A, B, C…Z" already discussed.

This brings me back to the need for testing such hypotheses, and this can only be useful if there are explicit goals and objectives. These, therefore, are essential not just for design, but also for evaluation—both post occupancy evaluation and the "predictive evaluation," in silico, of simulation. It follows that research—basic, translational and applied plays a critical role in the whole environmental design process—programming, design, implementation and evaluation.

The question of proper evaluation, especially as opposed to "architectural criticism" is central to design as I describe it. Most "criticism is strictly visual and based on the critic's personal tastes and preferences. As a result not only does it not lead to any useful conclusions, but it has highly negative consequences for environment design (Rapoport 1999b).[43]

Consider an example of a particularly glaring misfit between "architectural criticism" and environmental design. A recent report on national level planning in post-earthquake Haiti (Ourousoff 2010) is in the arts section of the New York Times!! It clearly belongs elsewhere (the science section?) because it is not art, nor did artists play any role in the planning process. Moreover, there is not mention of how the plan relates to the inhabitants, who are also often missing from many studies of urban ecology (Rapoport 1984).

I have collected much material dealing with the vacuous nature of architectural criticism. Consider just a single example (RIBA Journal, vol. 115, No. 5, May 2008, with the theme "What does British architecture stand for?"). Everything in it is based on visual or pictorial material, mainly exteriors[44] and assertions are made about these without analysis or supporting evidence. There are no criteria given for why specimens selected are "great architecture." Essentially, as is the case in studio juries, self-appointed "experts" with "good taste" say "I like it, therefore it is good" or the reverse. There is much on materials and details (which may not even be noticeable differences, as I will discuss later). Relations to landscape are similarly asserted without analysis and there is not a single mention of users (nor do the pictures show people). The general problem is that art "criticism" is used as the model, rather than evaluation as testing of design hypotheses. I return to the question of details, and whether they constitute noticeable differences, i.e. are noticed.

As an informal experiment I asked someone to keep a diary for a number of weeks of the time spent on various tasks in a well-known architectural office. The project was a junior high school for boys. Much of his time was spent in studying how door frames fitted into walls at twice full size. These would probably not be noticeable to anyone when built. Also, they would certainly be of no importance to the teenage boys who were the users. It appeared in that case and the literature generally (and my personal experience with work on a new university (Rapoport 1990e)), that details, materials etc., received much more attention than educational policy, behavioral programming, the effects of design choices on learning, mood and behavior. It serves as an example of how little time is spent on what to do, none on why—the how is primary because it can be drawn and photographed.

In discussing evaluation, I begin with a quote from Steven Jobs (of Apple). "Most people [and certainly environmental designers] make the mistake of thinking design is what it looks like…design is how it works" (Editorial, "Einstein is dead," Nature, 433/7023, 20 Jan., 2005, p. 179, cf. Grene 2010). Clearly critical is how one specifies "works" and the criteria one uses in evaluation. Jobs certainly includes looks in Apple designs, in addition to hardware and software (both based on science and its applications). How it looks, however, requires research on the role of looks, preferences for looks and how they differ for different groups and so on.

In terms of specifics (dismantled) how designs look can in many cases be an important part of how it works. In environmental design it requires research-based knowledge at each stage, to identify and specify the components of both perceptual and associational (meaning) aspects of environmental quality. This comprises visual, textural, material, thermal, color, sonic and even olfactory and perceptive qualities of environments. These are clearly important in the immediate affective response ("I like it/ I do not like it") and hence the choices made (Rapoport 1977). As discussed earlier, while this response is adequate for users it is not for environmental designers. In their case it

43
This very brief outline is in a publication which is mainly in Greek, and almost impossible to access. I am working on a greatly expanded version.

44
In (Rapoport 1987a) I referred to architects as exterior decorators.

In addition to the problems the visual preoccupation of the environmental design professions and education already discussed, is that associational aspects, the meanings of particular perceptual aspects of environments, and an important reason for preference, have been neglected yet may be central (Rapoport 1990f). As such they play (and should play) an important role in design, since they may be a most important function. It would be useful to test this hypothesis, and do research on the relative importance of perceptual vs. associational aspects of environments, including comparative work on various groups. This would also help discover any patterns and regularities and any constancies that may underlie apparent variability, as it increasingly seems to be the case for culture and human nature.

An important first question to ask is whose meaning? (Rapoport 1995[a] (1967[a]), 1995b (1967b)) I have already emphasized that designers' and users' meanings are very different, as are the meanings of the many different user groups (Rapoport 1996, 1998, 2000c, 20003, 2005[a]). Meaning can be shown to play a major role in many (if not most) aspects of the built environment and material culture generally (clothing, furnishings, watches, hairstyles and beards, etc). Thus, the proliferation of what is called the global (vs. the local) environment has to do with meaning, with images of modernity (freeways, skyscrapers, subways, etc.), (Rapoport 2000c, 2006c).

Similarly, such images make unrealistic many proposals to improve "sustainability" by learning from traditional environments. This is because they communicate the "wrong" image and meaning and thus conflict with users' wants (Rapoport 1983[a], 1986, 1987b, 1994[a], and examples therein). This becomes highly relevant in the case of developing countries, culture change, cultural identity and culture-environment relations generally.

This also helps explain difficulties with the preservation of traditional environments (Rapoport 2002[a], 2006b). Consider Luang Prabang (Laos) where the traditional wooden houses, unlike non-domestic traditional environments (like temples) are being rejected for concrete houses. UNESCO architects are trying to preserve this World Heritage site. Locals say this is unrealistic. "People are getting richer. They don't want the old things" (my underline) (Perlez 2004). If people own a wooden house they will move it outside the town and build concrete houses. The excuse is that traditional wooden houses are hotter than concrete. Having recently visited Luang Prabang (and the houses) I personally feel that the exact opposite is the case in the absence of air conditioning. The latter is also wanted as a symbol of modernity, as are new materials (Shokoohy and Shokoohy 1994). The abandonment of and changes to, traditional environment can also be understood in these terms (Shrestha et al. 1997) including the abandonment of Tuscan hill towns that architects love (Guliani and Rossi 1992) as can the world-wide spread of suburban landscapes as soon as resources (money) become available, already discussed.

I have previously described and illustrated an example of an inner city renewal project in Milwaukee, using a suburban image (Rapoport 1990f, Ch. 6, esp. Fig. 27). That this was not a unique case is shown by a similar phenomenon in Chicago (Johnson 1999).

needs to be dismantled, analyzed, articulated and clarified through empirical research (recall also that users and designers differ in their preferences, and that there are many user groups).

New research, especially in brain science, allow such preferences and affective responses to be identified and studied even if they are below awareness, it clarifies the brain mechanisms involved and how the work, e.g. via values [= meaning] (Patton et al. 2006, Dijksterhuis et al. 2006, Gladwell 2005, p. 182-1830). All of these are related and linked to work on subliminal perception which, as we have seen, can also play a role in non-conscious decision-making.

I have already pointed out that the visual preoccupation of designers also leads to a neglect of the other senses and have listed some of these (Rapoport 1977, Crunelle 1999/2000). There is now a body of work on the non-visual senses; there is less known on how the different senses work together, although such work is ongoing (Advertisement for the 4th annual Salk Institute and Foundation IPSEN Symposium on biological complexity (Jan. 13-15, 2010). Theme: Sensory systems: Smell, taste, touch, hearing and vision. Thus evaluation need not be purely visual but can consider other senses, and the supportiveness of environment.

To reiterate a point already emphasized one can only evaluate whether anything works or does not, if one knows what that thing is supposed to do, i.e. the goals and objectives set, in this case supportiveness for people. This requires that programming be an essential part of the design cycle. By this I do not mean the usual specification of areas, spaces, rooms and the like but behavioral programming. That would set justified goals about the experiences, moods, meanings, orientation and way finding and other aspects of supportiveness. The best example I know is Charles Garnier's 19th C. behavioral program for the Paris Opera House[45] (Van Zante 1977). I suspect other useful examples could be found.

45
This was brought to my attention by Philip Thiel. See also (Thiel 1997).

Consider, in somewhat more detail, a policy, planning and design initiative that explicitly seems to have considerer this. In Australia there has, for some time, been a government policy of urban densification (in the name of 'sustainability'), although that has been questioned (Troy 1996). A series of posters was produced showing examples of such densification (The Green Streets Project).[46] These were intended to "sell" the public on this policy. The images used are strikingly "suburban" and appear to be low density. The elements used were based on market research, on user wants, preferences for street widths, parking, greenery, etc. There are many more such potential cues (Rapoport 1990f, esp. p. 182-189). Research could identify the full range of appropriate (desired) elements of the appropriate image and meaning, both generally and specific to particular locales.

In the Green Streets project reality, however, proved different. It is more difficult to "fool" people in real environments. Evaluation after construction was negative, leading Troy (1996) to call them "mean streets." It follows that images as communicated by photos seem inadequate, an interesting and important caution for architectural magazines and architectural "critics." The Green Streets Project, however, had two aspects worth emulating. First, understanding the importance of the image, of meaning, and basing it on marketing research. Second, the use of evaluation after implementation.

In discussing evaluation, and as an example of the point made earlier that the most unexpected fields and studies become relevant at a sufficient level of abstraction, the best example of how one goes about evaluating the design of anything is an analysis of how well the blood circulation system is "designed" by nature[47] (Turner 2007).

In studying how well the blood vessel network works [cf. Jobs' quote above, Greene 2010] Turner argues that to judge the quality of a design one must have objective criteria for evaluation. Intuition, especially a priori intuitions of what is good design, will not do. He then discusses two functions of the arterial system in terms of which the evaluation will be done. Simulations are used to test the efficiency of blood vessel networks by comparing them to optimal networks (based on network theory). The same principles apply to pipe networks, package delivery systems, heat flow in solids, heat removal in electric circuits and material and traffic flows, i.e. theory is generalized at a conceptually abstract level. These general principles can then be used in an objective evaluation.

This exemplary evaluation should serve as a model and should replace "architectural criticism," both in the environmental design professions, and in the studio.[48]

I now summarize my rather lengthy discussion of the nature of design based on a science rather than an art metaphor.

The first and most important step in environmental design is to specify what needs to be done (based on having identified the problem(s)). These objectives need to be justified by state-of-the art research-based evidence (why these objective). Only then does one ask how it can be achieved, i.e. what means are available—technical, material, financial, institutional, societal, etc.

In current practice and education it is the latter that receives most attention. The more important issue of justified objectives tend to be neglected, if not ignored. This does not in any way diminish the importance of how design projects are to be implemented. The issue is to emphasize and give much more importance to the setting of justified objectives, and to have implementation considered later in the design process.

It is also the case that economic feasibility, the socio-political context, regulations, technology and the various branches of engineering (structure, services, materials, soils and foundations, fire protection, fire escapes and evacuation (in which EBS is needed)) are much better researched. This research tends to be applied primarily through the use of consultants, regulations and manufacturers. This is also the case with construction management and facilities management, etc. In effect, once again, environmental designers seem to be largely concerned with visual matters (Rapoport 1987ª).

It is significant that it is primarily research on users, and their needs and wants, which tends to be resisted (or at least ignored and not used). I also find it significant that animals seem to fare better! For example, the programming analysis for the elephant house at the Copenhagen Zoo could serve as a model of what should be done for people (RIBA Journal, vol. 115, No. 8, Aug. 2008). The material seems to suggest that humans (visitors) seem neglected. Recent zoo design in general, in its analysis of animal needs based on research could serve as a good model. Results show that it works for the animals. Human needs—how people circulate, observe, react, etc.—do not seem to be of the same quality; It would be a useful research exercise to analyze recent 300 designs in terms of visitors' experiences.

This also seems to be the case with open-endedness, where designers seem much more willing to provide it to accommodate services and instrumental functions, but not for user needs, activities and wants, especially not for those that affect "aesthetics" (Rapoport 1995f (1990/91)), again a result of designers' artistic attitude.

Once justified goals have been set, the need for proper evaluation becomes essential, regarding both the specific project and, more generally, so that learning and cumulativeness can take place.

In all this it is essential that both problems and proposed solutions be made very specific, dismantled and clear, and shared terms and concepts used. Only in that way can one begin to know what attributes make a setting "healing," "stimulating," "relaxing," "restorative" or, indeed, "supportive"—for which human characteristics, wants and needs of which groups, by what means or mechanisms this is supposed to be achieved, and then how we know these have been achieved.

In ending this section it is important to emphasize how much suggestive work there is in many fields (even in this highly selective bibliography). These can be most helpful, conceptually, substantively and methodologically. It is unfortunate that even EBS, let alone environmental design, do not seem to know these, have not kept up with them let alone used them. It follows that the radical shift in

46
I have slides of these posters.

47
There are two different uses of "design" involved here, evolutionary in biology, purposive by people.

48
The studio is a different topic, but see Rapoport 1983b, 1999b, 2000d.

the nature and meaning of "design," that I advocate, and about which more could and should be said is, at least in principle, not as difficult as it might seem. There is much help available. The problem is with the design professions and education.

I now, therefore, turn to an examination of the implications of designing for people for these.

The nature of the environmental design professions

The nature of the environmental design professions follows directly from the argument so far. That, in turn, suggests changes needed in the education of environmental designers. The key requirement is that design for people must be based on the best-available knowledge, on up-to-date, state-of-the-art research. This becomes critical because knowledge changes, advances and improves rapidly in science and science-based professions. It is also impossible to wait for "perfect" knowledge. It is thus essential to keep up with research, sometimes on a weekly basis, in a great variety of fields (Rapoport 2001, 2005ª, p. 15). It is also necessary to relate these to each other and to identify their relevance for EBS and environmental design. That, as already emphasized, requires operating at some level of abstraction as well as the development of explanatory (scientific) theory that identifies mechanisms and causal connections (Rapoport 1997ª, 2000d).

Two things follow. The first relates to the need to keep up with research developments in a variety of fields and to develop theory. The second follows from looking at design as a series of hypotheses.

Keeping up with research, often week by week, and in many fields, is a full-time job involving many people. This has major implications for the nature of the environmental design professions, specializations in them and hence for education.

Practitioners cannot possibly keep up with the literature especially since, in EBS the literature covers many fields and theory is lacking. Even academics cannot keep up. There is a need for specialized researchers in retrieval, evaluation and synthesis of information. There needs to be an organized systematic, evaluative and updated summary of state-of-the-art research. As I argue later, medicine offers a most useful model. One (of several) examples is the Cochrane collaboration in Oxford. It examines and analyzes research and offers updated conclusions about the effectiveness of treatments for specific conditions.

I have long argued that EBS has failed to keep up with new fields and with new developments in others. This has been a major problem, as has the neglect of theory development (Rapoport 1990e, 1997ª, 2000d, 2008ª). It is no longer possible for an individual to know everything even in a single field (hence the proliferation of many specialized sub-fields in science). In the case of environmental design that will require specialists in producing knowledge (research) knowing how to obtain and use such data to identify problems, how to address the problems, how to make the tradeoffs involved in design as a choice process and how to evaluate design. It will also require specialists in synthesizing data and developing theory. It follows that there can no longer be a Renaissance genius (Designer) and consequently there is a need for what I think of as hyphenated environmental designers (proposed in the 1980s (Rapoport 1995c (1983), cf. Nunn 2005, p. 137).

I have already discussed the lack of databases and information retrieval systems in EBS and their ongoing development in science and medicine (as a science-based profession) and the need for their development in EBS. Thus just recently, Professor Hong Yu, at my university, obtained a $1.1 million grant to develop a database for doctors and other health professionals at the point of care, based on the latest research and building on already existing systems (UWM Report, vol. 29, No. 4, May 2008, p. 7).

Since EBS is so highly interdisciplinary, and deals with many more fields than a typical scientific discipline, the problem of locating and retrieving information is much more challenging. This is compounded by the presence of many different publications (some now defunct), some proprietary (e.g. POEs).[49] Work done in one place is hardly known elsewhere (e.g. the body of work on Australian Aboriginal environments). Moreover, literature reviews (when they exist) are not analytical or synthetic—they tend to be just lists. Moreover, I have even heard the view expressed that knowing the literature is unnecessary, hence the tendency in EBS to reinvent the wheel, and lack of cumulativeness. Many studies are on specific building types or settings, ignore links among environments, fail to identify patterns, commonalities and constancies that only comparative work can reveal (Rapoport 2008ª).

Designers' commissions are in terms of building types (office building, hospital, nursing home, housing, etc.). Each type can (and does) have research specific to it. As they stand these cannot be synthesized. Very useful linkages and syntheses can be done by using the concept of "behavior setting" or "setting." This concept, which came into EBS from psychology is extremely useful and is one of the best developed concepts. Settings are the basic "building blocks" of environments and are most useful both in research and design. The same settings occur in many different environments—buildings, urban areas (which may contain 100s or 1000s) and cultural landscapes. This links and relates buildings and urban areas (Rapoport 1982). Using settings also allows for comparative studies and makes synthesis easier. Settings seem to apply cross-culturally (Liu 1994) and the same mechanisms seem to operate in all settings, allowing generalization and theory development and the resulting compressibility. Settings can play a role in many aspects of EBS and environmental design (Rapoport 1982, 1990ª, 1990c, 1990f, 2005ª).

It is, therefore, striking that EBS and environmental design have been trying to replace "setting' with "place" and "home," terms that are vague, confusing, seem to have no empirical validity and are not useful, if not damaging (Rapoport 1994b, 1995i, 2005b). This is similar to the fact that EBS (let along environmental design) have essentially ignored sciences, failed to keep up with relevant new scientific fields and developments in science. The only new approaches adopted have been post-modernism, phenomenology and hermeneutics from the humanities. This seems to have been particularly the case in architec-

49
The growth of such proprietary materials is also becoming a problem in U.K. archaeology but, unlike in EBS and environmental design it is being tackled (Ford 2010).

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Some comparable differences among specializations already exist in other fields, e.g. chemists vs. chemical engineers, chemists/physicists vs. material scientists (cf. Nature, 452/7190, 24 April 2008, p. 970, referring to the "Princeton Institute for Science and Technology of Materials"). In science we find a range of specialists from philosophers of science, theoreticians, methodologists, experimentalists, etc. In environmental design there may, of course, be effects of scale (e.g. urban design vs. interiors) which require research (as briefly discussed earlier) and other differences (e.g. plants and soils in landscape design, or highly specialized building types in architecture) may continue.

ture where rather than turning mysteries into (solvable) problems there is an attitude of obfuscation and mystification.

I have already discussed the need to combine new work with existing data, to evaluate the latter critically in the light of new work and this make these usable. Research is not just empirical—the synthesis of different bodies of research, critical analysis, theory development, translation and evaluation of applications are all essential forms of research.

Analysis and synthesis of information is as important as new data. While theory is a critical need, synthesis to develop unifying concepts and frameworks are essential steps toward theory development. It has been pointed out that even in medicine, which is highly advanced as a science-based profession, there is not enough capacity to incorporate new knowledge, let alone to use the resulting information (Bloom 2003). However, such work has been ongoing and there have been rapid advances as will be discussed later.

In order to be able to synthesize data they need critical analysis—analytic reviews, meta-analyses, etc. Data also needs to be "normalized" so that they can be combined. Data are typically the result of different people at different research institutions doing their own research, with particular questions and objectives in mind and using different methods. These need to be standardized to produce a common data set. Only then can useful synthesis occur and rational decision-making become possible (cf. Dickersin 2010).

Given this discussion and the range of skills needed, the specializations I am discussing are in terms of these sets of skills which will (or may) cut across traditional divisions, e.g. by professions (architecture, landscape architecture, urban design, interiors, etc.) or, in architecture, by building type.[50] The specializations need to be in terms of the complete design cycle discussed, and necessary for evidence-based design, and that any science-based profession needs. Also the specifics of how the environmental design professions are "subdivided" are hypothetical and a researchable topic, as is the nature of the interactions among the different specializations—they cannot be independent of each other.[51] (Fig. 6)

In the approximately 40 years since EBS began, its impact on design has been disappointing, and much has been said about bridging "the gap" between research and design. The explanation offered (or rather the excuse) for this gap has been the argument that designers cannot use research because they cannot even understand it, because of the way it is reported.[52] As a result it has been argued that research and how it is communicated need to change, so as to make it understandable to designers as they currently are—it is researchers who need to change, rather than designers (as I argue). Implicitly the model seems to be some form of 'formula"—like easy to use material, some form of design guides.

Admittedly research and design differ in one fundamental way, science, and hence much research, is concerned with understanding the world (each science in its particular domain). Design (understood broadly as a technology) is concerned with changing the world (Patten 2006). In essence, engineers, environmental designers and technologists generally turn the often abstract ideas and findings of scientists into reality, changing the world (Nature, 441/7094, 8 June 2006, p. 691). I will shortly discuss how this process can be improved.

The above distinction refers to basic research (empirical, theoretical, simulation). This is essential for any science-based profession. Without basic research there is nothing to apply. Moreover, such application should result in changing the world in predictable ways, and for the better.

Three things need to be said about the standard excuse for the gap. First, how research is communicated is important, and as we will see ways of improving it are being developed in other fields and could be most useful guides. Second, research can only be done one way—properly, if it is to remain good research and thus potentially useful. Third, and most important is that designers, their world view, how they think, what they read and what they do must change completely—it is a prerequisite for all other changes. Without that, research would probably not be used even if understood. The essential step is to want to use it, to see it as essential for design—and to be able to use it.

51
This also tends to result in team work, and it is significant that in scientific journals one increasingly finds work done by large research teams with numerous authors rather than individuals or single authors.

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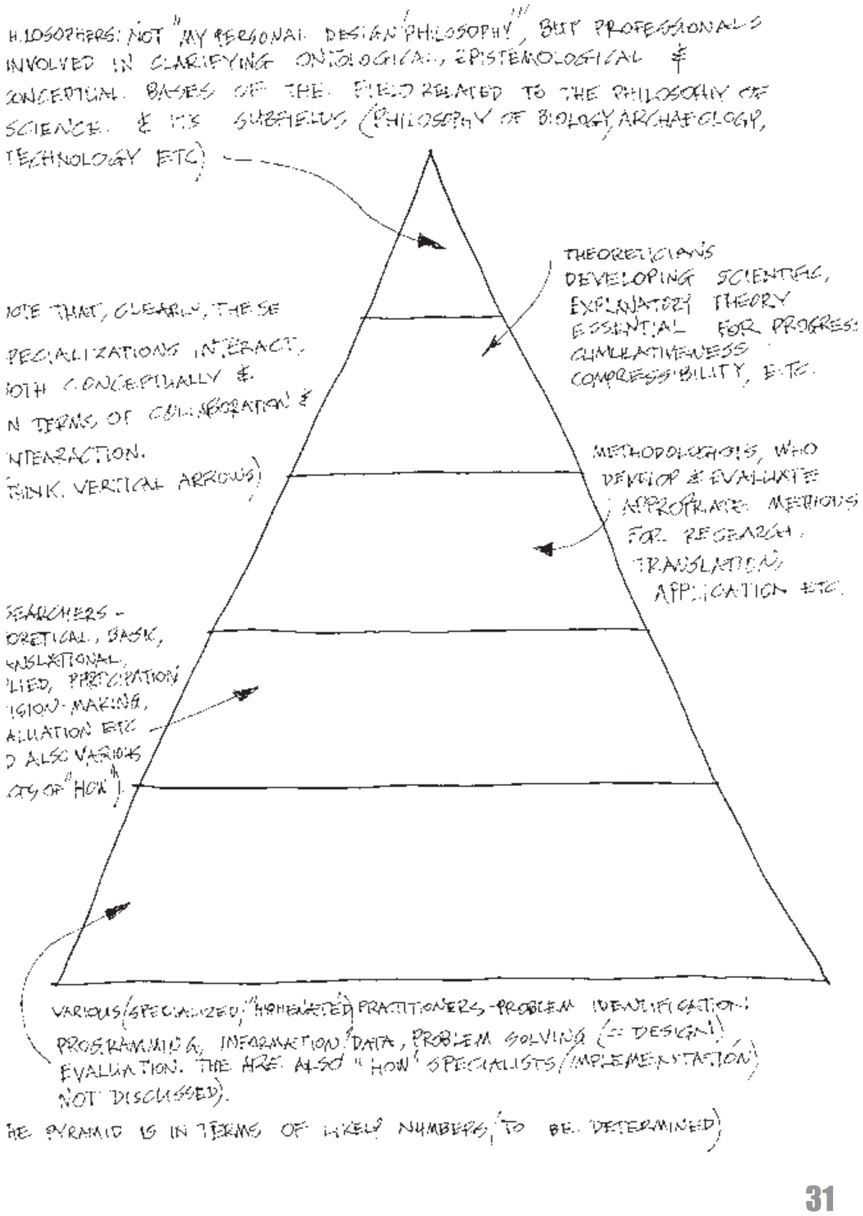
This, of course is a result of the nature of the environmental design professions, and the education for them. Changing these is, therefore central to my argument.

Figure 6: The structure of the environmental design professionals (based partly on Rapoport 1995c (1983))

▼



53
Recall that design is also present in related biomedical areas—rational drug design; protein, enzyme and peptide design, synthetic life, etc. These, together with material science are, in fact, the model of design that I propose.

54
In 1915 he came to a similar conclusion about the professional status of social work.

The real problem is that designers, even if they understood research, will not and cannot use it. Consider a striking example (Low 1982).

This concerns a problem addressed by a graduate landscape architecture studio at the University of Pennsylvania—the redesign of a Philadelphia inner-city park. The first half of the semester was devoted to research—of the literature, of the site and with the potential users—the community. The second half was devoted to the redesign. When design began, however, the research was essentially ignored and design proceeded in the usual way—as a more or less free, intuitive, "artistic" activity. Clearly there could be no problem of understanding—the same minds did both research and design—there was no "GAP." Yet research was not used.

I realize that this was a single case, involving students in one class at one institution. As far as I know this study has received hardly any attention since publication, and has certainly not been replicated (a common problem), yet it tells us something important. Accepting the results provisionally, what would it take for research to be used in design? My answer is the theme of this paper: a radical and fundamental change of world view, of the nature of the domain, of the meaning of "design," and the adoption of a science metaphor.

There are, however, a number of other impediments basic to the environmental design professions and the education for them. One has to do with reading. To be able to use the research literature it is essential to learn its vocabulary and also to be able to read analytically, and to extract important and relevant empirical and conceptual information from text—and to do so at some level of abstraction (cf. special section "Learning to Read, Reading to Learn" Science, 328/5977, 23 April 2010, p. 447-466).

At the moment, at least, architects are not capable of this, are not taught these skills, deprecate reading, and do not really want to read. This attitude is implied in a letter by George Oldham (RIBA Journal, vol. 117, No. 2, Feb. 2010, p. 24). It begins "Architects, more interested in images than words (and that might be most of us), might understandably have given up" [on a article which he criticizes, apparently as being too "prolix"]. To be able to use research this attitude based on the visual (more correctly pictorial) preoccupation of architects and other designers must change.

Before I examine that field in more detail, I would suggest the medicine may be the best model of how environmental design can be changed into a science-based profession. In medicine and medical schools one finds the full range of research from basic to applied, to application—i.e. clinical practice. Medicine has recently pioneered translational research and emphasizes evidence-based practice (discussed later). It has systematic evaluation of outcomes, for example comparative effectiveness research (CAR) providing reliable information to practitioners.[53] All of these provide a very useful model for environmental design as described in this paper.

Lewis Thomas once pointed out the extraordinary speed of development of medicine during his own career, and how little doctors could do as late as 1945. Architecture today has been compared to medicine in 1860! (Bonetta 2003, in a discussion of laboratory design) It should be pointed out that, in the mid 19th Century "…medicine was regarded as a lowly trade in which cures were rare and scientific understanding of disease even rarer" (Enderby 2009, p. 1496).

Admittedly the change in medicine, the rate of which has been described as "breathtaking" (as it has for science in general), and has been accelerating, took quite some time and is still ongoing. It began (in 1910) with Abraham Flexner's investigation of the quality of medical education for the American Medical Association. A major recommendation was to eliminate those schools that were vocational (as schools of environmental design still are) and make them professional (Starr 1982 p. 118, 121).[54]

As Stresz (2008) points out, Flexner's view of what constitutes a profession is still highly relevant "…professions involve essentially intellectual operations with large individual responsibility. They derive their raw material from science and learning; This material they work up [apply] to a practical and definite end; They possess an educationally communicable technique…" (p. 168, my underlines). With the addition of evaluation, a good description of what environmental design should be.

Medicine has not been satisfied with its progress and has also continued its self-examination (e.g. Association of American Medical Colleges 1984). Improvements are still both needed and being made (e.g. calls for a greater role for evolution (Krause 2010)) and for greater integration across fields and within fields, both in the scientific literature and in practice (e.g. the Institute for Integrative Neuroscience at Karolinska Institute as just one example) (cf. Rapoport 1990c, 1997ª, 2000d, 2005ª, 2008b).

This suggests that the radical changes I am proposing will take time. However, the example of medicine (and other scientific fields and science-based professions) make it easier for environmental design. The efforts made, the successes and failures, the methods and institutional arrangements are there as guides. Medicine provides a model of how to get started and how to proceed. There is no need to reinvent the wheel (yet again). Also, one must have these (rather extreme) aspirations—otherwise nothing will happen.

There are three recent developments in medicine which show the continuing efforts to improve the profession, and the lack of self-satisfaction (as opposed to architects), and merit discussion. These are translational research, evidence based medicine and the effort to develop physician/researchers (some MD/Ph.D.).

Despite the extraordinary progress already achieved by medicine, there is dissatisfaction with a perceived gap—the relative lack of application of new research. The rapid developments in basic research have had relatively little impact on clinical practice. The objective is to develop specific, stepwise translational pathways both to ensure and to speed up the process of moving systematically from basic research to therapy (clinical practice) to provide guidance to practitioners of how basic and applied research can be used in practice (Contopoulos-Iannides et al. 2008, Chin 2004, Smaglik 2004).

This itself requires research on how best to achieve these goals since the domains of medicine and environmental design are very different, the domain-specificity of translational research needs to be investigated. Research will thus be needed on how to translate translational research to a different domain, which methods and techniques offer lessons and which do not, and to develop specific methods and techniques. Two things should already be clear. As always, the lessons will be at some level of abstraction, and they will not be direct but via principles. In any case, in order to help close the gap between EBS and environmental design there is a need to initiate translational research, and to follow the developments in medicine for use as a guide or model.[55]

One recent example seems relevant Cressey (2010). It describes the work of Alan Ashworth as a "shining example of a successful translation of basic biology research into clinical application" (in less than 15 years!) (p. 422). I find it significant that Ashworth prefers the term "integration" to "translation." The journal Science Translational Medicine (started in Fall 2009) also refers to "integrating science and medicine." It focuses on converting basic biomedical research to bridge "the research to application gap." It lists 8 areas to which translational research is applicable and its approach should also lead to integration and generalization.

It is important, however, to note the continuing importance of basic research (there needs to be something to translate or apply). For example, Weill Cornell Medical College, in starting a new school of medicine in Qatar, advertises for "Basic science faculty research" (Science 322/5899, 10 Oct., 2008). Also, quoting M. B. Silber "Driving drug discovery—the fundamental role of academic labs," from Science Translational Research, it is pointed out that "researchers in academic labs make almost all the basic science discoveries that underlie the creation of innovative new medicines" (Science 328/5959, May 7, 2010, p. 661).

In addressing the problem of how to move the HIV-1 vaccine field forward Barouch (2008) argues that "a renewed commitment to basic discovery research in addition to preclinical and clinical trials will be required…clinical trials that are focused on answering specific scientific hypotheses rather than exclusively aimed at product development may be most useful" (p. 619). This seems most applicable to environmental design. It follows that in addition to other types of research, basic research must be a major part of the environmental design professions and, of course its schools (cf. Rapoport 1979[a]).

Recent, translational research has grown rapidly. In addition to the journal mentioned, many advertisements testify to it. For example, an advertisement for a "webinar" on translational medicine in Denmark on February 10, 2010 at a specified time (Science 327/5963, 15 Jan. 2010) or for the 1st São Paulo school of translational science, between April 19-30, 2010 (Nature 463/7282, 11 Feb., 2010). There are advertisements (in late 2009) for faculty and research appointments, e.g. NIAID research positions for both basic and translational research, and similarly by Texas A & M Health Center, College of Medicine for faculty in systems biology (basic research) and translational medicine (Science 317/5844, 14 Sep. 2007). Ohio State

University Medical Center advertized for a translational researcher to develop a new, sophisticated information system to enable integration across all sectors of the center (Nature 438/7068, 1 Dec., 2005). The Cambridge (UK) Research Institute was advertising for post-doctoral fellows in translation.

Singapore, which is aiming to become a major center for biomedical research, early in the process set up a clinical translational science center and attracted senior researchers from the U.S. and elsewhere. The Ludwig Institute for Cancer Research, the largest international not-for-profit cancer research organization has set up a new center in Melbourne (Australia) as its principal translational and clinical research site (The Australian, June 3, 2010) i.e. using basic research done elsewhere. It is also clear that many other institutions are establishing institutes and departments of translational science and medicine.

There are also conferences. As one example an advertisement for the UCSD Clinical and Translational Research Institute, and Nature Medicine Frontiers of Clinical Investigation Symposium, Pain 2010: From Bench to Bedside, La Jolla, CA, Oct. 14-16, 2010 (Nature 466/7306, 29 July 2010). Included are multidisciplinary approaches in basic, translational and clinical research to bridge laboratory and clinical research on pain, i.e. emphasizing a range of research (see Fig. 6, page 31).

There have also been major investments of resources by the U.S. NIH and FDA, and the UK MRC. These include the establishment of major translational research centers over the past few years and the funding of research (Science, 328/5982, 28 May 2010, p., 1090, Nature, 464/7289, 1 April 2010, p. 649). Since 2003 NIH has funded 55 translational research programs and, during 2010 will have clinical and translational sciences awards of $500 Million (Milwaukee Journal-Sentinel, July 15, 2010). Also, the new director of NIH, Francis Collins, is emphasizing translational research and giving "basic researchers the tools to convert their discoveries into therapies" (Science,

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Translational research in environmental design leads to practice—to design. Therefore the synthesis (re-unification) of EBS with design methods needs to play a part. It would also be helpful if the third response to the perceived problems of environmental design—participatory design—could also be related and synthesize (with EBS and design methods (and research from architectural science).

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See the earlier mention of the Cochrane collaboration.

328/5982. 28 May 2010, p. 1090). The rapid development of the field is shown by a special section on translational research (Nature, 453/7197, 12 June 2008, p. 823, 838-849). The important point is made that translational research is a two-way process, from bench to bedside and back; it also requires a relationship between academia and industry (= environmental design and the building industry).

Funding, in turn, influences career choices since researchers often follow grant money (Carpenter 2007). It also influences education. There are almost weekly advertisements for special international programs for translational research, for graduate students, post-doctorates and young researchers. Also, a Science Translational Medicine commentary by W. C. McGaghie argues that "early incorporation of translational science in physician education will improve patient care" (Science, 327/5968, 19 Feb. 2010, p. 915, cf. Pain 2007). In another commentary M. L. Disis and J. T. Slattery argue for the need for multidisciplinary team science in translational research (Science, 327/5971, 12 March 2010, p. 1295, cf. Garber 2007). University College London Hospitals advertise for a director to lead an ongoing strategy to deliver world-class translational research (Nature, 464/7286, 11 March 2010).

Although translational research began in the biomedical sciences and is being developed there most explicitly, examples of it exist in other fields—engineering, education, chemistry, electronics and material science. In the latter, as I discussed earlier, new materials with predicted attributes are based on basic research in physics and chemistry. There is also another interesting area of basic research which relates to both model systems and translational research—research on biomaterials and biomimetic materials. The basic research is interdisciplinary and many examples can be found—research on how Geckos are able to hang upside down, how barnacles cling to substrates in water, how bones work, how spider silk works all provide information that is then translated into materials in many domains (Forbes 2005, special section on biomaterials Nature 462/7272, 26 Nov., 2009, p. 425-464, Omenetto and Kaplan 2010). Research on how lotus leaves manage to stay clean has led to self-cleaning glass now used in buildings.

As always, in all these cases the translation is not direct, is at some level of abstraction, and is in the form of lessons and principles (Marwan 2010, Tero et al. 2010) (see Fig. 3). My discussion of translational research also shows how one deals with "the gap" rather than talking about it for 40 years. It is high time for EBS and environmental design to start developing translational research. Using the model of medicine (and other fields) should make its development there considerably easier and faster.

The current emphasis on developing evidence-based medicine also provides a guide for the development of evidence based design. In medicine, it builds on much earlier trends, and it has been suggested that the history of medicine can be seen as the gradual development of evidence based medicine (Singh and Ernst 2009). It can be traced to Hippocrates who apparently argued that science leads to knowledge, opinion to ignorance. The term as such, was first published in 1992 (p. 24), but has only recently become emphasized and much work devoted to it.

The ultimate goal of evidence-based medicine (as of evidence based design) is to replace prejudices, subjective beliefs and unsupported opinions that still survive in clinical practice by research-based evidence. The intention is to ensure that all decisions (clinical interventions) are based explicitly on well-justified evidence, using the latest and best, state-of-the-art research, basic, translational and clinical. The outcomes must then be evaluated in terms of the clear, explicitly and well justified objectives, very much like the approach to design I advocate.

For example, although the treatments used to prevent heart attacks in diabetics seem reasonable and logical they have recently been shown not to be useful (Kolata 2010). Similarly, the U.S. Institute of Medicine recently reported that "half the treatments lack clear evidence of effectiveness." The Institute has a program to try and learn which treatments work and which do not. At the moment data are either incomplete or unavailable (Leonhardt 2010). This is also the purpose of the current emphasis on comparative effectiveness research (CAR) mentioned earlier, which is meant to provide clinicians with reliable information regarding treatments,[56] Note that in this process the elimination of wrong decisions is as important as the introduction of correct ones.

Although starting in medicine, and most advanced there, calls for evidence based decisions are to be found in other fields: dentistry (Dr. J. Markenson, personal communication, 2009), education (Editorial "The brain/education barrier" Science, 317/5843, 7 Sept. 2007; Feldon et al. 2010), business (J. Pfeffer's recent book on evidence based management). In the U.K. there is a move to strengthen the role of scientific advice in government policies by acknowledging when such policies are not based on evidence ("U.K. government urged to disclose evidence," Nature, 460/7255, 30 July 2009, p. 563). This is clearly becoming a general phenomenon.

The use of evidence is also useful in checking the reliability of folk beliefs about people. I have already referred to its possible impact on how we view culture, altruism, human nature and behavior, decision-making and folk psychology generally. For example, there is a belief that testosterone only generate aggression whereas, in fact, it also increases fair bargaining behavior. Current views are folklore, not fact (Fehr 2010, Eisenegger et al. 2010). Similarly the idea that tribal societies were ecologically prudent, or were peaceful have been shown to be myths (regarding the latter see Keeley 1996, LeBlanc 2003). Since knowing what people are really like is central to EBS (Basic question 1) and hence design for people, the use of such evidence is essential for evidence based design.

A relatively new journal (World Health Design) which deals with the design of hospitals and other health settings, tries to apply the lessons of evidence based medicine to design, i.e. to address "the gap" in this particular building type.

I know of only one possible example in EBS that explicitly refers to translation (Zahn 2005), although it seems to be more in the nature of a design guide based on research in criminology. There may well be others (and there may be examples of implicit translation). It would be a useful exercise to review the EBS and environmental design literature for other examples as part of the development of formal translational research in these fields.

In addition to medical schools and the profession having the full range of research, there is also a move to train clinician/researchers or clinician/scientists skilled in both practice and research (sometimes in MD/Ph.D. programs). One example is a recent advertisement by UC San Francisco for a new residency track—investigator anesthesiologists (Science 322/5899, 10 Oct., 2008, p. 318).

It follows that if environmental design is to become a science-based profession the full range of research—basic, theoretical, translational and applied must be present, and specializations in these developed in order to make research application (design) possible. The discussion above also shows that there are precedents (or models) that can be followed and there is no need to start from scratch. As part of the central change—to a science metaphor—it is also important to consider two responses from architects when I discuss these topics.

One is that design is too complex, beyond anything else, to be approached in this way. The second brings up the issue of "creativity." Regarding the first, one wonders how design compares with the universe, evolution, the human brain, the genome and proteome, etc. As just one example among many in diverse fields it is most enlightening to look at the analysis of just one biological sub-system, and compare it to environmental design (Behrends et al. 2010).

As regards creativity I would argue that research, and its application to problem identification and problem solving are much more challenging, and therefore require much more creativity, than "defining" a problem so that it can then obviously be solved, and only by satisfying oneself and only regarding visual aspects. In fact, problem identification has been shown to be an important part of creativity even in art (e.g. Getzels and Sikszentunihalyi 1976). It is also worth reading an early paper on the topic which, unfortunately, has had little impact (Stringer 1975). Science is the most creative human endeavor and the creativity in environmental design needs to be like that, rather than like art.

The implication for the environmental design professions is that what provides satisfaction, and the nature of the reward system (awards etc.) must change. The evaluation of predicted outcomes must replace, as already suggested, "architectural criticism."

As I put it in my more extreme moments (of which I have many) designers must be prepared to design something they hate, if it is the correct solution for the users. Designers' likes and dislikes are irrelevant (except in their own dwellings). To reiterate: Satisfaction, awards and honors should come from correctly identifying and solving problems, as revealed by evaluation, which should be like hypothesis testing rather than art criticism.

This also means that awards need to be given for various forms of research, the setting of justified objectives (behavioral programming), designs that have achieved these and the quality of the evaluation.[57]

All this has institutional implications for how the environmental design professions should be organized as science-based professions. For one thing, they need to become learned societies, as well as professional organizations and themselves sponsor and disseminate research. These implications go beyond the structure shown in Fig. 6, which emphasizes the role of specialization. The founding dean of my school (the School of Architecture and Urban Planning at UWM), John Wade, had a medical analogy in mind. This involved a chain of consultation starting with general practitioners, specialists, specialized clinics, teaching hospitals and research institutions. He envisioned schools of environmental design as equivalent to the latter, as consultants of last resort, since they should create and "store" the knowledge needed.[58]

This discussion has begun to deal with schools of environmental design, and I now turn to the last set of implications of designing for people—education.

Implications for Education

As is the case for any design, the nature of educational programs depends on what one wants the outcome to be, what the "end product" is supposed to be. That is turn depends on all the issues I have been discussing. Once explicit goals and objectives have been established, the rest follows, although clearly much work is needed for specifics and implementation (also based on research in relevant areas).[59]

In discussing the problem of science metrics (how to judge the quality of science and scientists) West (2010, p. 871) points out that "the first step in addressing any mechanism-design problem is identifying the desired outcome." Currently design education is for taste, creating a class of people with "good taste," cultured people (using "culture" in its non-anthropological sense) (Stevens 1998). These, then, both design and criticize design on the basis of their superior taste—not the best qualifications for designing for people. I therefore begin by summarizing what skills are needed in designing for people based on the discussion to this point, and the institutional support needed in schools of environmental design. These are discussed in more detail later.

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There should also be awards for developing systems for making locating and retrieving data possible—and easy.

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Although some schools, or rather small parts of them, or individuals in them have done that, in general this has not been an emphasis of schools of environmental design.
It is interesting that it was psychologists (not designers) at the University of Hertfordshire (U.K.) that designed "the world's most relaxing room," using research on the effect on relaxation of lighting, color, effects of relaxation of lighting, color, scent and music, Obviously, given the group variability I have emphasized, they have already found that not everyone likes it (Holden 2008a). It should not be seen as a useable environment, but as an experimental environment, a full scale physical simulation. In a school of environmental design it could be used to develop an environmental quality profile of what helps relaxation. It could also be tested on a variety of groups. In principle, this approach could be applied to a large range of settings.

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As mentioned earlier, there is now a move towards evidence-based education (among other fields). I will not be discussing issues of curriculum etc., here, nor the growing literature on these topics.

Students (practitioners)	Schools
Must know that the use of state-of-the-art research is mandatory	Research must be a major component of the institution. The full range of research must be present—basic (theoretical and empirical), translational, applied, research application elaboration of different research methods. Redefine the nature of the domain
Must know what research is already available, and what research still needs to be done.[60] Be able to find the literature and access it.	Provide adequate databases and information retrieval systems, and continue to improve them.[61]
Be able to understand and use that research literature.	Emphasize research methods, how science operates, the nature of scientific literature, its vocabulary, etc.
In addressing any problem to be able to identify the relevant groups, their characteristics, needs, wants, etc., i.e. address Basic Question 1 of EBS.	Emphasize and encourage a variety of career paths (Fig. 6). Not everyone is to be a "designer." Allow specialization at entry.
Address Basic Question 2 of EBS. Identify what effects different attributes of settings have on which people, under what circumstances, how and why. Hence identify and characterize the components of supportive environments for the group(s) in question, the environmental quality profiles of the settings to be provided, etc.	Be able to help students learn these skills—or those necessary for their chosen career path.
Be able to identify, characterize and rank the mechanisms involved, i.e. address Basic Question 3 of EBS. As a result of the above be able explicitly to state the problem in these terms.	Do research on design methods, participatory design and architectural science, and make these available.
Since groups change and also undergo culture change, consider open-ended design.	Do research on issues of open-ended, flexible design.
For students in the design path to be able to solve the problem identified to the extent possible given the knowledge available, explicitly stating goals/objectives, how these are to be achieved and also explicitly dealing with tradeoffs.	Generate the necessary (and not yet available) knowledge and make the full range of knowledge available, do research on the best ways to communicate that knowledge for different career paths.
Since the proposed solution is a series of hypotheses, explicitly suggest possible alternatives (hypotheses) and run simulations to identify those best meeting the goals. Consider this as "predictive evaluation."	Keep up with new techniques such as brain scans, full size simulations, virtual reality simulations. Do research on simulation, especially agent-based modelling, teach it and make it available.
Once the "how" has been incorporated (which I do not discuss) the proposed solution is in place.	Teach synthesis and various techniques of decision-making.
Be able to specify, were the proposal to be built, how it could be evaluated. To discover whether the goals/objectives set have been met (success) or have not (failure). If yes—how, it not—why not.	Do research on, and teach methods of evaluation. Forbid "criticism" and "I like it/I do not like it" approaches by students or faculty
Learn and cultivate the ability to communicate clear ideas clearly—in speech, writing and diagrams.	Disseminate everything discussed, all these findings, so that the knowledge gained can become cumulative and can then be fed back into the system (including "learning by design")

There is clearly one problem with all this (among others)—time. Time is limited and the process described is very time consuming. Early attempts will probably leave much to be desired, but the process should improve by following precedents in other fields and as the relevant research, body of knowledge and skills develop, and theory development is emphasized. At the same time it requires the specialists discussed earlier (see Fig. 6).

It is clear that the educational system I have described incorporating my views of the nature of the domain, design and the professions is very different to the one that currently prevails. A very different world view will be needed, different knowledge and skills will be taught and practiced, and there will be many more, and different, career paths corresponding to the professional pyramid discussed earlier (Fig. 6). [62] Selection criteria will also need to be very different, emphasizing different strengths and skills for entering students. These will also vary for the different career paths chosen, as will the material taught.[63]

Currently, the emphasis on drawing and "design skills," and portfolios, excludes precisely those students that are needed in order to make environmental design a science-based profession able to design for people. One could be a genius in one of the essential areas that I have described and not be able to draw. That was the case with Henri Poincaré, who could not get into the École Polytechnique, because his drawing skills were judged to be poor (Szpino 2007, p. 23). I personally would rather have Poincaré in a school of environmental design than someone with a (subjectively judged) "good" portfolio.

Although drawing as it is now conceived may not be relevant to designing for people, visualization and diagramming are essential, and neglected skills. There is thinking through visualization and diagramming and the latter (rather than sketching and drawing) can be a powerful form of analysis and reasoning, it can also help link analysis and synthesis (Netz and Noel, 2007, Ch. 4).

Synthesis is particularly difficult to teach and learn and requires research on its literature—but once again, models exist in other fields.[64] In this connection environmental designers have skills which could be extremely useful if cultivated and combined with diagramming. That is their ability at visualization, which people in other fields do not have, and find extraordinary.[65]

Note that diagramming is different to the visual communication of data (as in the work of Tufte). Visual representation is not only to communicate but to reveal new science, one can think with diagrams (Netz and Noel 2007, p. 87-115; special section "Big data" Nature, 455/7209, 4 Sept., 2008). Diagrams are not picture—they are non-pictorial abstract, schematic representations, i.e. like models they omit details.

It is significant that the important role of visualization and visual thinking in science is currently receiving increasing emphasis, e.g. in the development of chemistry (e.g. Hoffmann and Torrence 1993, Hoffmann 1995, Robinson 2010, Ramberg 2010). Scientists thought visually about atoms, bonds and molecules and constructed physical models—3 dimensional diagrams (as did Watson and

Crick for DNA). Visualization and diagrams also played an important role in the development of physics (e.g. Maxwell, Helmholtz, Boltzmann, Faraday, etc. (Nersessian 2008). Robinson (2010) says "…visualization in the in microworld is now commonplace," but adds that the role in visual thinking of science generally is still not universally accepted (but see Miller 1996). That is because visualization is often speculative. However science then tests such speculation (which is sometimes correct) and replaces it with research-based knowledge which confirms, disproves or modifies these (e.g. Jungers 2010). The implication for environmental design education is that rather than teaching sketching and drawing one should teach visualization techniques and diagramming.

I have obviously been emphasizing graduate education and implicitly the U.S. 4+2 professional degree system + Ph.D. I would argue, however, that in the first, non-professional degree (which is necessary) there should be much more emphasis on science, including social and behavioral science, on scientific thinking and reasoning, and research methods, rather than on the arts or humanities. Recall, however, my earlier argument that it is possible to learn from these if they are approached scientifically (The Tokyo Institute of Technology program, Rapoport 1990b).

It is also essential that schools of environmental design greatly strengthen and develop science oriented Ph.D. programs, emphasizing basic (theoretical and empirical) and translational research. Without these I do not believe, that as they are, schools of design belong in universities. That is because while universities pass on knowledge, they are even more where knowledge is created. Universities play the major role in basic research which is then applied and taught. Research, including "design as research" (which is now impossible, just a slogan) is central to everything I have discussed.

Schools of environmental design tend to be extremely introverted and isolated from other fields, both at the university and in general. The few attempts to remedy this have failed, and the major culprit, in addition to the art-oriented world view, is the amount of time spent in studio. In order to be able to design for people close links to the many relevant disciplines are essential.

I could go on listing things needed: how properly to learn from history, evolution and animal building; from the domain that includes pre-literate, vernacular and popular design and spontaneous settlements; from archaeology; from peoples' changes to environments and from suburbia, and why it is preferred almost universally as soon as resources become available. Rather than sneer at suburbia and "sprawl," market research, advertising, the housing marketing literature and actual choices made, and popular design need to be studied. They often provide a most useful, indeed critical way to identify problems, needs and, above all wants (as already discussed).

One can argue that house builders do better housing than professional designers, the public certainly prefers their products. Developers base their designs on market research, they have pioneered market segmentation—the presence and definition of numerous (lifestyle) groups, and continue to refine the methods. Moreover, to survive they must respond to user wants.

This also applies to shopping where retailers also use rigorous scientific techniques to improve their profits. Methods include anthropological studies of wayfinding in stores, brain scans and sophisticated statistical methods used in testing nuclear weapons (Chang 2006). The details of all these research methods and their results are obviously applicable to other settings. This also relates to the point made earlier about the usefulness of microeconomics in understanding values, preferences, wants and choices, which is becoming even more useful with the development of evolutionary, behavioral and neuro-economics, and the increasing use of experiments, gaming, simulations, brain scans, etc. This is an example of the way fields (including new fields) and development in them become relevant. It then becomes essential for schools to keep up with all that and communicate and teach these to students in the appropriate career paths.

When all forms of research are applied to the domain as defined earlier, its different components can then serve as model systems (as discussed earlier). These can generate hypotheses and findings (to be replicated) about dwelling, entertainment, relaxation, work, social interaction, aging, health, etc., and settings for those at various scales. These hypotheses would be constrained by already existing research (Nabel 2009 and Fig. 4). The findings can be applied and hypotheses tested using the full range of research methods, including "indirect" methods and "reading" environments. It is necessarily to develop skills in looking and seeing environments in this way by posing questions that can be pursued across different environments with different groups and in different contexts. One needs to learn how to analyze the environments one encounters and traverses, know how to seek out other appropriate environments and do comparative studies. It is also necessary to learn how to use advertising, newspapers, novels, film, TV, etc. To reiterate, the questions posed must be informed by up-to-date existing research-based knowledge and theory.

If the domain is to be used as a source of model system, one must know how model systems are chosen and used in various sciences (see earlier discussion, cf. Slack 2009, Maher 2009, Dugatkin 2001, Rapoport 2006[a]). It will also be necessary to modify such techniques for environmental design, and to develop and learn techniques specific to environmental design (hence the need for methodologists). This, in turn, then leads to ways (to be developed, taught and learned) of how the knowledge gained can be used to provide precedents, as a source not for copying but by deriving principles and lessons (see Fig. 3).

Most of the skills I have been discussing are analytical. Being able to relate and combine different forms of research and bodies of information and to use them to identify and solve problems (i.e. design), developing concepts and theory and to use comparative studies require a skill not yet discussed—synthesis. That skill is also needed to relate different setting and units of settlement to one another, then link them into systems and use them to relate, for example, buildings and urban fabric. Synthesis is also needed for many other aspects of turning environmental design into a science-based profession.

There is, therefore, a need to develop, to teach explicitly, and acquire and practice skills in synthesis.[66] This is less

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"To know that we know what we know, and to know what we do not know, that is true knowledge" (Copernicus, cited in Shimadzu advertisement, (Nature, 440/7083, 23 March 2006).

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Note that developing databases and retrieval systems is an ongoing activity in medical schools, e.g. a $1.1 million grant to Professor Yu, of the Health Care Informatics program at UWM to improve on existing systems— which are already rather good (UWM Report, vol. 29, No. 4, May 2008, p. 7).

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In medical education some schools now require a choice (in one case among 6 career paths) at entry.

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An interesting approach is described in an advertisement by the Singapore University of Technology and Design (Science 327/5911, 13 March, 2010). This combines architecture with sustainable design, engineering product development, engineering systems and design and information systems technology and design. It says that "Design as an academic discipline cuts across the curriculum, is the focus of the program and will be the framework for novel research and educational programs." There will be research on design, a major international design center, and a center for learning, knowledge creation and dissemination. I think basic research seems to be neglected, but experiments such as these are worth studying.

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Integrative, comparative and systems biology, integrative neuroscience, ecology, the Santa Fee Institute, etc., all emphasize synthetic and systems thinking.

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For a number of years I had a joint appointment in architecture and anthropology. I rely on diagramming a great deal, in my own work and in teaching. Ph.D. students in anthropology (unlike in architecture) were not able to use diagramming to visualize relationships.

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Currently synthesis is supposed to take place in studio. It is however, never explicitly addressed or evaluations done to see if it has occurred. Furthermore, most of the material I have discussed, which needs synthesis, is not currently considered.

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I would argue, that my work, including this paper, can also provide a model.

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When I came to Sydney in 1969 to introduce EBS, I was able to cut studio time in half. It was admitted that it seemed to make no difference. As an interim step, studio could be changed to, the emphasis what and why, and use research-based evidence as much as possible. For example: design a circulation system for X, using research knowledge on way-finding, emphasizing both neuroscience and environmental cognition research (as discussed earlier). Even just changing the name might help, e.g. "laboratory" (science) as opposed to "studio" (art) elicits very different expectations.

Acknowledgements

I thank Professor Kosta Mathéy of the School of Architecture, Technical University Darmstadt, for encouraging me to develop the argument by offering to publish it in TRIALOG. I am also grateful to Dean Robert Greenstreet of the School of Architecture and Planning, University of Wisconsin-Milwaukee, for offering typing assistance, and to Ms. Leila Graham for her outstanding typing.

developed and more difficult to teach than analytical skills. A systematic review of what is known, and have been done on this topic (which I have not done) is essential in order to develop the teaching of synthesis. However, as usual there are some models and precedents to get us started.[67] For example it has been shown that for synthesis one first needs to dismantle, then understand and only then can one unify, i.e. synthesize (Narasimha 2004, McGill 2010, p. 576, More generally, see Damasio et al. 2001, Wilson 1998).

There also the recent, and ongoing, efforts to develop integrative and systems biology, integrative medical sciences (e.g. integrative neuroscience), animal personality studies (Siebert 2006) and others. That, in turn demands shared terminology and conceptual frameworks, clearly defined concepts and accessible (reviewed, evaluated and standardized) data (e.g. Collins 2006, advertisement for scientific curators for ZFIN (Zebrafish model organism database), Institute of Neuroscience, University of Oregon, Science, 311, 13 Jan., 2006). Which emphasizes the use of common terms and methods (when possible) for both Zebrafish and humans. Discussions of both successes and problems encountered in these attempts are also useful (Cassman et al. 2005, Collins 2006, Cain et al., 2008).

As already pointed out, in the short term the environmental design professions and schools, need to develop databases, which most scientific fields have developed and are continuously improving. There also need to be organized and systematic efforts to agree on terminology, concepts, etc., and critically to review and standardize the content of databases. In the longer term (probably rather long due to neglect) there needs to be a major emphasis and efforts to develop theory (hence the need for theoreticians) and also to clarify the ontological and epistemological bases of the field (hence philosophers of environmental design). The compressibility and cumulativeness theory brings make communication, teaching and learning of the succinct theory much easier—the specifics can be obtained and plugged-in if and when needed. All these are tasks for major basic research components in schools of environmental design.

For a more complete theory EBS needs synthesis with the other responses to the failings of the design professions—design methods (how best to handle information, make decisions and choices, etc.) and participatory planning and design (both to elicit needs and wants and to involve users in the process). It would also be useful to continue this synthesis to include architectural science which, quite independently, has developed scientific approaches to many aspects of design (acoustics, lighting, comfort, materials, etc.). These, as discussed earlier, would benefit from EBS by introducing human reactions, wants, etc., EBS would also benefit. In addition, architectural science is most relevant for "how" questions. All of these suggest other professional and academic specializations.

As part of the changed world view there is also a need to think of under-design rather than the total control designers seek (Rapoport 1990f, 1995ª (1967ª), 1995f (1990/91)). There is a need to discover what are the least necessary constraints in any given design situation, that will provide the maximum freedom for users to manipulate their environments. Research and teaching need to emphasize open-ended design, of frameworks (physical or rule systems) within which maximum change can happen (see earlier discussion; cf. the work of Habraken and SAR, Open House International, Oxman 1977, Tipple 2000 among many others).

As is often the case much of my discussion about education has been about adding things. An inevitable question is then what to subtract, reduce or eliminate (cf. Krause 2010). Obviously, the first thing is studio and what it represents. This, however, is a different topic about which I have, to put it mildly, very strong and extreme views (Rapoport 1983b, 1990e).[68] Other topics that could be reduced are traditional architectural history, so-called "theory," drawing, etc. What makes all the new material possible is the high degree of specialization, the possibility of a variety of different career paths rather than the current assumption that everyone will be a "designer"—few are (I am told 25%). Obviously there is a need for a common core, or base so that communication is possible. That would be at the undergraduate level and would emphasize science. The specifics, as for the rest of this discussion are an open question and remain to be worked out.

Conclusion

Earlier in this paper I discussed a few small signs of change, most of which come from clients, industry, government, and even the professions. They should be coming from schools of environmental design. As we have seen, universities are typically the source of most of the basic research on which innovation depends. Even in those schools apparently involved in research, that is done by individuals or small groups. Research is not basic to the whole program, especially not design. At the very least schools should seize the opportunity, become involved and plan to become the leaders. Without that, schools of design do not belong in universities.

There have been attempts, here and there, to try incrementally to introduce some of these changes, to fit them into the traditional system. I do not think that will work and believe that the radical shifts I have been discussing are essential if design for people is to happen.

I am well aware that much of this is probably unrealistic and just a dream (to many possibly a nightmare). It will probably not happen and what does happen will, of course, be incremental and occur gradually, over time (after all, medicine has been at it for a long time). But to reiterate, explicit objectives are essential and without aiming at (or at least discussing) the ideal as a goal nothing will happen.

Addendum

After finishing the manuscript, Professor Jerry Weisman drew my attention to a book on evidence-based design in architecture (D. K. Hamilton and D. H. Watkins (2009) Evidence-Based Design for Multiple Building Types, Hoboken, NJ, John Wiley and Sons). Without discussing it, two things seem clear. First, the idea of evidence-base design is beginning penetrate. Second, the approach is quite unlike mine.

References

Abbot, A. (2008) "The brains of the family." Nature 454/7201, 10 July, p154-157.

Abbot, A. (2010) "The rat pack," Nature 465/7296, 20 May, p282-283.

Akbar, J. (1988) Crisis in the Built Environment (The Case of the

Muslim City), Singapore, Mimar Books.

Alcock, J. (2001) The Triumph of Sociobiology, New York, Oxford University Press.

Allen, J. S. (2009) The Lives of the Brain, Cambridge, MA, Belknap Press of Harvard University Press.

Alroy, J. et al. (2008) "Phanerozoic trends in the global diversity of marine invertebrates," Science, 321/5885, 4 July, p97-100.

Anathaswamy, A. (2010) The Edge of Physics, Boston, Houghton, Mifflin Harcourt.

Appiah, K. A. (2008) Experiments in Ethics, Cambridge, MA, Harvard University Press.

Ariely, D. (2010) Predictably Irrational (The Hidden Forces That Shape Our Decisions), New York, Harper Perennial (Revised Edition).

Association of American Medical Colleges (1984) Physicians for the Twenty-First Century (Project on the General Professional Education of the Physician and College Preparation for Medicine) (The GPEP Report), Washington, DC, Association of American Medical Colleges.

Baker, D. (2008) "Making the paper," Nature, 453/7192, 8 May, p xii.

Ball, P. (2006) "What chemists want to know," Nature, 442/7102, 3 Aug., p500-502.

Ball, P. (2010) "Predicting human activity," (Review of A-L. Barabasi, Burst: The Hidden Pattern Behind Everything We Do, New York, Dutton 2010, Nature, 465/7299, 10 June, p692.

Bally, P. (2008) "Near perfect "black,"" Nature, 453/7197, 12 June, p834.

Balter, M. (2008) "Why we're different: probing the gap between apes and humans," Science, 319/5862, 25 Jan., p404-405.

Balter, M. (2010a) "Animal Communication helps reveal roots of language," Science, 328/5981, 21 May, p969-971.

Balter, M. (2010b) "Probing culture's secrets, from children to Capuchins," Science, 329/5989, 16 July, p266-267.

Barouch, D. H. (2008) "Challenges in the development of an HIV-1 vaccine," Nature, 455/7213, 2 Oct., p617-619.

Bartsch, T. et al. (2010) "Focal lesions of human hippocampal CA1 neurons in transient global amnesia impair place memory," Science 328/5984, 11 June, p1412-1415.

Batterman, R. W. (2002) Devil in the Details (Asymptotic Reasoning in Explanation, Reduction and Emergence), New York, Oxford University Press.

Baumgartner, M. P. (1988) The Moral Order of the Suburb, New York, Oxford University Press.

Beauchamp, G. (2008) "On the Scent," (Review of A. Gilbert, What the Nose Knows, 2008), Nature, 454/7206, 14 Aug., p825-826.

Behrends, C. et al. (2010) "Network organization of the human autophagy system," Nature, 466/7302, 1 July, p68-76.

Behrens, T. E. J. et al. (2009) "The computation of social behavior," Science, 324/5931, 29 May, p160-164.

Bell, G. et al. (2009) "Beyond the data deluge," Science, 323/5919, 6 March, p1297-1298.

Betzig, L. (Ed.) (1997) Human Nature: A Critical Reader, New York, Oxford University Press.

Bickerton, D. (2008) Bastard Tongues, New York, Hill and Wang.

Bishop, J. (1983) "Will the real Milton Keynes please stand up?" Paper presented at the British Association for the Advancement of Science, Annual Meeting (Section E5), (Aug. 22-26).

Bloom, F. E. (2003) "Science as a way of life: Perplexities of a physician scientist," Science 300/5626, 16 June, p. 1680-1681.

Bohannon, J. (2010) "A taste for controversy," Science, 328/5985, 18 June, p1471-1473.

Bonetta, L. (2003) "Do you want to work here?" Nature, 424/6950, 14 Aug., p718-720.

Bonner, J. T. (1988) The Evolution of Complexity by Means of Natural Selection, Princeton, Princeton University Press.

Bouchaud, J-P. (2009) "Economics needs a scientific revolution," Nature, 455/7217, 30 Oct., p1181.

Bowles, S. (2008) "Conflict: Altruism's midwife," Nature, 456/7220, 20 Nov., p 326-327.

Boyce, D. G. et al. (2010) "Global phytoplankton decline over the past century," Nature, 466/7306, 29 July, p591-596.

Boyer, P. (2008) "Religion: Bound to believe," Nature, 455/7216, 23 Oct., p1038-1039.

Bray, D. (2009) Wetware (A Computer in Every Living Cell), New Haven, CT, Yale University Press.

Brower, S. (1988) Design in Familiar Places (What Make Home Environments Look Good), New York, Praeger.

Brower, S. (1996) Good Neighborhoods (A Study of In-Town and Suburban Residential Environments), Westport, CT, Praeger.

Bruegmann, R. (2006) Sprawl (A Compact History), Chicago, Chicago University Press (Paperback edition).

Buchanan, M. (2007) The Social Atom, New York, Bloomsbury.

Buchanan, M. (2008) "Wine-omics," Nature, 455/7213, 2 Oct., p. 699.

Buchanan, M. (2009) "Meltdown modeling," Nature, 460/7256, 6 Aug., p680-682.

Bunge, M. (1998) Philosophy of Science, Vol. 1, From Problem to Theory, New Brunswick, NJ, Transaction Publishers.

Burns, J. A. (2010) "The four hundred years of planetary science since Galileo and Kepler," Nature, 466/7306, 29 July, p575-584.

Burr, C. (2008) "In the lab, creating the essence that entices consumers to buy," NY Times, Feb. 23.

Busskamp, V. et al. (2010) "Genetic reactivation of cone photoreceptors restores visual responses in retinitis pigmentosa," Science, 329/5990, 23 July, p413-417.

Cadieu, E. et al. (2009) "Coat variation in the domestic dog is governed by variants in three genes," Science, 326/5949, 2 Oct., p 150-151.

Cain, C. J. et al. (2008) "What systems biology is (not yet)," Science, 320/5879, 23 May, p1013-1014.

Caminos, H. and R. Goethert (1978) Urbanization Primer, Cambridge, MA, MIT Press.

Carey, B. (2008) "Monkeys think, moving artificial arm as own," NY Times, May 29.

Carpenter, S. (2007) "Carving a career in translational research," Science, 317/5840, 17 Aug., p966-967.

Cartwright, J. (2001) Evolution and Human Behavior (Darwinian Perspective on Human Nature) (A Bradford Book), Palgrave (2nd Printing).

Cassman, M. et al. (2005) "Barriers to progress in systems biology," Nature, 438/7071, 22-29 Dec., p1079.

Cepko, C. (2010) "Seeing the light of day," Science, 329/5990, 23 July, p403-404.

Chakravarti, S. (2008) "From complexity to simplicity," Science, 319/5864, 8 Feb., p735-736.

Chakravarti, A. (2009) "Kinship: Race relations," Nature, 457/7228, 22 Jan., p380-381.

Chang, K. (2006) "Enlisting science's lessons to entice more shoppers to spend more," NY Times, Sept. 19.

Cheney, D. L. and R. M. Seyfarth (2007) Baboon Metaphysics (The evolution of a Social Mind), Chicago, University of Chicago Press.

Cherruau, P. (2010) "Dakar-Paris à pied," Le Monde (Weekend magazine), 30 Jan., p6.

Chin, K. R. (2004) "Lost in translation," Nature, 428/6983, 8 April, p607-608.

Cho, A. (2005) "String theory meets practice as violin makers rethink their craft," Science, 310/5753, 2 Dec. p1414-1415.

Choi, C. Q. (2009) "Going with Golgi," Scientific American, vol. 301, no. 4, Oct., p24.

Clark, W. R. and M. Grunstein (2004) Are We Hard-wired? (The Role of Genes in Human Behavior), New York, Oxford Unversity Press (Paperback Edition).

Clayton, M. (2010) "Once more into the animal mind," (Review of S. J. Shuttleworth, Cognition, Evolution and Behavior, Oxford University Press, 2010 (2nd Ed.), Nature 464/7290, 8 April, p835).

Cochran G. and H. Harpending (2009) The 10,000 Year Explosion (How Civilization Accelerated Human Evolution), New York, Basic Books.

Collins, H. (2006) "A little judgement," (Review of D. M. Berube, Nano-Hype: The Truth Behind the Nanotechnology Buzz, Prometheus, 2005), Nature, 439/7073, 12 Jan. p141.

Colombo, P. (2008) "In praise of pores," Science, 322/5900, 17 Oct., p381-383.

Connolly, M. (2009) 9 Dragons, New York, Little Brown,

Contopoulos-Ioannides, D. G. et al. (2008) "Life-cycle of translation research for medical interventions," Science 321/5834, 5 Sept., p1298-1299.

Costi, J. L. (1997) Would be Worlds (How Simulation is Changing the Frontiers of Science), New York, John Wiley and Sons.

Cressey, D. (2010) "Talking up translation," Nature, 463/7280, 28 Jan., p422-423.

Cronk, L. (1999) That Complex Whole (Culture and the Evolution of Human Behavior), Boulder, CO, Westview Press.

Crunelle, M. (1999/2000) L'Architecture et Nos Sens, Brusells, Université Libre de Bruxelles, (2nd Edition).

Custers, R. and H. Aarts (2010) "The unconscious will: How the pursuit of goals operates outside of conscious awareness," Science, 329/5897, 2 July, p47-50.

Cyranoski, D. (2009) "Marmoset model takes center stage," Nature, 459/7246, 28 May, p492.

Dahaene, S. et al. (2008) "Log or linear? Distinct intuitions of the number scale in Western and Amazonian indigine culture," Science, 320/5880, 30 May, p1217-1220.

Damasio, A. R. et al. (Eds.) (2001) The Unity of Knowledge, New York, New York Academy of Sciences.

Davis, G. et al. (2006) "So money is tight…how do you make "informed transparent and defendable" choices?" Unpublished paper prepared for the U.S. Coast Guard (March).

Dearborn, L. M. (2006) "Reconstituting Hmong culture and traditions in Milwaukee, Wisconsin," Traditional Dwellings and Settlements Review, vol. 19, no. 2 (Spring), p37-49.

De Dreu, C. K. W. et al. (2010) "The neuropeptide oxycontin regulates parochial altruism in intergroup conflict," Science, 328/5984, 11 June, p1408-1411.

Diaz-Ferreira, E. (2009) "Chronic stress causes frontostriatal reorganization and affects decision-making," Science, 325/5940, 31 July, p621-625.

Dickersin, K. (2010) "To reform U.S. healthcare start with systematic reviews," Science, 329/5991, 30 July, p516-517.

Dijksterhuis, A. et al. (2006) "On making the right choice: The deliberation without attention effect," Science, 311/5763, 17 Feb. p1005-1007.

Disney, M. J. et al. (2008) "Galaxies appear simpler than expected," Nature 455/7216, 23 Oct., p1082-1084.

Doeller, C. F. (2010) "Evidence for grid cells in a human memory network," Nature, 463/7281, 4 Feb., p657-661.

Douglas, T. and M. Young (2006) "Viruses making friends with old foes," Science, 312/5775, 12 May, p873-875.

Doya, K. (2010) "Journal club," Nature, 466/7306, 29 July, p535.

Dreyfus, C. (2010) "A conversation with John Donoghue," NY Times, Aug. 3.

Dugatkin, L. A. (Ed.) (2001) Model Systems in Behavioral Ecology (Integrating Conceptual, Theoretical and Empirical Approaches, Princeton, NJ, Princeton University Press.

Eisenegger, C. et al. (2010) "Prejudice and truth about the effect of testosterone on human bargaining behavior," Nature, 463/7279, 21 Jan., p. 359.

Endersby, J. (2009) "Lumpers and splitters: Darwin, Hooker and the search for order," Science, 326/5959, 11 Dec., p1496-1499.

Enserink, M. (2006) "The joy of evidence-based cooking," Science, 314/5083, 24 Nov., p1235-1236.

Epstein, J. (2009a) "Modeling to contain pandemics," Nature, 460/7257, 6 Aug., p687.

Epstein, J. (2009b) "Toddling Town," Commentary, vol. 128, no. 4 (Nov.) p. 31-35.

Etzioni, E. (2009) "Bottom-up nation building," Policy Review, no. 158 (Dec.) p51-62.

Falk, A. and J. J. Heckman (2009) "Lab experiments are a major source of knowledge in the social sciences," Science, 326/5952, 23 Oct., p535-538.

Farmer, J. D. and D. Foley (2009) "The economy needs agent-based modeling," Nature, 460/7256, 6 Aug., p685-686.

Fehér, O. et al. (2009) "De Novo establishment of wild-type song culture in the Zebra Finch," Nature, 459/7246, 28 May, p564-568.

Fehr, E. (2010) "Making the paper," Nature, 463/7279, 21 Jan., p268.

Feldon, D. F. et al. (2010) "Performance-based data in the study of STEM Ph.D. education," Science, 329/5989, p282-283.

Firestein, S. (2008) "A sharp look at stories of smell," (Review of A. Gilbert, What the Nose Knows (2008), Science, 321/5890, 8 Aug, p774.

Fitch, W. T. (2009) "Birdsong normalized by culture," Nature, 459/7246, 28 May, p519-520.

Forbes, P. (2005) The Gecko's Foot (Bio-Inspiration: Engineering New Materials From Nature), New York, W. W. Norton and Company.

Ford, M. (2010) "Hidden treasures," Nature, 464/7290, 8 April, p826-827.

French, C. (2010) "People, societies and landscapes," Science, 328/5977, 23 April, p443-444.

Fuller, R. A. et al. (2010) "Replacing underperforming protected areas achieves better conservation outcomes," Nature, 466/7304, 15 July, p365-367.

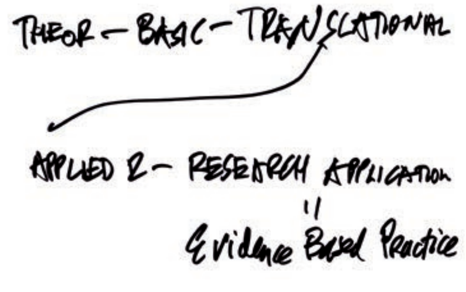
Furukawa, H. et al. (2010) "Ultrahigh porosity in metal-organic frameworks," Science, 329/5990, 23 July, p424-428.

Garber, K. (2007) "Translational institute unites unlikely partners at Penn," Science, 317/5840, 17 Aug., p968-969.

Garreau, J. (1994) "Don't walk," The New Republic, Issues 4157 and 4158 (Sept. 19 and 26), p24-28.

Geha, M. (2010) "Gone with the wind," Nature, 463/7278, 14 Jan., p167-168.

Getzels, J. W. and M. Csikszentmihalyi (1976) The Creative Vision: Longitudinal Study of Problem Finding in Art, New York, Wiley.



Ghirlanda, G. (2008) "Old enzymes, new tricks," Nature, 453/7192, 8 May, p164-166.

Gibson, D. G. et al. (2010) "Creation of a bacterial cell controlled by a chemically synthesized genome," Science, 329/5987, 2 July, p52-56.

Giere, R. N. (1999) Science Without Laws, Chicago, University of Chicago Press.

Gifford, R. et al. (2000) "Decoding modern architecture: A lens model approach for understanding the aesthetic differences of architects and lay persons," Environment and Behavior, vol. 32, no. 2 (March), p163-187.

Gifford, R. et al. (2002) "Why architects and lay persons judge building differently: Cognitive properties and physical bases," Journal of Architectural and Planning Research, vol. 19, no. 2 (Summer), p131-148.

Gilbert, A. (2008) What the Nose Knows (The Science of Scent in Everyday Life), New York, Crown Publishers.

Giuliani, M. V. and M. C. Rossi (1992) "Urban settlements and residential quality in an Italian town," in M. V. Giuliani (Ed.) Home: Social, Temporal and Spatial Aspects, San Giuliani Milanese, Progetto Finalizzato Edilizia, p215-228.

Gladwell, M. (2005) Blink (The Power of Thinking Without Thinking), New York, Little Brown and Company.

Glancey, J. (1985) Editorial "What price public esteem?" RIBA Journal (Overseas Edition) (October) p3.

Goldberger, P. (1981) 'Transformed houses of the working class," NY Times, October 22.

Golledge, R. G. (1999) Wayfinding Behavior: Cognitive Maps and Other Spatial Processes, Baltimore, John Hopkins University Press.

Gould, J. L. and C. G. Gould (2007) Animal Architects: Building and the Evolution of Intelligence, New York, Basic Books.

Grene, J. (2010) Design is How it Works, Portfolio.

Groat, L. N. (1979) "A Study of Meaning in Contemporary Architecture: Do 40 Post-Modern Contemporary Buildings Really Exist for Anyone Besides Architectural Critics?" Masters' Thesis, University of Surrey (UK).

Groat, L. N. (1982) "Meanings in post-modern architecture: An examination using the multiple sorting task," Journal of Environmental Psychology, vol. 2, p3-22.

Groat, L. N. and D. Canter (1979) "Does Postmodernism communicate," Progressive A8,5sophical Essays), Cambridge, MA, Bradford Books/MIT Press.

Harvey, C. D. (2009) "Intracellular dynamics of Hippocampal place cells during virtual navigation," Nature, 461/7266, 15 Oct., p941-946.

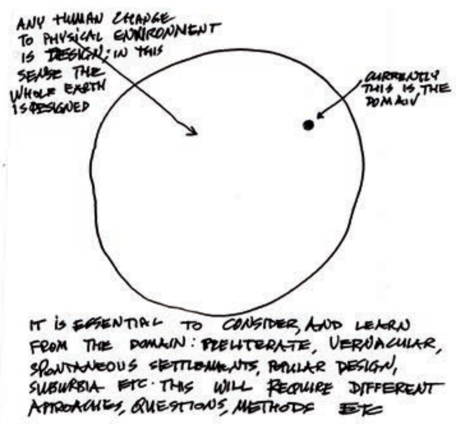
Haslam, M. et al. (2009) "Primate archaeology," Nature, 460/7253, 16 July, p339-344.

Hasselmo, M. J. (2008) "The scale of experience," Science, 321/5885, 4 July, p46-47.

Hauser, M. D. (2009) "The possibility of impossible cultures," Nature, 460/7552, 9 July, p190-196.

Hauser, M. D. and T. Bever (2008) "A biolinguistic agenda," Science, 322/5904, 14 Nov., p1057-1059.

Hayden, E. C. (2010) "Life is Complicated," Nature, 464/7289, 1 April, p664-667.



Heath, T. (1984) Method in Architecture, Chichester, UK, John Wiley and Sons.

Heinrich, J. et al. (2010a) "Most people are not WEIRD," Nature, 466/7302, 1 July, p29.

Heinrich, J. et al. (2010b) "Markets, religion, community size, and the evolution of fairness and punishment," Science, 327/5972, 19 March, p1480-1484.

Heuer, R. J. Jr. (1999) Psychology of Intelligence Analysis, Washington, DC, Center for the Study of Intelligence, CIA.

Himsworth, H. (1986) Scientific Knowledge and Philosophic Thought, Baltimore, Johns Hopkins University Press.

Hoff. K. (2010) "Fairness in modern society," Science, 327/5972, 19 March, p1467-1468.

Hoffmann, R. (1995) The Same and Not the Same, New York, Columbia University Press.

Hoffmann, R. and V. Torrence (1993) Chemistry Imagined (Reflections on Science), Washington, DC, Smithsonian Institution.

Holden, C. (2008a) "Random samples," Science, 322/5907, 31 Oct., p658.

Holden, C. (2008b) "Study Shows how degraded surroundings can degrade behavior," Science, 322/5905, 21 Nov., p1775.

Honan, W. H. (1988) "Cremona in Texas? Professor says his violins can rival Stradivari's," NY Times, October 13.

Houk, K. N. and P. H-Y. Cheong (2008) "Computational prediction of small-molecule catalysts," Nature, 455/7211, 18 Sept., p309-313.

Hsu, M. et al. (2008) "The right and the good: Distributive justice and neural encoding of equity and efficiency," Science, 320/5879, 23 May, p1092-1095.

Huh, D. et al. (2010) "Reconstructing organ-level lung function on a chip," Science, 328/5486, 25 June, p1662-1668.

Hunt Thompson Associates (1988) Maiden Lane: Feasibility Study for the London Borough of Camden, London, Hunt Thompson Associates.

Johnson, D. (1999) "A suburbiascape grows in inner-city Chicago," NY Times, Oct. 22.

Jolly, A. (2004) "Love actually" (Review of A. P. Fisher, "Why We Love: The Nature and Chemistry of Romantic Love, (2004))" Nature, 427/6973, 29 Jan., p306-397.

Jolly, D. (2010) "An artificial heart its makers say could be a standard replacement," NY Times, July 14.

Jorgensen, W. L. (2010) "Pulled from a protein's embrace," Nature, 466/7302, 3 July, p42-43.

Judson, H. F. (2006) "The theorist," (Review of M. Ridley (2006) Francis Crick: Discoverer of the Genetic Code, New York, Harpen Collins), Nature, 443/7114, 26 Oct. p917-918.

Jungers, W. L. (2010) "Barefoot running strikes back," Nature, 463/7280, 28 Jan., p433-434.

Kandel, E. R. (2006) In Search of Memory (The Emergence of a New Science of the Mind), New York, W. W. Norton and Company.

Kareiva, P. (2010) "Trade-in to trade-up," Nature, 466/7304, 15 July, p.322-323.

Katsnelson, A. (2010) "Synthetic biology resets biotech goals," Nature, 465/7297, 27 May, p406.

Keeley, L. H. (1996) War Before Civilization, New York, Oxford University Press.

Keizer, K. et al. (2008) "The spreading of disorder," Science, 322/5908, 12 Dec., p1681-1685.

Kenneally, C. (2007) The First Word (The Search for the Origins of Language), New York, Penguin.

Khattab, O. (1993) "Environmental quality assessment: An attempt to evaluate government housing projects," Open House International), vol. 18, no. 4, p41-47.

Kim, K-J. et al. (2009) "Interdimensional universality of dynamic interfaces," Nature, 458/7239, 9 April, p740-742.

Kjelstrup, K. B. et al. (2008) "Finite scale of spatial experience in the hippocampus," Science, 321/5885, 4 July, p140-143.

Koder, R. L. (2009) "Design and engineering of a 02 transport protein," Nature, 458/7236, 19 March, p305-309.

Kohler, T.A. et al. (2005) "Simulating ancient societies," Scientific American, vol. 293, no. 1, p77-84.

Kohler, T. A. and G. J. Gummerman (Eds.) (2000) Dynamics in Human and Primate Societies (Agent-Based Modeling of Social and Spatial Processes), New York, Oxford University Press.

Kolata, G. (2010) "Measures expected to prevent heart attacks in diabetics offer no help, studies say," NY Times, March 15.

Krackhardt, D. (2009) "A plunge into networks," (Review of M. O. Jackson, Social and Economic Networks, Princeton, NJ, Princeton University Press, 2008), Science 326/5949, 2 Oct., p47-48.

Krajuch, I. et al. (2009) "Using neural measures of economic value to solve the public goods free-loader problem," Science, 326/5952, 23 Oct., 596-599.

Krause, K. W. (2010) "Scientists: High time for medicine to adapt to evolution," Skeptical Inquirer, vol. 34, no 4 (July/Aug.), p25-27.

Kron, J. (1983) Home Psych (The Social Psychology of Home and Decoration), New York, Clarkson N. Potter.

Lartigne, C. et al. (2009) "Creating bacterial strains from genomes that have been cloned and engineered in yeast," Science, 325/5948, 25 Sept., p1693-1700.

Le Blanc, S. A. (2003) Constant Battles: The Myth of the Peaceful, Noble Savage, New York, St. Martin's Press.

Le Compte, W. F. (1972) "Behavior settings: The structure of the treatment environment," in W. Mitchell (Ed.) EDRA 3, Los Angeles, UCLA, vol. 1, p4.2.1 – 4.2.5.

LeCompte, W. F. and E. P. Willems (1970) "Ecological analysis of a hospital: Location dependencies in the behavior of staff and patients," in J. Archea and C. Eastman (Eds.) EDRA 2, Pittsburgh, PA, p.236-247.

Lehrer, J. (2009) "Small, furry…and smart," Nature, 461/7266, 15 Oct., p862-864.

Leighton, J. P. and R. J. Sternberg (Eds.) (2004) The Nature of Reasoning, Cambridge, Cambridge University Press.

Leonhardt, D. (2010) "In medicine the power of learning to say no," NY Times, April 7.

Levitt, S. D. and J. A. List (2008) "Homo Economicus, evolves," Science, 319/5865, 15 Feb., p909-910.

List, J.A. (2008) "Homo Experimentalis, evolves," Science, 321/5886, 11 July, p207-208.

Liu, C-W. (1994) From Old Town to New City: A Study of Behavior Settings and Meaning of Streets in Taiwan, Ph.D. Dissertation in Architecture, University of Wisconsin-Milwaukee.

Lock, A. and C. R. Peters (Eds.) (1999) Handbook of Human Symbolic Evolution, Oxford, Blackwell Publishers.

Lohr, S. (2007) "Three share Nobel in economics for work on social mechanisms," NY Times, Oct 16.

Loose, C. et al. (2006) "A linguistic model for the rational design of antimicrobial peptides," Nature, 443/7113, 19 Oct., p867-869.

Lopreato, J. and T. Crippen (1999) Crisis in Sociology (The Need for Darwin), New Brunswick, NJ, Transaction Publishers.

Lovesey, P. (2009) Skeleton Hill, New York, SOHO.

Low, S. M. (1982) Professional Culture: The Boundary Between Theory and Practice in Design, U.S. Department of Health, Education and Welfare, National Institute of Education, (ERIC) Reports, ED., 219-290; So. 013 958 (January).

Lutz, S. (2010) "Reengineering enzymes," Science, 329/5989, 16 July, p285-287.

Lyon, B. E. (2010) "Coots use hatch order to learn to recognize and reject conspecific parasitic chicks," Nature, 463/7278, 14 Jan., p223-226.

MEDICINE

TRANSLATIONAL RESEARCH

Maher, B. (2009) "Biology's next top model?" Nature, 458/7239, 9 April, p695-698 (Also "model making" in Ibid, this issue, p477).

Marwan, W. (2010) "Amoeba inspired network design," Science, 327/5964, 22 Jan., p419-420.

Mayle, P. (2009) The Vintage Caper, New York, Knopf.

McGill, B. J. (2010) "Matters of scale," Science, 328/5978, 30 April, p575-576.

McIntyre, L. (2006) Dark Ages (The Case for a Science of Human Nature), Cambridge, MA, Bradford Books/MIT Press.

McMillan, D. W. C. (2008) "The advent and development of organocatalysts," Nature, 455/7211, 18 Sept. p304-308.

Maestripieri, D. (2007) Macachiavellian Intelligence (How Rhesus Monkeys and Humans Have Conquered the World), Chicago, University of Chicago Press.

Mancuso, K. et al. (2009) "Gene therapy for red-green colour blindness in adult primates," Nature, 461/7265, 8 Oct., p784-787.

Marean, C. W. (2010) When the Sea Saved Humanity, Scientific American, vol. 303, no.2 (Aug) p54-61.

Marris, E. (2007) "What to let go," Nature, 450/7167, 8 Nov., p.152-155.

McGill, B. J. (2010) "Matters of Scale," Science, 328/5978, 30 April, p575-576.

Messing, G. L. and A. J. Stevenson (2008) "Toward pore-free ceramics," Science, 322/5900, 17 Oct., p383-384.

Miller, A. I. (1996) Insights of Genius (Imagery and Creativity in Science and Art), New York, Copernicus/Springer Verlag.

Miller, G. (2000) The Mating Mind (How Sexual Choice Shaped the Evolution of Human Nature), New York, Doubleday.

Miller, G. (2008) "The roots of morality," Science, 320/5877, 9 May, p734-737.

Miller, G. (2010) "The seductive allure of behavioral epigenetics," Science, 329/5987, 2 July, p24-27.

Mills, T. J. et al. (2010) "Development of the Hippocampal cognitive map in preweanling rats," Science, 328/5985, 18 June, p1573-1580.

Mithen, S. (1996) The Prehistory of the Mind (The Cognitive Origins of Art and Science), London, Thames and Hudson.

Mulder, M. B. (2008) "Bonding as key to Hominid origins," (Review of B. Chapai's Primeval Kindship: How Pair Bonding Gave Rise to Human Society), Nature, 454/7200, 3 July, p29-30.

Murphy, R. A. et al. (2008) "Rule learning by rats," Science, 319/5871, 28 March, p1849-1851.

Nabel, G. J. (2009) "The coordinates of truth," Science, 326/5949, 20 Oct., p53-54.

Nam, K. T. et al. (2006) "Virus assembled synthesis…(s.t.)," Science, 312/5775, 12 May, p885-888.

Narasimha, R. (2004) "Divide, conquer and unify," Nature, 432/7019, 16 Dec., p807.

Nasar, J. L. (1998) The Evaluative Image of the City, Thousand Oaks, CA, Sage.

Neitz, J. and M. Neitz (2009) "Making the paper," Nature, 461/7265, 8 Oct., p695.

Nersessian, N. J. (2008) Creating Scientific Concepts, Cambridge, MA, MIT Press/Bradford Books.

Netz, R. and W. Noel (2007) The Archimedes Codex, Chicago, University of Chicago Press.

Neumann, H. et al. (2010) "Encoding unnatural amino acids via evolution of a quadruplet-decoding ribosome," Nature, 464/5287, 18 March, p441-444.

Nisbett, R. E. (2003) The Geography of Thought, New York, Tree Press.

Nitz, D. (2009) "The inside story on place cells," Nature, 461/7266, 15 Oct., p889-890.

Norman, D. A. (1988) The Psychology of Everyday Things, New York, Basic Books.

Nowak, M. A. (2008) "Generosity: A winner's advice," Nature, 456/7222, 4 Dec., p579.

Nunn, C. (2005) de la Mettrie's Ghost, London, McMillan.

Odling-Smee, F. J. et al. (2003) Niche Construction (The Neglected Process in Evolution), Princeton, Princeton University Press.

Ohiorhenuan, I. F. et al. (2010) "Sparse coding and high order correlations in fine-scale cortical networks," Nature, 466/7306, 29 July, p617-621.

Oho, A. (2010) "Probing the secrets of the finest fiddles," Science, 328/5985, 18 June, p1468-1470.

Okasha, S. (2010) "Does diversity always grow?" (Review of D. W. McShea and R. N. Brandon Biology's First Law (The Tendency for Diversity and Complexity to Increase in Evolutionary Systems, University of Chicago Press 2010), Nature, 466/7304, 15 July, p318.

Olhausen, B. A. and M. R. DeWeese (2010) "The statistics of style," Nature, 463/7284, 25 Feb., p1027-1028.

Omenetto, F. G. and D. L. Kaplan (2010) "New opportunities for an ancient material," Science, 329/5991, 30 July, p528-531.

Oswald, A. J. and S. Wu (2010) "Objective confirmation of subjective well-being: Evidence from the USA," Science, 327/5965, 29 Jan. p576-579.

Ourousoff, N. (2006) "Shanty town as a new suburban ideal," NY Times, March 12.

Ourousoff, N. (2010) "Plan to decentralize Haiti," NY Times, March 31.

Oxman, R. (1977) Flexibility in Supports: An Analysis of the Effect of Selected Physical Variables Upon the Flexibility of Support Type Housing Systems, D. Sc., Dissertation, Technion-Israel Institute of Technology, Haifa.

Oxman, R. M. et al. (1995) Design Research in the Netherlands, Eindhoven, Faculty of Architecture, Planning and Building Science, Eindhoven University of Technology.

Pain, E. (2007) "European programs offer translational training," Science, 317/5840, 17 Aug., p968-969.

Palmer, L. and G. Lynch (2010) "A Kantian view of space," Science, 328/5985, 18 June, p1487-1488.

Patten, C. (2006) "Science answers "whys," technology works out "hows,"" Nature, 441/7094, 8 June, p69.

Pennisi, E. (2010) "Synthetic genome brings new life to bacterium," Science, 328/5981, 21 May, p958-959.

Parsons, J. and Y. Wand (2008) "A question of class," Nature, 455/7216, 23 Oct., p1040-1041.

Passini, R. (1984) Wayfinding in Architecture, New York, Van Nostrand Reinhold.

Patton, J. J. et al. (2006) "The primate amygdale represents the positive and negative value of visual stimuli during learning," Nature, 433/7078, 16 Feb., p865-870.

Perlez, J. (2004) "Where pagodas draw tourists, concrete is unwelcome," NY Times, July 8.

Peterson, T. H. et al. (2010) "Tissue engineered lungs for in vivo implantation," Science, 329/5991, 30 July, p538-541.

Petronis, A. (2010) "Epigentics as a unifying principle in the aetiology of complex traits and diseases," Nature, 465/7299, 10 June, p721-727.

Petroski, H. (2006) Success Through Failure: The Paradox of Design, Princeton University Press.

Plenio, M. B. (2009) "Less is more," Science, 324/5295, 17 April, p342-343.

Pinholster, G. and B. Han (2008) "In pursuit of cures researchers track impact of stress on brain," Science, 322/5906, 28 Nov., p1342.

Pinker, S. (1997) How the Mind Works, New York, W. W. Norton and Company.

Pinker, S. (2002) The Blank Slate (The Modern Denial of Human Nature, New York, Viking.

Plambeck, J. (2010) "A test of neuromarketing," NY Times, August 9.

Povolotskaya, I. S. and F. A. Kondrashov (2010) "Sequence space and the ongoing expansion of the protein universe," Nature, 465/7300, 17 June, p922-926.

Ramberg, P. J. (2010) "Imagination in Chemistry," (Review of A. J. Rocke Image and Reality, University of Chicago, 2010), Science, 329/5989, 16 July, p280-281.

Rapoport, A. (1977) Human Aspects of Urban Form, Oxford, Pergamon Press.

Rapoport, A. (1979a) "Pure research in architecture and urban planning," Wisconsin Architect, (Sept.), p5.

Rapoport, A. (1979b) Review of H. Caminos and R. Goethert, Urbanization Primer, Journal of Architectural Historians, vol. 30, no. 4, (Dec.), p402-403.

Rapoport, A. (1980) "Environmental preference, habitat selection and urban housing," Journal of Social Issues, vol. 36, no. 3, p118-134.

Rapoport, A. (1980/81) "Neighborhood homogeneity or heterogeneity," Architecture and Behavior, (Switzerland), vol. 1, no. 1, p67-77.

Rapoport, A. (1981) "Some thoughts on units of settlement," Ekistics, vol. 48, no. 291, (Nov./Dec.), p447-453.

Rapoport, A. (1982) "Urban design and human systems—on ways of relating buildings to urban fabric," in P. Laconte et al. (Eds.) Human and Energy Factors in Urban Planning: A Systems Approach, The Hague, Martinus Nijhoff, p161-184.

Rapoport, A. (1983a) "Development, culture change and supportive design," Habitat International, vol. 7, no. 5/6, p249-268.

Rapoport, A. (1983b) "Studious questions," The Architects Journal, (London), no. 43, vol. 178, (October 26), p55-57 (Reprinted in Architectural Record, Oct. 1984, p100 ff).

Rapoport, A. (1984) Book review of A. W. Sprin The Granite Garden, Urban Ecology, vol. 8, no. 4, (Dec.), p364-266.

Rapoport, A. (1986) "Settlements and energy: Historical precedents," in W. H. Ittelson et al. (Eds.) Cross-Cultural Research in Environment and Behavior, Tucson, University of Arizona, p219-233.

Rapoport, A. (1987a) "Statement for the ACSA 75th Anniversary (Jubilee) issue of JAE," Journal of Architectural Education, vol. 40, No. 2, p65-66.

Rapoport, A. (1987b) "Learning about settlements and energy from historical precedents," Ekistics, vol. 54, nos. 325-327, (July-Dec.), p262-268.

Rapoport, A. (1988) "Spontaneous settlements as vernacular design," in C. V. Patton (Ed.) Spontaneous Shelter, Philadelphia, Temple University Press, p51-77.

Rapoport, A. (1989) "On the attributes of tradition," in J-P. Bourdier and N. Aesayyad (Eds.) Dwellings, Settlements and Tradition, Lanham, MD, University Press of America, p77-105.

Rapoport, A. (1990a) "Systems of activities and systems of settings," in S. Kent (Ed.) Domestic Architecture and the Use of Space, Cambridge, Cambridge University Press, p9-20.

Rapoport. A. (1990b) "Indirect approaches to environment-behavior research," The National Geographical Journal of India, vol. 36 (parts 1 and 2), (March/June), p30-46. Also in R. L. Singh and R. P. B. Singh (Eds.) Literature and Humanistic Geography, Varanasi (India), Banaras Hindu University (National Geographical Society of India, Research Publication 37) p30-46.

Rapoport, A. (1990c) History and Precedent in Environmental Design, New York, Plenum.

Rapoport, A. (1990d) "Defining vernacular design," in M. Turan (Ed.) Vernacular Architecture (Paradigms of Environmental Response), Aldershot, UK, Avebury, p67-101.

Rapoport, A. (1990e) "Science and the failure of architecture," in I. Altman and K. Christensen (Eds.) Environment and Behavior Studies (Emergence of Intellectual Traditions), (Vol. 11 of Human Behavior and Environment), New York, Plenum, p79-109.

Rapoport, A. (1990f) The Meaning of the Built Environment, Tucson, University of Arizona Press.

Rapoport, A. (1990g) "Levels of meaning and types of environments," in Y. Yoshitake et al. (Eds.) Current Issues in Environment-Behavior Research (Proceedings, 3rd Japan-US Seminar, Kyoto), Tokyo, University of Tokyo, p135-148.

Rapoport, A. (1992a) "On cultural landscapes," Traditional Dwellings and Settlements Review, vol. 3, no. 2 (Spring), p33-47.

Rapoport, A. (1992b) "On regions and regionalism," in N. C. Markovich, W. F. E. Preiser and F. G. Sturm (Eds.) Pueblo Style and Regional Architecture, New York, Van Nostrand Reinhold, p272-294 (Paperback Edition Only).

Rapoport, A. (1993a) Cross-Cultural Studies and Urban Form, (The 1992 Lefrak Lectures), College Park, MD, University of Maryland, Urban Studies and Planning Program.

Rapoport, A. (1993b) "On the nature of capitals and their physical expression," in J. Taylor et al. (Eds.) Capital Cities: International Perspectives, Ottawa, Carleton University Press, p31-67.

Rapoport, A. (1994a) Sustainability, Meaning and Traditional Environments, Berkeley, CA, Center for Design Research, University of California, Traditional Dwellings and Settlements Working Paper Series, vol. 75 (IASTE 75-94).

Rapoport, A. (1994b) "A critical look at the concept 'place,'" National Geographical Journal of India, vol. 40 (Parts 1-4), p31-45; also in R. P. B. Singh (Ed.) The Power of Place: Discourse, Sacrality and City Images, Varanasi, Banaras Hindu University Press, p31-45.

Rapoport, A. (1995a (1967a)) "Whose meaning in architecture?" in A. Rapoport, Thirty-Three Papers in Environment-Behavior Research, Newcastle (UK) Urban International Press, p13-22.

Rapoport, A. (1995b (1967b)) "Some consumer comments on a designed environment," in A. Rapoport, Thirty-Three Papers in Environment-Behavior Research, Newcastle (UK) Urban International Press, p1-11.

Rapoport, A. (1995c (1983)) "Debating architectural alternatives," in A. Rapoport, Thirty-Three Papers in Environment-Behavior Research, Newcastle (UK), Urban International Press, p359-371.

Rapoport, A. (1995d (1989)) "A different view of design," in A. Rapoport, Thirty-Three Papers in Environment-Behavior Research, Newcastle (UK), Urban International Press, p457-470.

Rapoport, A. (1995e (1990)) "Environmental quality and environmental quality profiles," in A. Rapoport, Thirty-Three Papers in Environment-Behavior Research, Newcastle (UK), Urban International Press, p489-512.

Rapoport, A. (1995f (1990/91)) "Flexibility, openendedness and design," in A. Rapoport, Thirty-Three Papers in Environment-Behavior Research, Newcastle (UK), Urban International Press, p529-562.

Rapoport, A. (1995g) "On the nature of design," Practices, Issue 3/4 (Spring) p32-43.

Rapoport, A. (1995h) "Rethinking design," in E. Schaur (Ed.) Building with Intelligence, ILF, University of Stuttgart, IL 41, p236-242.

Rapoport, A. (1995i) "A critical look at the concept 'home,'" in D. N. Benjamin (Ed.) The Home: Words, Meanings and Environments, Aldershot (UK), Avebury, p25-52.

Rapoport, A. (1996) "On globalization and cultural landscapes," Korea Landscape Architecture, 99, (July), p172-175.

Rapoport, A. (1997a) "Theory in environment-behavior studies: Transcending times, settings and groups," in S. Wapner et al. (Eds.) Handbook of Japan-U.S. Environment-Behavior Research (Toward a Transactional Approach), New York, Plenum, p399-421.

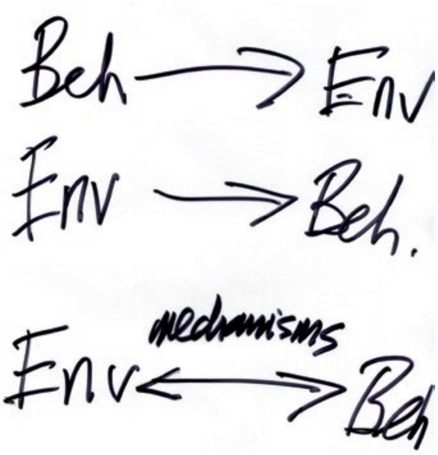
Rapoport, A. (1997b) "The nature and role of neighborhoods," in M. Shokoohy (Ed.) Urban Design Studies, vol. 3, London, School of Architecture and Landscape, University of Greenwich, p93-118.

Rapoport, A. (1998) "Using 'culture' in housing design," Housing and Society, vol. 25, no. 1, (Out summer 1999), p1-20.

Rapoport, A. (1999a) "A framework for studying vernacular design," Journal of Architectural and Planning Research, vol. 16, no. 1 (Spring), p52-64.

Rapoport, A. (1999b) "Against 'criticism,'" in G. Z. Zafripoulos (Ed.) Orion (vol. 2), Thessaloniki (Greece), Faculty of Architecture, Polytechnic University, p379-389.

Rapoport, A. (2000a) "On the perception of urban landscapes," Urban Design Studies, vol. 6, London, School of Architecture and Landscape, University of Greenwich, p129-148.



Rapoport, A. (2000b) "The role of neighborhoods in the success of cities," Ekistics (Triple issue out 2003), vol. 69, no. 412-414 (Jan.-June), p145-151.

Rapoport, A. (2000c) "Theory, culture and housing," Housing, Theory and Society, vol. 17, no. 4, p145-165.

Rapoport, A. (2000d) "Science, explanatory theory and environment-behavior studies," in S. Wapner et al. (Eds.) Theoretical Perspectives in Environment-Behavior Research: Underlying Assumptions, Research Problems and Methodologies, New York, Kluwer Academic/Plenum, p107-140.

Rapoport, A. (2000e) "On the size of cultural groups," Open House International, vol. 27, no. 3 (Sept.) p7-11.

Rapoport, A. (2001) "Architectural anthropology or environment-behavior studies?" in M-J. Amerlinck (Ed.), Architectural Anthropology, Westport, CT, Bergin and Garvey, p27-41.

Rapoport, A. (2002a) "Traditional environments, culture and preservation," in H. Turgut and P. Kellett (Eds.) Traditional Environments in a New Millennium, Istanbul, Istanbul Technical University IAPS-CSBE, p26-32.

Rapoport, A. (2002b) "Environment-behavior research in an Asian-Pacific context," Journal of Asian Urban Studies, vol. 3, no. 3 (March), p17-20.

Rapoport, A. (2005a) Culture, Architecture and Design, Chicago, Locke Scientific.

Rapoport, A. (2005b) "On using "home" and "place,"" in G. D. Rowles and H. Chaudhury (Eds.) Home and Identity in Late Life (International Perspectives), New York, Springer, p. 343-360.

Rapoport, A. (2006a) "Vernacular design as a model system," in L. Asquith and M. Vellinga (Eds.) Vernacular Architecture in the 21st Century: Theory, Education and Practice, Abingdon, Oxon (UK), Taylor and Francis, p179-198.

Rapoport, A. (2006b) "Local environments in a global context," Ekistics, vol. 73, no. 436-441 (Jan.-Dec.), p122-131.

Rapoport, A. (2007) "The nature of the courtyard house: A conceptual analysis," Traditional Dwellings and Settlements Review, vol. 18, no. 2 (Spring) p57-72.

Rapoport, A. (2008a) "Environment-behavior studies: Past, present and future," Journal of Architectural and Planning Research, vol. 25, no. 4 (Winter), p276-281.

Rapoport, A. (2008b) "Mind, land and society in an environment-behavior perspective," Arquitectonics 15, (Barcelona, Edicions UPC), p33-61.

Rapoport, A. (2008c) "Some further thoughts on culture and environment," International Journal of Architectural Research, vol. 2, issue 1 (March), p16-39.

Regis, E. (2008) What is Life? (Investigating the Nature of Life in the Age of Synthetic Biology), New York, Farrar, Strauss and Giroux.

Resulaj, A. et al. (2009) "Changes of mind in decision-making," Nature, 461/5261, 10 Sept., p263-266.

Revkin, A. C. (2006) "String theory," NY Times, Nov. 28.

Reynolds, J. D. and R. F. Freckleton (2005) "Population dynamics: Growing to extremes," Science, 309/5734, 22 July, p567-568.

Robinson, A. (2010) "Chemistry's visual origins," (Review of A. J. Rocke, Image and Reality, University of Chicago 2010), Nature, 465/7294, 6 May, p36.

Robinson, J. W. (2006) Institution and Home: Architecture as a Cultural Medium, Amsterdam, Techne Press (Transformations 7).

Rotenberg, R. and G. McDonogh (Eds.) (1993) The Cultural Meaning of Urban Space, Westport, CT, Bergin and Garvey.

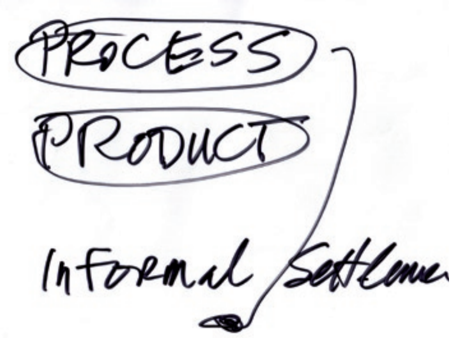
Röthlisberger, D. et al. (2008) "Kemp-elimination catalysts by computational enzyme design," Nature, 453/7192, 8 May, p228-232.

Russell, R. J. (1993) The Lemur's Legacy (The Evolution of Power, Sex and Love), New York, G. P. Putnam's Sons.

Santos, F. (2009) "Fewer Hasidim backed mayor, study finds," NY Times, Nov. 16.

Sasaki, E. et al. (2009) "Generation of transgenic non-human primates with germline transmission," Nature, 459/7246, 28 May, p523-527.

Sastrosasmita, S. and A. T. M. Nurul Amin (1996) "Housing needs of informal sector workers: The case of Yogyakarta, Indonesia," Habitat International, vol. 14. no. 4, p75-88.



Schatten G. and S. Mitalipov (2009) "Transgenic primate offspring," Nature, 459/7246, 28 May, p515-516.

Schofield, A. J. (2010) "The emergent and hidden unveiled," Nature, 465/7298, 3 June, p553-554.

Schuger, A. et al. (2010) "Reproducibility distinguishes conscious from non-conscious neural representations," Science, 327/5961, 1 Jan., p97-99.

Schwartzkopf, D. S. and G. Rees (2010) "Brain activity to rely on," Science, 327/5961, 1 Jan., p43-44.

Service, R. F. (2008) "Framework materials grab CO2 and research attention," Science, 319/5865, 15 Feb., p893.

Service, R. F. (2010) "Next wave of metamaterials hopes to fuel the revolution," Science, 327/5962, 8 Jan., p138-139.

Shapley, R. (2009) "Gene therapy in colour," Nature, 461/7265, 8 Oct., p737.

Shekiev, V. M. (2008) "Transforming light," Science, 322/5900, 17 Oct., p384-385.

Shermer, M. (2008) The Mind of the Market, New York, NY Times Books.

Sherrill, B. M. (2008) "Designer atomic nuclei," Science, 320/5877, 9 May, p751-752.

Shokoohy, M. and N. H. Shokoohy (Eds.) (1994) Kirtipur, London, Araxus.

Shrestha, U. S. et al. (1997) "Social effects of land use change in Kirtipur, Nepal," in M. Shokoohy (Ed.) Urban Design Studies, vol. 3, London, School of Architecture and Landscape, University of Greenwich, p51-73.

Siebert, C. (2006) "The animal self," NY Times Magazine, Jan. 22, p48 ff.

Siegel, D. A. and B. A. Franz (2010) "Century of phytoplankton change," Nature, 466/7306, 29 July, p569-571.

Siegel, J. B. et al. (2010) 'Computational design of an enzyme catalyst for a stereoselective biomolecular Diels-Alder reaction," Science, 329/5989, 16 July, p309-313.

Sigman, D. M. et al. (2010) "The polar ocean and glacial cycles in atmospheric CO2 concentration," Nature, 466/7302, 1 July, p47-54.

Silva, K. D. (2001) Advances in Environmental Cognition Research 1980-2000), Department of Architecture, University of Wisconsin-Milwaukee, Ph.D. term paper (Unpublished).

Singh, I. and N. Rose (2009) "Biomarkers in psychiatry," Nature, 460/7252, 9 July, p202-207.

Singh, S. and E. Ernst (2009) Trick or Treatment (The Undeniable Facts About Alternative Medicine), New York, W. W. Norton and Company (Paperback edition).

Slack, J. M. W. (2009) "Emerging market organisms," (Review of Cold Spring Harbor Laboratory, Emerging Model Organisms (A Laboratory Manual, Vol. 1, 2009), Science, 323/5922, 27 March, p1674-1675.

Smaglik, P. (2004) "Pitching ideas," Nature, 427/8976, 19 Feb., p759.

Smith, M. L. (Ed.) (2003) The Social Construction of Ancient Cities, Washington, DC, Smithsonian Books.

Sokolowski, M. B. (2002) "Social eating for stress," Nature, 419/6910, 31 Oct., p893-894.

Solso, R. L. (2003) The Psychology of Art and the Evolution of the Conscious Brain, Cambridge, MA, MIT Press.

Song, C. et al. (2010) "Limits of predictability in human mobility," Science, 327/5968, 15 Feb., p1018-1021.

Starr, P. (1982) The Social Transformation of American Medicine, New York, Basic Books.

Stevens, G. (1998) The Favored Circle (The Social Foundations of Architectural Distinction, Cambridge, MA, MIT Press.

Ston, A. J. (2008) "Intermolecular potentials," Science, 321/5890, 8 Aug., p787-789.

Stresz, D. (2008) "Social work Agonistes," Academic Questions, vol. 21, no. 2, Spring, p164-182.

Stricker, J. (2008) "A fast, robust and tunable synthetic gene oscillator," Nature, 456/7221, 27 Nov., p516-519.

Stringer, P. (1975) "The myths of architectural creativity," Architectural Design 45, October.

Strogatz, S. (2009) "Math and the city," International Herald Tribune, May 23-24.

Suchar, C. S. and R. Rotenberg (1988) "Judging the adequacy of shelter: A case from Lincoln Park," Paper presented at the meeting of the Society for Applied Anthropology, Tampa, Florida (Mimeo).

Sugden, R. (2010) "Identity Matters," (Review of G. A. Akerlof and R. E. Kranton (2010) Identity Economics (How Our Identities Shape Our Work, Wages and Well-Being), Princeton, NJ, Princeton University Press), Science, 328/5981, 21 May, p978.

Superti-Furg, G. (2008) "A network solution," Nature, 455/7214, 9 Oct., p730-731.

Susskind, L. (2008) The Black Hole War, New York, Little Brown and Company.

Szathmàry, E. and S. Számadó (2008) "Language: A social history of words," Nature, 456/7218, 6 Nov., p40-41.

Szigeti, F. and G. Davis (2006) "Application of EDR in practice (1965 to 2006—Forty years of practice at "bridging the gap"), Unpublished paper, International Center for Facilities, Ottawa, Ontario, Canada.

Szpiro, G. G. (2007) Poincaré's Prize (The Hundred-Year Old Quest to Solve One of Math's Greatest Puzzles), New York, Dutton.

Taubes, G. (1997) "Center seeks synthesis to make ecology more useful," Science, 275/5298, 17 Jan., p310-311.

Tero, A. et al. (2010) "Rules for biologically inspired adaptive network design," Science, 327/5964, 22 Jan., p439-442.

Thiel, P. (1997) People, Paths and Purposes (Notations for a Participatory Envirotecture), Seattle, University of Washington Press.

Thiel, P. and G. Nitzschke (1968) "Entwicklung einer modernen darstellungs methode bewegungstzeit und Stimunge-structurierten umwelterlebenisses," Bauen + Wohnen, December.

Tipple, G. (2000) Extending Themselves (User-Initiated Transformations of Government-Built Housing in Developing Countries), Liverpool, Liverpool University Press.

Troy, P. N. (1996) The Perils of Urban Consolidation (A Discussion of Australian Housing and Urban Development Policies), Sydney (Australia) Federation Press.

Tsien, J. Z. (2007) "The memory code," Scientific American, vol. 297, no. 1, p52 ff.

Turchin, P. (2003) Historical Dynamics, (Why states rise and fall), Princeton, Princeton University Press.

Turchin, P. (2007) War and Peace and War (The Rise and Fall of Empires), New York, Plume Books.

Turchin, P. (2008) "Arise 'Cliodynamics,'" Nature, 454/7200, 3 July, p34-35.

Turner, J. S. (2007) The Tinkerer's Apprentice: How Design Emerges From Life Itself, Cambridge, MA, Harvard University Press.

Valentine, J. (2008) "Three-dimensional optical metamaterial with a negative refractive index," Nature, 455/7211, 18 Sept., p376-379.

van Schaik, C. (2004) Among the Orangutans—Red Apes and the Rise of Human Culture, Cambridge, MA, Belknap Press of Harvard University Press.

van Zante, D. (1977) "Architectural composition at the École des Beaux Arts from Charles Percier to Charles Garnier," in A. Drexler (Ed.) The Architecture of the École des Beaux Arts, New York, Museum of Modern Art.

Venturi, R. (1966) Complexity and Contradiction in Architecture, New York, Museum of Modern Art.

Vicsek, T. (2010) "Closing in on evaders," Nature, 466/7302, 1 July, p43-44.

von Frisch, K. (1974) Animal Architecture, New York, Harcourt, Brace Evanovich.

Wagner, W. R. and B. P. Griffith (2010) "Reconstructing the lung," Science, 329/5991, 30 July, p520-522.

Wald, C. (2008) "Crazy Money," Science, 322/5908, 12 Dec., p1624-1626.

Wender, P. A. and B. L. Miller (2009) "Synthesis at the molecular frontier," Nature, 460/7252, 9 July, p197-201.

Wenner, M. (2008) "Magnifying taste," Scientific American, 299/2, 2 Aug, p96-99.

West, P. (2010) "Learning from game theory," Nature, 465/7300, 17 June, p871-872.

West, S. A. and A. Gardner (2010) "Altruism, spite and greenbeards," Science, 327/5971, 12 March, p1341-1344.

Wilczek, F. (2008) The Lightness of Being, New York, Basic Books.

William, L. E. and J. A. Bargh (2008) "Experiencing physical warmth promotes interpersonal warmth," Science, 322/5901, 24 Oct., p606-607.

Winther-Jensen, B. et al. (2008) "High rate of oxygen reduction over a vapor-phase polymerized PEDOT electrode," Science, 321/5882, 1 Aug., p671-674.

Wilson, E. O. (1998) Consilience (The Unity of Knowledge), New York, Knopf.

Wynn, C. G. et al. (2009) "A neutron star with a carbon atmosphere in the Cassiopeia A. supernova remnant," Nature, 462/7269, 5 Nov., p71-73.

Yi Lu et al. (2009) "Design of functional metalloproteins," Nature, 460/7257, 13 Aug., p855-862.

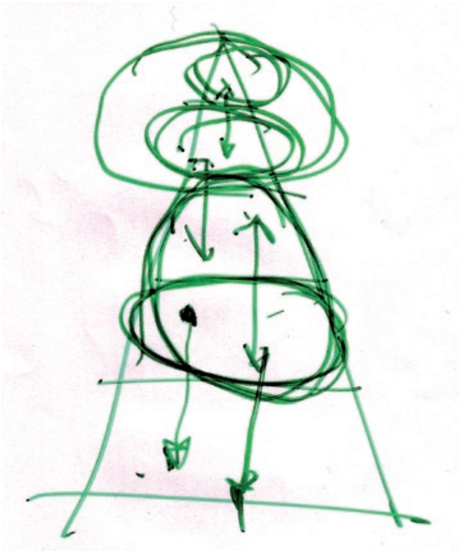
Young, L. J. (2009) "Love: Neuroscience reveals all," Nature, 457/7226, 8 Jan., p148.

Zahn, D. (2005) "Learning, translating and implementing CPTED," Journal of Architectural and Planning Research, vol. 22, no. 4 (Winter), p284-293.

Zeki, S. (1999) Inner Vision (An Exploration of Art and the Brain), Oxford, Oxford University Press.

Zerubaval, E. (2003) Terra Cognita (The Mental Discovery of America) Brunswick, NJ, Transaction Publishers, (original 1992).

Zimmer, C. (2008) Microcosm: E. Coli and the New Science of Life, New York, Pantheon Books.



From Vernacular to High Design

Extending Some Aspects of "House Form and Culture"

Franco Frescura

Vom vernakulären zum modernen Entwurf – in Anlehnung an „Hausform und Kultur"

Dieser Beitrag führt einige Aspekte von „Hausform und Kultur", dem Meisterwerk von Amos Rapoport weiter. In den 1970er Jahren, der Hochphase der Studien zur 'anonymen Architektur', besannen sich viele Architekten der Bedeutung traditionellen Bauens als Lektion für naturnahes und menschengerechtes Wohnen. Amos Rapoport war einer der ersten Autoren, der 1969 ein theoretisches Modell für die sogenannte „vernakuläre Architektur" anbot, die er zwischen primitiver und moderner Architektur ansiedelte und die er in den sozio-ökonomischen Kontext der Entwicklung von der Agrargesellschaft über die vorindustrielle hin zur modernen Produktionsweise setzte. Die Grenzen zwischen den Modellen waren bewusst nicht klar gezogen, aber sind nach wie vor gültig. Der hier folgende Beitrag versucht, die Abgrenzungen zu präzisieren und mit einem Modell zu kombinieren, das dabei die Rollenverteilung zwischen Handwerkern, Bauherren und Planern in der Produktion der gebauten Umwelt definiert.

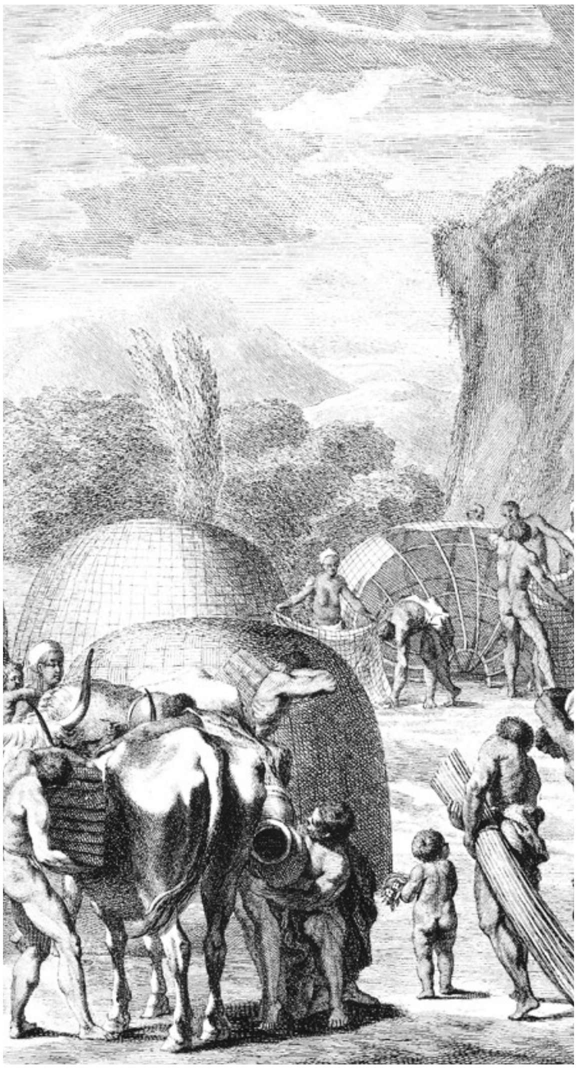


Figure 1: Khoikhoi settlement, 1727. Early hunter-gatherers and migrant pastoral societies employed dwellings that were simple to erect and could be transported on the back of a pack animal.

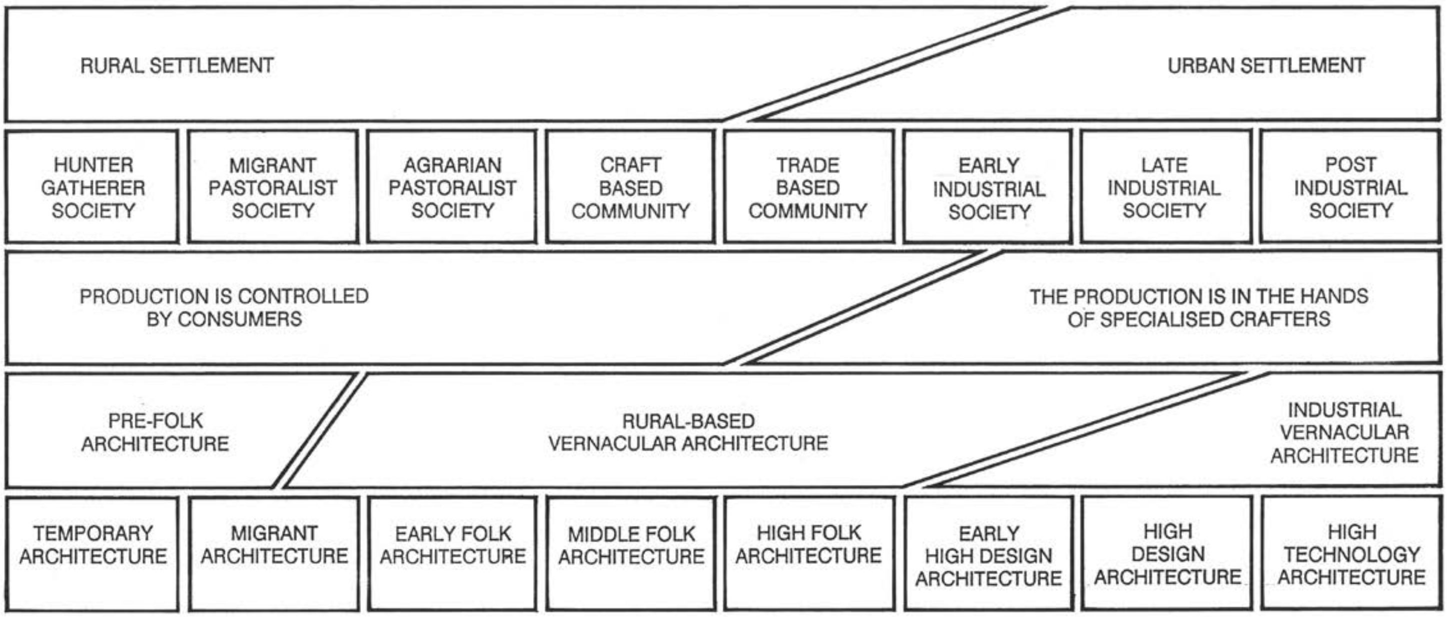
Producer vs. Consumer

Because of the difficulties involved in creating hierarchies and stereotypes based upon building technology, the phases which follow are based upon a range of economic activities and the kind of architectures that each has given rise to. This does not mean to say that any one community can only be described in terms of one specific mode of production. A farming pastoralist group, for example, may have hunter-gathering, migrant pastoral, craft and trading functions in its economic make-up. Each one of these activities, however, is typified by particular attitudes and sets of values towards the structures needed to house them, giving rise in each case to building types that are identifiable as belonging to a particular aspect of their economic life.

Also, as is seen in the enclosed diagram, the transition between one stage and the next is seldom clear-cut, and may involve a number of overlaps in time, technology, and social attitudes. These areas of social-economic activity have been drawn as follows:

a. Hunting and gathering.

These are staple economic activities generally associated with regions of impoverished land resources, or with societies lacking in basic agrarian skills. In spite of the fact that hunter-gatherers generally build shelters which are impermanent, often roughly constructed and easily discarded, they are also known to have included a number of other dwelling forms in their architectural vocabulary. Hunter-gathering societies in the southern African region, for example, were not static but had a dynamic interrelationship with neighbouring groups that followed a migrant pastoral economy (Elphick 1977). For any number of reasons a group could evolve into the next economic system and could, just as easily fall upon hard times, and devolve back again. For this reason visitors to the region



during the late eighteenth and early nineteenth centuries were unable, in many cases, to differentiate between the dwellings of the hunter-gathering San and those of the migrant pastoral Khoikhoi (Burchell 1953, Barrow 1801, and others). It is also recorded that over a century ago the Masarwa, a San group living on the fringes of the Karoo, were building their dwellings, albeit imperfectly, in the manner of their Tswana neighbours (Campbell 1815). This, however, may have been the result of their society moving into a more sedentary pastoral farming mode of production rather than as a result of cultural transmissions.

b. Migrant pastoral activities

are generally associated with regions of impoverished land resources and low rainfalls where pasturage is sparse and must be conserved to prevent encroaching desertification. This necessitated the development of an early cattle-based economy in which farming groups were forced to make frequent moves from one grazing place to the next. As a result residents of such areas evolved a sophisticated form of portable dwellings that could be rapidly deployed according to their nomadic needs (Burchell 1953). Although it is true that their range of forms was somewhat limited, this must be attributed to the limitations of building materials available rather than to local levels of technological development.

c. Sedentary agricultural pastoralists.

The evolution of a migrant pastoral economy into one based upon more sedentary agricultural pastoral activities was normally conditioned by increased competition for pastoral resources together with an availability of land suitable for planting. This was generally accompanied by the development of legal concepts relating to land tenure, as well as social value systems identifying the dwelling as a permanent fixture in the rural landscape. This means that, during this stage, architecture becomes, among other things, a marker of land holding, with implications of group identity, of heritage, of inheritance, of spiritual belief, and of social continuity. Although agrarian pastoral activi-

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Figure 2: Venda farmers, c. 1910. The tradition of self-built architecture was continued in settled farming communities, where dwellings were of a more permanent nature but continued to use natural materials in their construction.

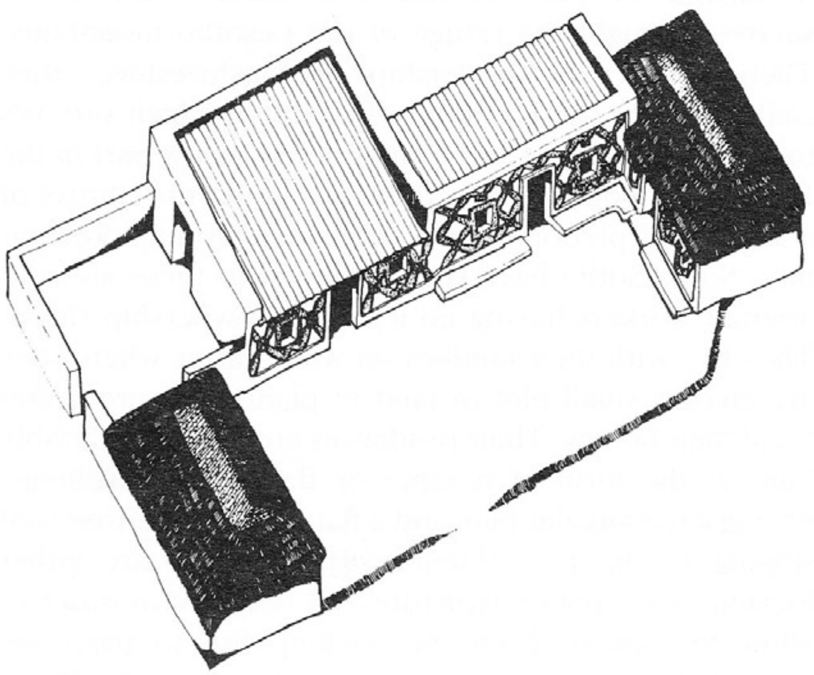


Figure 3: Basuto household, South Africa, 1980. The introduction of new materials often created tensions between vernacular building technologies and new materials, frequently leading to inventive adaptations to the building forms.

ties were often housed in a variety of structures, these were marked by their nature and materials of construction, both of which have an implied element of identity. It is probable that early agricultural pastoralists relied upon grazing activities to a great degree and that therefore these farmers erected lightly-built dwellings based upon a timber and grass technology which, although difficult to move, still retained a measure of mobility. In time, increased population densities reduced such options, making the movement of settlement impractical and wasteful of resources. Late agricultural pastoral communities were therefore marked by an increasing reliance upon planting, producing an architecture that made increasing use of materials such as stone and clay. Their settlements were also strongly structured along formal lines of social, family, gender and age hierarchies. During this, as well as preceding stages, the roles of a consumer, or client, as well as that of the producer, or builder, was filled by the same person or by members of the same family. Although the technical expertise of the "better" thatcher or the more "proficient" builder were often recognised and publicly lauded, such skills were seldom the subject of specialization or given to specific economic reward. Every person in the community was knowledgeable of the tasks involved in the building process and, given the limits of gender and age specialization, was able to perform them in the construction of their dwellings.

d. Craft manufacturing economies

have their roots in the production of functional artefacts for the internal consumption of an agricultural pastoral community. In time, a combination of exclusive access to materials as well as increasing skill of production induced farmer-manufacturers to barter their surpluses with groups holding similar monopolies. The changeover from an agrarian economic system to one of manufacture was therefore gradual, and only took place once a hierarchy of values had been established in the bartering process, usually through the introduction of a rudimentary monetary system. Manufacture also encouraged settlement based upon an availability of resources which, when combined with an access to markets, generated small urban growth. In most cases, however, craft production remained focussed upon the rural homestead. The creation of small agrarian-based communities of crafters brought about specific changes in their architecture. Initially, crafted objects remained within the home, but as their scope of production grew, so then manufacturing activities spread into specialist buildings. Because of their nature, these often posed a threat to the village, both through pollution and fire. This was most particularly true in the case of butcheries and smithies, whose activities were fundamental to the success of early settlement, and it seems probable that the regulation of such activities lay at the heart of later land use regulations. It also seems

Figure 4: Trading store, South Africa, c. 1900. Agents of change in indigenous custom could often be found in various guises, including traders, missionaries and local farmers.

Figure 5: Cape farmhouse, c. 1910. Often builder/owners were able to make changes to their floor plan whilst retaining the use of traditional building materials.

probable that a fear of fire induced some communities to introduce more permanent, and less flammable, materials in their construction, moving away from timber and thatch to stone, clay and slate.

The social values based upon family, group, clan and gender hierarchies, which formerly played an important role in the structuring of rural settlement, were replaced by ones focusing upon the social, religious and economic life of the community. In this way the common, the church and the market place began to gain architectural substance and planning recognition ahead of family spaces and clan structuring. In the process, though, the latter also began to also lose spiritual significance and symbolic value, as many of the spatial concepts of "home" began to be transferred to the community's public spaces. It was at this stage, then, that the first buildings of a community nature began to find a place in the lexicon of local architecture.

For the purposes of this analysis, the architecture of this era can be grouped into two distinct phases. During the first it is probable that, in most cases, the roles of producer and consumer in the building process remained essentially unaltered from that of previous eras. It is true that this period saw the rise of specialized builders-craftsmen, specifically experts in roofing, stone carving and carpentry, but both builder and client shared the same building language and traditions and, if necessary, the owner could conduct the work without expert assistance. This condition began to break down during the course of the second phase, when an increasing separation between agrarian and manufacturing activities encouraged the specialization of building functions into separate skills or schools, eventually resulting in the development of a system of guilds.

e. Trade-based communities.

The shift from a craft-based to a trade-based community signalled the end of reliance upon agrarian methods of production and marked a gradual transition to manufacturing. The centre of social and economic activity became the town, which served not only the needs of its residents but also those of the surrounding region. The centralization of facilities created a focus of administration as well as resources, requiring protection and hence fortification. This led to the creation of two new classes of citizens, the professional soldier and the administrator, neither of whom could, strictly speaking, be classed as being capable of either producing food or of contributing to the community's stock of trade goods. As consumers, their existence in a trade-based society could only be justified once the social group as a whole was able to produce sufficient surpluses as to make their presence affordable. This obviously represents a simplification of their status, for the strength and success of the Roman Republic could only be maintained for as long as the patrician and military classes continued to manage extensive commercial farming estates, and agricultural lands continued to be made available for the settlement of its military veterans. It is also a gross contraction of time, for as late

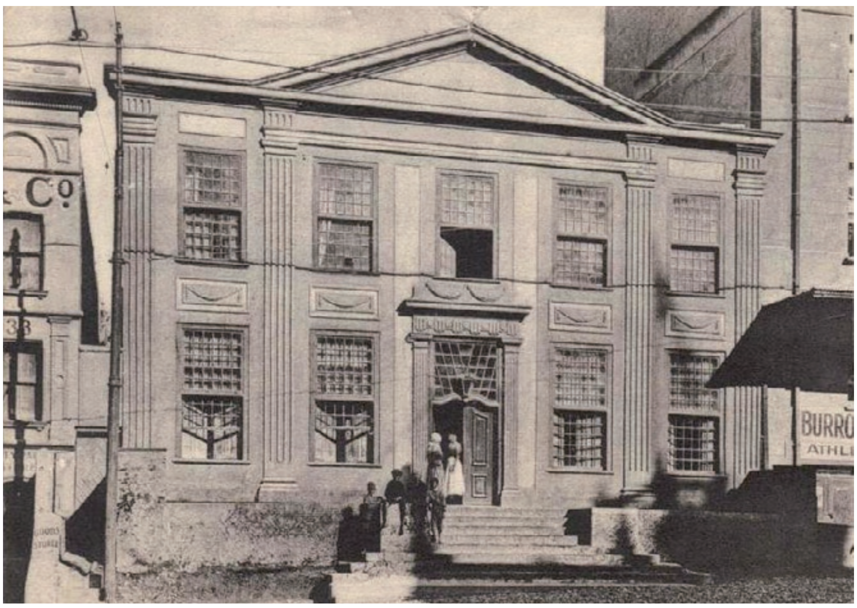
Figure 6: Groot Constantia, Cape Town, c. 1910. Built in the 18th century, this substantial farmhouse continued the tradition of earlier peasant architecture by using traditional materials whilst moving to a new scale of construction.

as the 1400s European armies relied heavily upon the continued supply of arms and men from their agricultural sectors. In general, though, the establishment of a class of food consumers, who took no part in the production of crops, could only take place once the group as a whole had achieved levels of production sufficient to generate surpluses.

Another factor that needed to be dealt with concurrently was the fact that the consolidation of populations into urban centres of production inevitably led to higher population densities within the city and, consequently, to competition for available living space. This necessitated the replacement of flammable building materials as well as the invention of new structural technologies to facilitate the vertical spread of residences to two or more storeys. In spite of this, building methods and materials remained linked with those used in the immediate countryside. Increased densities also required the introduction of specialist infrastructures for the supply of potable water and the removal of wastes. During this time, the market, the square and the church or temple were confirmed as primary foci of social activity in the town.

Not unnaturally, an increased specialization in the manufacturing sector also brought about the separation of building functions into a number of distinct trades. This was encouraged by the rise of guilds in other areas of production, as well as the introduction of new building methods to facilitate multi-storey construction. During this time the roles of client and builder became therefore irrevocably separated. Although during the early stages of this era both parties shared in a common knowledge of the local architectural language and its building tradition, by its end the gap between consumer and producer had widened to the point where the client ceased to be an active participant in the building process. The division between consumer and producer was bridged by the rise of a new profession, the specialist designer, although during this time this role was fulfilled by the master crafter, usually the project mason or carpenter.

Figure 7: De Waal House, Cape Town, c.1910. The construction of traditional forms in urban areas often brought about dramatic changes to the aesthetic of vernacular forms whilst retaining substantially the same use of indoor spaces.



f. Early industrial economies.

During the early stages of industrial economic development, the focus of the community's primary economic activities continued to shift at an increasing pace from the countryside to the town. Not only did the urban areas act as major generators of employment and wealth but, as happened in many historical instances, they also become havens for peasants and rural crafters fleeing land dispossession, rural poverty, increasing capitalization of farming activities, unequal distributions of the tax burden, and oppressive feudal socio-political systems.

Although the urban guild system was relatively difficult for outsiders to enter, the opportunities for economic development in the town were infinitely preferable to the conditions prevailing in the countryside. The architecture of this period largely continued the building traditions of the previous era. However, it also marked a breakpoint with its rural roots, both technological and aesthetic. Much of the domestic and infrastructural work was still being conducted under the guidance of master builders, but, at about this time, the new profession of the architect began to gain ground as part of a newly-established beaux arts tradition separate from the guild system. However, the scope of the architect-artist remained limited to the design of larger public works as well as the homes of the rich, the powerful and the ostentatious.

g. Late industrial economies.

The rise of an industrial society heralded the virtual end of land-based craft manufacture and brought about the centralization of all such activities in urban areas. The concept of "craft" also began to disappear as, in most cases, machinery took over the production of artefacts on a mass basis. This breakdown was facilitated, on the rural side, by the introduction of mechanized capital-intensive modes of agricultural production, which made many small-scale marginal farmers and crafters uneconomical and forced them to migrate off their lands and into the cities. Faced with the loss of agricultural activity as a supplement to their income from small-scale manufacture, many crafters were left with little choice but to enter employment in urban areas where industry was being given the additional support of a growing railway infrastructure and the availability of new power sources, such as steam and electricity. During this period architecture abandoned all links with its historical rural roots. Faced with the needs of meeting the housing and infrastructural requirements of a growing urban population, the processes of building became increasingly industrialized.

However, the incorporation of industrial material in domestic architecture gave also rise to an aesthetic that is now sometimes referred to as "industrial vernacular". In the process, the small consumer lost all control of the production process, becoming part of an amorphous industrial proletariat to be dealt with on a mass basis. The disciplines of engineering and town planning emerged as design professions in their own right, competing with architecture in areas of structural and social design. Faced with this challenge, architects began to emphasize their roles as specialist designers and project managers. As a result, they shed many of their beaux arts links and, to a small degree, returned to the medieval ideal of placing a master crafter in charge of the project. At this stage, architecture ceased to be concerned predominantly with domestic structures and began to include an increasing range of building types to accommodate an increasingly wider range of human activities.

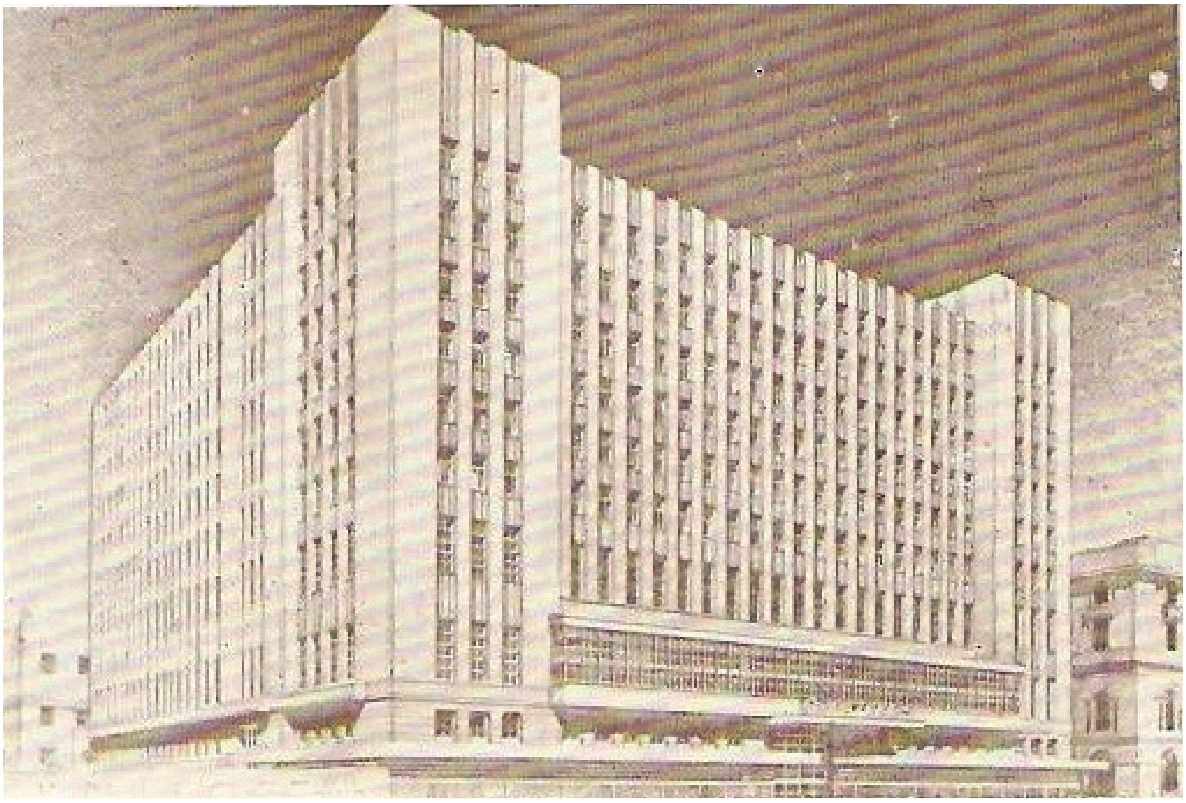


Figure 8: OK Bazaars, Cape Town, c. 1936. By the 1930s, the Modern Movement had brought about a final break between the vernacular tradition of previous eras and the use of new technologies so as to create buildings with a completely new aesthetic, and few or no links to the architecture of previous eras.

h. Post industrial economies.
During this final stage, societies began to move into modes of post-industrial economic activity, where building is dominated by industrial processes that emphasise technology and cash-intensive modes of production. These are supported by a wide range of newly-evolved specialist skills, and although architects retain a pivotal role in coordinating the design process, many of the guiding decisions are now being taken by technologists and town planners. The architect, however, becomes a mediator between the client and the team of specialist builders, and as such retains control, on behalf of the client, over the project. Unfortunately, this mediation is only possible where the consumer can afford the luxury of such specialist services, making the profession relevant only in those countries with a well-developed economy, or where the role of a specialist designer has been legislated into the building process. In other areas, where economic systems are either developing or under-developed, the services of the architect are limited to either a small number of high-profile projects or to large-scale buildings whose scale and technology are beyond the scope of local society.

Conclusions

Significantly, the history of industrial society may already have reached a point where a new stage of development can already be identified. Much of this has been driven by radical improvements in the field of communications, where the need for centralized places of work, developed over the last century, has been made obsolete with almost breathless rapidity. As cheap and accessible technologies have become available across the world, so then the definition of what constitutes “work” and a “workplace” has also changed, moving away from the cities and their incomprehensible buildings towards a more informal domestic environment. In the process, the concept of a Centralised Business District, a CBD, has become obsolete and irrelevant to the future of our cities. This means that such architectural building types as offices, banks, libraries, city halls, cinemas and retail stores have already become redundant, while such concepts as home and community spaces are currently undergoing revaluation. Others, such as museums, art galleries and theatres, have reached an acknowledged crisis point. .

In a larger sense this analysis has been concerned with the relationship, in the building process, existing between producer and consumer. Historically, the two roles were generally incorporated in the same person, and the client, who more often than not was also the builder, had an intimate knowledge of the building process and was aware of the type, style and form of the structure which was being erected. By way of contrast, virtually all building activity in urban areas was in the hands of specialist crafters. In some cases this was also enforced by legislation. More recently, clients have had no hand in, and usually even no knowledge of, the building process; and unless wealthy enough to be able to employ the services of a specialist designer, they have had only the most superficial of choices in the aesthetics of their dwellings. Often, the structure was purchased already completed much like an appliance at a retail store.

Rural architecture, on the other hand, short cuts the relationship that has been established in modern urban society between consumer and producer. Because it uses locally available materials, incorporating them into a highly functional structure and employing the cheapest labour possible, that of the client, it is both a functional and an economic way of building. It therefore offers a solution to at least some of the problems that beset the current provision of housing in the developing world, where the choice most often is not between a pretty house and an ugly house, but between having a house and no house at all.

References

Barrow, John (1801 and 1804) An Account of Travels into the Interior of Southern Africa. London: Cadell and Davies.

Burchell, William J. (1953) Travels in the Interior of Southern Africa. London: Batchworth Press.

Campbell, John (1815) Travels in South Africa. London: Black and Parry.

Campbell, John (1822) Travels in South Africa ... Being A Narrative of a Second Journey. London: Francis Westley.

Elphick, Richard (1977) Kraal and Castle: Khoikhoi and the Founding of White South Africa. Yale University Press.

Rapoport, Amos (1969) House Form and Culture. New Jersey: Prentice-Hall.

Cultural Identities, Social Cohesion and the Built Environment

Kosta Mathéy*

Kulturelle Identität, sozialer Zusammenhalt und gebaute Umwelt

Rapides Stadtwachstum in Verbindung mit den Auswirkungen der Globalisierung hat in vielen Ländern die kulturelle Identität der Städte zerstört und durch architektonische Monotonie ersetzt. Bürotürme, Wohnblöcke oder Einkaufszentren sehen inzwischen weltweit identisch aus. Gleichzeitig nimmt die soziale Segregation zu, was ein Widerspruch zu sein scheint, wenn man bedenkt, dass Homogenisierung und Differenzierung im Allgemeinen schwer zu vereinen sind. Um diesen Widerspruch zu verstehen und eine Alternative zu der allgemein als unerwünscht angesehenen Uniformisierung der Umwelt zu entwickeln, hilft uns eine genauere Besinnung auf die verschiedenen Einflussfaktoren, die traditionell die Formensprache unserer Städte und ihrer Häuser bestimmt haben. Das ist ein erster Schritt zur Wiedergewinnung von kultureller Identität, sozialem Zusammenhalt und architektonischer Reichhaltigkeit..

Cultural identity

Cultural identity, when referring to geographical characteristics, describes perceivable physical and non-physical differences between one place and another as found in vernacular buildings. Architectural theory and urban anthropology have identified a number of different factors that can explain diverse identities of place.

Amos Rapoport was probably the first and most widely published author to systematically analyse the roots of these differences in his book *House Form and Culture.*[1]

In the following article, I review some well-established as well as other more recently recognised influential elements.

Form follows function

This well-known paradigm represents a central philosophy that has reigned in architectural studies for many decades, starting with the 'modern movement' in the early years of the 20th century.[2] In fact, every architect usually analyses the different functional needs first before developing a plan, followed by sections and elevations. Similar functions, say social housing, tend to result in similar shapes all over the world. Even in the absence of architects, as in the case of squatter settlements, we easily get the impression that they look the same everywhere. Therefore, the paradigm 'form follows function' is somewhat convincing. However, we cannot ignore that too many cases exist where the same functions result in quite different types of buildings. Therefore, 'form follows function' does not tell the full story.

1
Rapoport, Amos (1969) *House Form and Culture.* Englewood Cliffs. NJ. Prentice-Hall.

2
The term was first coined by Luis Sullivan, representative of the Chicago School, in his essay 'The Tall Office Building Artistically Considered', published in 1896. It became a guiding principle in the Bauhaus movement from 1920 onwards.

Cultural identity: Hardly anybody could guess which city this skyline belongs to. It is, in fact, Vancouver

Cultural identity: Vernacular architecture in Hue, Vietnam

*This article is an abridged version of a paper given at the 54th IFHP Congress BUILDING COMMUNITIES FOR THE CITIES OF THE FUTURE hold at the PUCRS in Porto Alegre in November 2010.

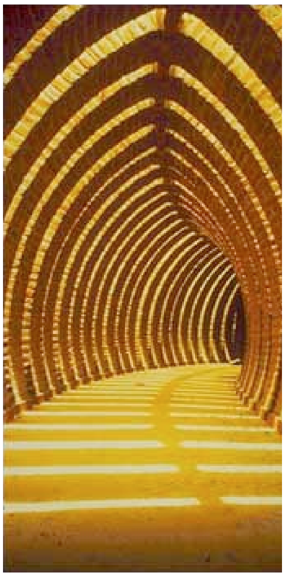
Form follows function: Informal housing in Sao Paulo, Brazil, 1977

Form follows function: Informal housing in Kibera, Kenya, 2009

Form follows function:? informal housing in Telal Zeinhoum, Egypt, 2000

Form follows material

For economic and practical reasons, it seems mandatory that builders are bound to use the locally available materials – except, maybe, for very prestigious buildings where costs do not matter. For example, in regions where timber is scarce, rooms tend to be covered by vaults and domes; and in ice-covered Alaska, igloos are a famous feature. But then, in places where timber is abundant, the architecture of houses still varies dramatically between different tribes and nations – or even in the same city. Therefore, material on its own, like function, does not provide a sufficient enough explanation to predict the shape of buildings.



Form follows income

As the previous two ideas suggest, even the prevailing use of a supposedly 'poor material' such as corrugated iron does not preclude architectural variety. If the owner can afford to engage a good architect, a high-standard building can be produced from corrugated iron. This observation suggests that the quality of the built environment is a direct result of the owner's income. However, authors such as John Turner have long made it clear that poor people are equally capable of expressing a high degree of aesthetics and fantasy in their self-built constructions, providing they produce for their own needs and are not guided by market interests or restricted by bureaucratic regulations. Thus, income – like function and material – does not necessarily imply a specific logic behind varying architectural expressions.

Form follows material: Arches and domes cover rooms where beams are not available: Fayoum in Egypt. Architect: Hassan Fathy

Form follows material: Arches provide shading in a desert area: Kaedi Hospital in Mauretania. Architect: Fabrizio Carola

Form follows material: Timber-frame house in Germany

Form follows material: ? Timber-frame house in London. Architect: Walter Segal

Form follows income: Architect designed corrugated iron house in San Jose, Costa Rica

Form follows income: Entry to a self-built home in La Guinera, Havana, Cuba

Form follows income: Self built home in a Township outside Pretoria, South Africa

Form follows topography: Living on water: Bangkok, Thailand

Form follows topography? Hillside architecture: Casa en pendiente in Caracas, Venezuela

Form follows topography? Strait flight of stairs in Villa el Salvador, Lima, Peru

Form follows topography: Hillside architecture…: Landscaped stairs in the Documenta Urbana Building Exhibition in Kassel, Germany

Form follows topography

Whereas level land certainly allows us the greatest freedom in architectural expression, more difficult terrain, such as slopes or swamps, restrict our choice in building form. Even the simplest constructive element used to master the challenge of settling on a slope, a flight of stairs, can adopt many different forms – and on some occasions, the topographic restrictions may inspire a builder to develop unconventional solutions. Again, topography may influence the shape of the built environment, but it does not necessarily determine it.

Form follows climate

The classic publications on building in the tropics[3] tell us that climate is the key determinant shaping a building, or even an entire city. They divide the globe in different climatic regions, such as dry-hot, hot-wet, savannah, continental desert, subtropical, etc. They provide us with rules on how to construct in each region, and illustrate their recommendations with locally rooted traditional houses. Nobody objects to the idea that maximum ventilation is needed in a wet tropical climate, whereas a house in a desert climate should have thick walls with optimum thermal storage capacity in order to guarantee a stable, intermediate indoor temperature between extremely hot days and freezing nights. Nevertheless, even within a small geographical region you can find completely different dwelling forms, such as the nomads' tents and the peasants' houses in the Syrian Desert.

Form follows faith

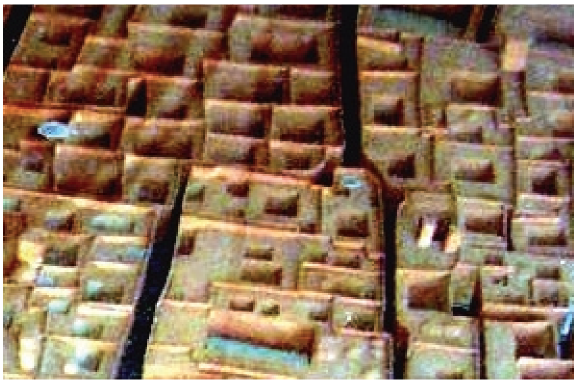
Christian churches and cathedrals look rather similar all over the world, and all planners can recognise the urban plan of a typical Islamic city with its semi-public, dead-end streets and the arrangements of windows and doors that prevent any view into the private courtyards. But then, many churches do not follow the traditional pattern and look more like sculptures than houses of God, and the contemporary Arabic street pattern tends to follow the classical western grid-iron design. At least today, religious faith does not seem to have a visual impact on townscape and housing design. This leads to the hypothesis that the period of construction and its prevailing fashion represent a more dominant factor.

Form follows climate: Maximum ventilation is desirable for buildings in a hot and wet climate

3
i.e. Lippsmeier, Georg (1969, 1980) *Building in the Tropics.* Müchnen: Callwey.

Form follows climate: Desert architecture protects against extreme temperature differentials: Mosque by Hassan Fathy in New Gurnia, Egypt

Form follows climate: Peasants refuge in the Syrian Desert



◄◄ *Form follows faith:* Christian village church in Bolivia that resembles a sculpture more than a house of God

◄ *Form follows faith:* Traditional islamic street pattern: model of the centre of Yazd, Iran

Form follows age: Al-Suhaymi Palace, Dharb el Asfar. builit in the 17^{th} century in Fatimid Cairo, Egypt

Form follows age: Ministry of Health in Gaborone, Botswana, about 2000

Form follows age

Historic city centres base their authenticity on a similar date of origin. Accordingly, the similarity of modern city centres can be explained by their identical or very close date of construction. This appears to be a convincing hypothesis, since the rationale of town planning, in the past, followed technical and military criteria, such as the accessibility of every plot, possible grading of roads and hydraulic pipes, the most economic or effective trajectory of city walls for defence, distances between houses to guarantee sufficient lighting and fire protection, etc. On the other hand, within the same town, many buildings, squares and even entire neighbourhoods of the same age can have quite distinct characters very different from one another.

4
Christian Norberg-Schulz (1982) *Genius Loci. Land-schaft, Lebensraum, Bau-kunst.* Klett-Cotta, Stuttgart.

Form follows culture: Cultural identity of a site is based both on physical structures and on collective memory: London & Kenya

Form follows culture

There are places whose identity cannot be reduced to be a result of either material, availability of funds, topography, climate, faith or age. This quality has been identified as genius loci[4], and can, at best, be associated with culture, formed by people and their collective memory. Whereas all the other qualities of space and houses can be explained in material terms, cultural identity cannot be separated from the people and communities that give it a unique meaning.

Social sustainability

Sustainability commonly refers to stability against decay and deterioration in environmental, economic, physical and similar terms. Particularly in the context of international co-operation and urban development projects, the main concern for sustainability refers to securing finances for continuous operation and cost recovery/reinvestment after the initial project period through external funding secured from the donor agency. Social sustainability is understood as preventing a neighbourhood from losing its status, which would induce habitual residents to leave the area, who might then be replaced by lower-income strata.The poorer newcomers tend to neglect the necessary maintenance of the building structures because they cannot afford the costs or because they are tenants and not owners. Such a downward-spiralling process can turn a previously respectable neighbourhood

5
Especially when coupled with red-lining practices by the mortgage banks.

Social sustainability: Decay of neglected neighbourhoods: Old Havana before upgrading

Social sustainability: Neighbourhood improvement promoted by a Taller de Transformacion: La Lisa in Havana, Cuba

Social sustainability vs. Gentrification: Gentrified street in Bermondsey, London

Social sustainability vs. Gentrification: Kampung Improvement Programme in Indonesia

into a slum within a few years.[5] Over the last decade, municipalities have often tried to halt such processes through poverty-reduction programmes targeted specifically at disadvantaged groups. These programmes were limited to clearly defined geographical areas and replaced previous citywide social programmes and services benefitting the entire population as a whole. They could be seen in countries with quite different economic and political characteristics including, for example, Germany with its programme 'die soziale Stadt' ('the social city') or Cuba with its programme of neighbourhood development centres ('Talleres de Transformación Integral del Barrio').

The social stability of a neighbourhood can be equally threatened through a self-propelled improvement process known as gentrification – typical for residential areas close to the city centre, which display qualities of local identity and offer shorter distances to the city's cultural life and white-collar workplaces. Gentrification processes tend to displace many low-income households, which municipal authorities rarely perceive as a serious problem. On the contrary: such processes are more often than not assisted by public investments, i.e. in the form of traffic calming, environmental improvement and betterment grants. The rationale behind such a strategy is less the creation of a better physical image of an area than the attraction of potential taxpayers within the city limits. Some experts fear that induced slum-upgrading programmes may have a similar effect and will eventually lead to the displacement of low-income families. So far, not much empirical evidence for such an effect has been documented – except for the fate of tenants who may be faced with higher rents reflecting the improved conditions in the neighbourhood.

Social cohesion

Whereas social sustainability refers to a rather homogeneous target group, this does not apply to social cohesion. Cohesion is the opposite of fragmentation. Social fragmentation of the city population has been a growing concern in urban sociology for the last 20 years and can be linked to a widening income gap between rich and poor and the erosion of the middle-income classes. In the urban development context, it manifests itself in the privatisation of public space, such as shopping malls, road closures and gated communities. When higher-income sectors of society enclose themselves, this means that access to better services and infrastructure is denied to the rest of the population; it avoids factual cross-subsidy towards the poor, which then concentrate in more distant parts of the city in a process of ghettoisation. Socio-spatial segregation is also propelled by public authorities by means of mass evictions of squatters and low-income settlements – still common practice in many countries – under the pretext of illegal land occupation or the need for large-scale infrastructure projects. In the process, the displaced population are deprived of their basic human right to shelter, which UN Agencies along with other institutions and activists claim under the (rather diffuse) slogan 'The Right to the City'.

Certainly, socio-spatial segregation policies may easily lead to social unrest, as we have repeatedly seen in cities like Paris and other places that expose the advanced ghettoisation of marginalised groups.

Social cohesion: Road closure in Paris

Social cohesion: Participatory urban planning meeting between planners and population in Fortaleza, Brazil

Globalisation: City marketing through iconic buildings: Bitexto Tower in Ho Chi Minh City, 2010

Conclusions

What have urban planners and architects to do with cultural identity, social sustainability, and social cohesion? Some progressive voices among them voluntarily accept responsibility for architectural monotony, formation of slums, or the promotion of gentrification and social segregation. They are wrong, because the real power of planners and architects is, in fact, negligible in modern society in comparison to the role and position they wish it to be associated with and what they are promised to attain in conventional schools of architectural and urban design. Sadly, the epoch in which planners were commissioned to build entire cities and determine the shape of urban space ended a long time ago. Today's decision makers are the real-estate professionals, private investors and perhaps corrupt politicians. If the planning professions want to recover a real stake in urban development, they must learn to anticipate the course of real-estate markets, become better investors than company bosses, and learn to negotiate with the politicians. Their classic design-oriented education is of little help in this business, which rather calls for interdisciplinary practice and strong management capacities.

If planners are prepared to redefine their role and meet the challenge to have an impact beyond only delivering some decoration to the outcomes of other players' decisions, they will fill an evident void in the steering of urban development. Cultural identity, social sustainability, and social cohesion are among the central urban issues today, and respond to the major global concerns, namely the effects of globalisation, environmental degradation and unruly cities.

Globalisation and the assumed economic crisis

Driving factors of globalisation are technological advances, particularly in the field of informatics, combined with the accumulation and concentration of finance capital, which can switch between countries much more easily than any other form of capital. This not only deprives national states and municipalities of their conventional access to funds needed for the provision of infrastructure to all, it also forces them to compete against other cities and regions for private investment. City marketing has become a survival strategy for municipalities and is largely linked to big events such as the Olympics, universal exhibitions, and the construction of architectural icons such as the Sydney Opera House, the Guggenheim Museum in Bilbao, or the Bitexco Financial Tower in Ho Chi Minh City.

The promotion of tourism – through such things as shopping malls, marinas or theme parks – is used to attract capital in smaller fragmentation from the tourists themselves, as well as to also attract big capital through the implicit advertising effect of a tourist destination. In all these undertakings, architects and planners are principal executors and they usually rely on tested design patterns. However, too much replication makes one place indistinguishable from another: a self-defeating effect in a Guinness Book society. Therefore, progressive planners and city promoters are rediscovering the genius loci quality, or cultural identity: the unique features that, due to the interaction with the local community, cannot be copied in another location. New skills are required by architect/planners in supporting community involvement. This does not seem an easy demand since the future users of their designed buildings rarely feature in architectural drawings or on the photographs of any of the published monographs of the architects.

Preventing environmental degradation through urban farming: Urban farming is part of green city planning. Eatable park in Darmstadt, Germany

Environmental degradation

Climatic change, the depletion of biodiversity, deforestation and environmental contamination are concerns commonly written into the workbooks of urban and regional planners of the last decade(s). Their 'progressive' response typically turns towards energy-conservation technologies or even energy self-sufficiency in buildings, occasionally also to the use of renewable building materials, city greening and reforestation. Urban farming may be another appropriate answer in certain cities of the South, but certainly requires an extension to the already acknowledged planner's knowledge and perception.

Preventing environmental degradation through conservation: Upgrading of the historic urban centre geared to avoid gentrification: Old Havana, Cuba

All this complies with the conventional understanding of sustainability, but depends on social sustainability for its successful implementation. As in the case of cultural identity, the human and community factor is also a key element to social sustainability. Community gardens – a New York innovation already implemented in the 1970s – are a perfect example of a perfect combination of environmental and social sustainability. For the involvement of the planning professions, it must also be remembered that the world-famous ecological venture of city planning in the Brazilian city of Curitiba was the work of Jaime Lerner – a local architect who advocated an integral approach to urban development and was elected mayor on those grounds three times!

The built environment forms an important part of city life. As mentioned above, the formation of slums is an expression of environmental degradation. Therefore, slum-upgrading efforts are the basis of social sustainability, since they ideally involve the entire neighbourhood in the decision making, realisation and later maintenance efforts.

Finally, particular skill is required to transform a historic urban centre into a socially sustainable neighbourhood, since commodification is a most likely side effect in such efforts due to the elevated construction expenses in the restoration of historic buildings that need to be renovated. A relatively successful example of socially sustainable renewal of a historic city, one even classified as a world heritage site, is La Habana Vieja in Cuba. There, only two street corridors were defined to cater to tourist needs, whereas the vast majority of the neighbourhood was to benefit the sitting resident population.

Improvement of the built environment, coupled with social sustainability, is also is a secondary aim of the

6
i.e. *Violence Prevention through Urban Upgrading in Khayelitsha,* South Africa (www.vpuu.com).

7
Häussermann, Hartmut; Siebel, Walter (2001) „Die Mühen der Differenzierung". In: Löw, Martina (ed.). *Differenzierungen des Städtischen.* Opladen: Leske + Budrich. 29-68.

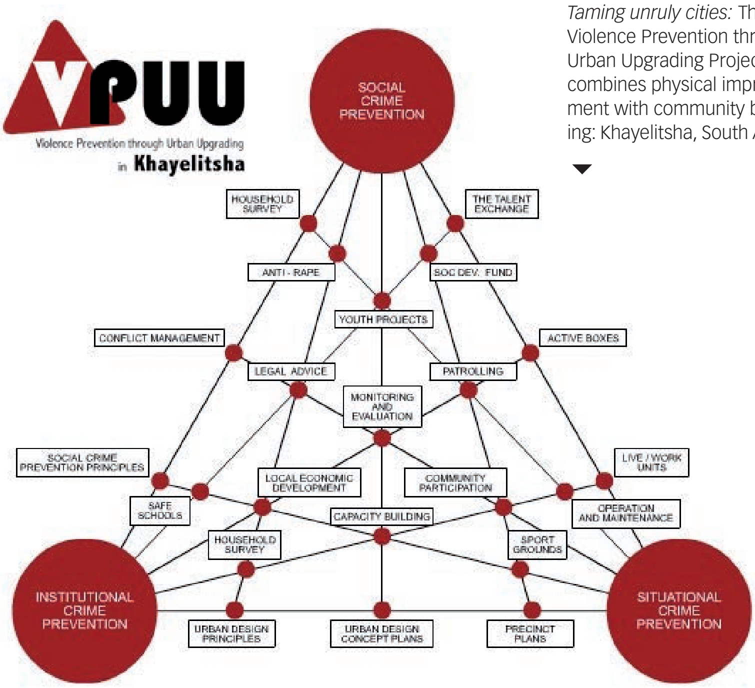
Preventing environmental degradation through architecture: Cost reduction in social housing through intelligent design and user participation: Telal Zeinhoum project by Mathéy, el Dahaan and Peterek, in Cairo, 2000 above-mentioned slum-upgrading programmes, but this effort should also be extended to new social-housing projects. Building for the poor does not necessarily mean poor architecture and lack of landscaping. A number of examples have shown that the cost need not increase for this if the authorities are flexible and corruption is kept under control – which can often be achieved through the participation of the resident target group.

Unruly cities

Social fragmentation, urban violence and social unrest are major concerns in big cities worldwide. One of the roots in this regard is widespread unemployment and excessive income differentials. Some of the underlying reasons are, of course, connected to the global economy, which can hardly be influenced on a city level. But this is only half of the story. Participatory budgeting, for example, can be a soft redistribution mechanism on the local level, and most of the funds being invested in urban infrastructure – where professional support by the planners plays a key role.

Social cohesion, as the answer to social fragmentation, is not based only on monetary criteria. The best approach to reducing urban violence is by community building and the subsequent self-organisation. A possible instrument to strengthen communities are social development funds, which often form part of urban upgrading projects, like in the VPUU programme in Cape Town.[6] An important element for success is the creation and valorisation of cultural identity on the local level. Again, the involvement of the residents is a key factor to foster an element of ownership in the improvements obtained. An example: in the same South African project, a mural decorating the new community centre was painted by the residents themselves. This supports the residents' identification with the building, which – although located in one of the most violent settlements worldwide – has not suffered any vandalism or break-ins since its completion more than a year ago. A similar example is a former rubbish dump converted into a park by the locals residents in La Lisa, Havana, with help only provided in kind (building materials, a bulldozer and technical assistance) by the municipality.

For many years, a fair social mix of residents of different statuses or nationalities in the same neighbourhood or



Taming unruly cities: The Violence Prevention through Urban Upgrading Project combines physical improvement with community building: Khayelitsha, South Africa

even residential building was believed to be a good recipe to achieve social cohesion. However, as Häussermann and Siebel pointed out, enforced social mixing can easily cause unnecessary tension.[7] The carrot is always a better strategy than the stick. A good example of strategy promoting the social integration of migrants in a city are the multi-cultural carnivals in cities like London (Portobello Road Carnival) or Berlin (Karneval der Kulturen), which rank as valuable enrichment to the local urban culture and even act as a magnet to attract tourism to the city.

The examples show that cultural identity, social sustainability and social cohesion play a central role in tackling the current central problem issues of big cities worldwide. Dealing with these problems is a responsibility of urban development planning. Conventional education for urban planners and architects does not prepare for the provision of these qualities, which are part of the solution. Unless professionals are prepared to engage in a much more interdisciplinary working practice, other, more-flexible professions will step in and offer practicable answers to contemporary urban problems.

Kosta Mathéy

Prof. Dr. Kosta Mathéy held the chair for Planning and Building Overseas at the University of Technology in Darmstadt 2002 to 2011. He was the founder of the postgraduate MSc course 'International Cooperation and Urban Development' which was replicated under the name 'Urban Development Planning' at the Vietnamese German University in Saigon. Since 2011, he is director of the Global Urban Studies Institute (GLOBUS) of the International Academy at Berlin Free University. Contact: <kosta.mathey@gmail.com>

Taming unruly cities: Mural made by the residents creates a sense of ownership and protects the building from vandalism

Community building: LA CEIBA

Inclusive cities: Social integration is fostered through the Karneval der Kulturen in Berlin

Neue Bücher / Book Reviews

Architektur

Candide. Journal for Architectural Knowledge No.3 (12/2010), 168 S., ISSN 1869-645, Department of Architecture Theory, RWTH Aachen. € 17,- (www.candidejournal.net/)

Seit November 2009 pflegt das Lehr- und Forschungsgebiet Architekturtheorie der RWTH Aachen in der halbjährlich erscheinenden Zeitschrift Candide den Garten des Wissens über die Architektur. Gegliedert in fünf Rubriken, die unterschiedlichen Textgenres vorbehalten sind (Essay, Analyse, Projekt, Begegnung und Fiktion), präsentieren die Herausgeber Axel Sowa und Susanne Schindler anspruchsvolle Beiträge über Entstehung, Transformation und Verlust architektonischen Wissens.

In der aktuellen dritten Ausgabe untersucht die Architekturhistorikerin Elâ Kaçel anhand des Anfang der 50er Jahre erbauten Hilton Hotels in Istanbul, wie ein spezifisches Projekt der Architektur des Internationalen Stils in der Türkei zum Durchbruch verholfen hat. Andrew J. Witt, Architekt bei Gehry Technologies und Hochschullehrer in Harvard, zeigt in einem reich bebilderten Essay wie mechanische Zeichengeräte des 18. und 19. Jahrhunderts Entwurfswissen speicherten und das Formenvokabular der Architektur erweitern halfen, bis das Neue Bauen die ästhetischen Vorlieben veränderte und das nötige Instrumentenwissen verloren ging. Witt macht auch deutlich, dass die zunehmende Nutzung digitaler Technologie bei der Konzeption und Ausführung von Gebäuden inzwischen wieder eine Situation geschaffen hat, in der Architekturwissen und Instrumentenwissen nahtlos ineinander übergehen. Jimenez Lai, Architekt und Dozent an der University of Illinois, illustriert die Bedeutung der Intuition für die Veränderung von Ethos, Syntax und Zeitgeist der Architektur als Science Fiction im Manga-Stil. Auch Amy Catania Kuper sucht nach alternativen Erzählstrukturen für den wissenschaftlich geprägten Architekturdiskurs. Fündig geworden ist sie beim französischen Schriftsteller Georges Perec und liefert eine kreative Analyse zeitgenössischer Architektur, die von Perec schon gelernt zu haben scheint.

Unter der Rubrik Begegnungen reflektiert Oliver Schetter über „die Herstellung von Wissen in der vernakulären Architektur Mosambiks", also über das Planen und Bauen in einem postkolonialen Kontext. Als Entwicklungshelfer hat Schetter die Erfahrung gemacht, dass architektonische Fachkenntnisse in einem der ärmsten Länder der Welt, das drei Jahrzehnte lang von Krieg gebeutelt wurde, nur begrenzt anwendbar sind. Vielerorts fehlt das Allgemeinwissen, welches die Nutzung technischen Wissens überhaupt erst ermöglicht. Verantwortlich ist dafür nicht nur die mangelnde Ausbildung in der Kolonialzeit und der anschließende Exodus portugiesischer Spezialisten. Die wenigen Architekten und Planer, die im Lande ausgebildet werden, haben auch heute nur wenig Gelegenheit, praktisches Wissen zu erwerben und beharren oft auf technischen Standards, die zu hoch angesetzt sind sowie kulturellen Gepflogenheiten widersprechen. Schetter beobachtet eine wechselseitige Beeinflussung der vernakulären Architektur sowie der formalen Architektur und Planung. Im Gegensatz zu herausragenden Beispielen der 60er und 70er Jahre zeigen die von heutigen Architekten geplanten Gebäude häufig technische Mängel. Gleichzeitig bauen Millionen Mosambikaner wie selbstverständlich ihre eigenen Behausungen, passen dabei moderne Techniken und Entwürfe an ihre Bedürfnisse an und setzen je nach Verfügbarkeit traditionelles und industriell gefertigtes Material ein. Die „moderne vernakuläre Architektur" hat Ausdrucksformen entwickelt, die zu den lokalen Verhältnissen passen.

Für Architekturkenner, die an theoretischen Diskursen interessiert sind, bietet Candide anregende Lektüre. Die durchgängig zweisprachig (deutsch-englisch) aufbereitete Publikation ist sehr sorgfältig übersetzt und hochwertig gedruckt. Alle Artikel werden auf kartonierten Vorsatzblättern eingeleitet, was die Eigenständigkeit der einzelnen Beiträge unterstreicht und ihr Auffinden erleichtert. Allerdings erscheint die Einteilung in die genannten Rubriken mitunter etwas gezwungen.

Gerhard Kienast

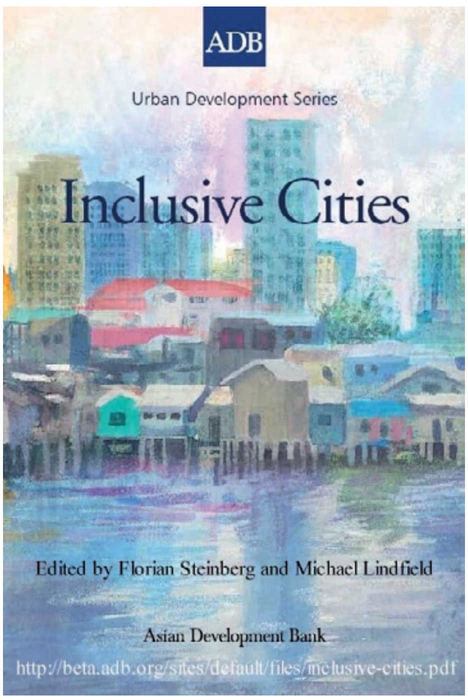
Gesa von Schöneberg. Contemporary Architecture in Arabia – Deutsche Projekte auf der Arabischen Halbinsel. 391 Seiten; ISBN 978-3-938666-32-6. DOM Publishers, Berlin, 2008 (Hardcover; Text deutsch, englisch, arabisch. 78 €.

Deutsche Projektvisionen für Arabien. Um es gleich vorweg zu sagen: hier können sich nicht etwa Freunde des Jemen über neue Projekte im Land informieren. Der Jemen ist in dieser Werkschau der international arbeitenden deutschen Architekturbüros nur mit einem von 50 Projekten vertreten. Jemen wurde bei dieser Schau der Großprojekte der Länder der arabischen Halbinsel nur der Vollständigkeit halber mit aufgenommen. Völlig verschieden sind die vom Erdölgeld glitzernden Städte der anderen Länder mit ihren gigantischen Projekten.

Das Mövenpick Hotel in Sana'a hat jedoch den Sprung in diese Großprojektesammlung geschafft. Das 2006 eröffnete Hotel liegt nordöstlich der Altstadt an der Berlin Street gegenüber der Botschaft von Qatar. Die Braunschweiger Architekten Dr. Richi, Opfermann und Partner haben das 5-Sterne-Hotel für ihren saudischen Bauherrn Scheich Ahmed Abdulrahman Banafe entworfen (International Company for Touristic Investments). Das 10-geschossige, breit gelagerte Gebäude hat 338 Zimmer und ist das größtes Tagungszentrum der Stadt. Für 110 Mio. US $ Baukosten wurde hier der Luxus für das internationale Hotel- und Tagungspublikum geschaffen, der durchaus mit vergleichbaren Einrichtungen der Golfstaaten Schritt halten kann. In der Fassadengestaltung werden jemenitische Bauelemente wie Rundbögen, verschieden farbige Natursteine und weiße Zickzackbänder der Altstadthäuser aufgenommen. Der Eingangsbereich mit Natursteinsäulen, goldener Dekoration und Kronleuchtern ist prächtig. Entstanden ist ein traditionell orientierter moderner Zweckbau, der allerdings nichts von der spektakulären Formenvielfalt der Golfstaatenarchitektur spüren lässt.

Die Einleitung des Buches heißt vieldeutig „Bauen im Sand" und weist darauf hin, dass fast nirgendwo so viel, so groß und so teuer wie auf der arabischen Halbinsel gebaut wird. Die sieben Länder auf der Halbinsel werden sehr knapp in ihrer Situation und Bauperspektive beschrieben (auch mit dem notwendigen Hinweis auf die deutlich schlechteren Bedingungen im Jemen). Es folgen 50 Projektdarstellungen auf jeweils 6 oder 8 Seiten.

Die Schmuckfarbe Gold zieht sich vom Schutzumschlag über die Zeichnungen und Fotos durch das gesamte Buch. Das kennzeichnet die Haltung dieser Werkschau: Pracht und Moderne mit traditionellen Versatzstücken bestimmen das Aussehen der Projekte. Von den Bauherren wird eingeworben, was im internationalen Maßstab Rang und Namen hat. Neben den angelsächsischen sind das auch einige deutsche Büros. Die ökologische Qualität ist auch bei den von deutschen Planern entwickelten Projekte eher fragwürdig. Zwar sind vielfach Solarelemente in die Fassaden integriert, Sonnensegel überspannen Gebäudeteile oder es ist eine verschattende Fassadenstruktur vorgesehen, doch ebenso oft



fehlen jegliche Hinweise, wie brennende Sonne, Komfortansprüche und Energiemanagement miteinander zu verbinden sind. Außerdem wäre den in den Industrieländern üblichen ökologischen Anforderungen an Energie- und Materialverbrauch bei der Gebäudeplanung ein weiteres Kriterium hinzuzufügen: wie erreichen die Benutzer mit welchen Verkehrsmitteln aus welchen Entfernungen die Büros, Wohnungen, Hotels oder Ferienressorts.
Bei den Projekten verschwimmt leider, ob sie bereits realisiert oder bisher nur geplant sind. Für die Pläne wären Maßstabsangaben hilfreich, da die Gebäude oft dimensionsslos und ohne Nachbargebäude schwer in ihrer Bedeutung zu werten sind.
Im „Fazit" wird die Kehrseite der Gigantomanie durchaus angesprochen, die sowohl fasziniert und abschreckt. Dubai erinnere „den Stadtsoziologen Mike Davis eher an einen Alptraum der Vergangenheit, in dem sich nationalsozialistische Monumentalarchitektur mit künstlicher Disneyarchitektur vereint" (S. 21). Nachhaltige Stadtplanungskonzepte sind hier nicht gewollt. Die Barackensiedlungen der Bauarbeiter werden nicht als Problem gesehen, sie sollen keine Spuren hinterlassen. „Gemessen am Bauvolumen und den Möglichkeiten gibt es nur wenige inspirierende Entwürfe und vielfach wird die mangelnde Bauausführung beklagt" (S. 21)
Ob diese Projekte funktional, ökonomisch und sozial eine Perspektive haben, wurde früher als erwartet in Folge der Finanzkrise Ende 2008 aktuell, die bei Drucklegung gerade noch nicht ausgelöst war. Inzwischen führte in Dubai, dem selbst ernannten „neuen Zentrum der Welt" Ende 2009 der Bauboom zur Staatsfinanzkrise und das Hotel im Jemen hat durch die traurige innenpolitische Situation mit dem Ausbleiben der Touristen zu kämpfen.

Wolfram Schneider

Henrickson, R., and Greenberg, D. (eds.) Bamboo Architecture in Competition and Exhibition. Hana, Maui, Hawaii 2011, 145 S. $29.95 (www.bamboosun.com; www.bambooarchitecturethebook.com)

Seit 2006 existiert die International Bamboo Building Design Competition, die auch schon 2007 in Kassel auf der Documenta gezeigt wurde. Dieses Buch dokumentiert die wichtigsten seither prämierten Projektvorschläge aus Bangladesh, Vietnam, Kolumbien, der Slowakei, den USA, Indonesien, Indien, Brasilien, Deutschland sowie anderen Ländern. Einige dieser Projekte sind schon gebaut worden, andere existieren bislang offensichtlich nur auf dem Papier oder in digitaler Form. Einer der beeindruckendsten Bauten in dieser Reihe ist das "Wind and Water" Kaffee in der Binh Duong Province, nördlich von Ho Chi Minh City. Auch prominente Bauten der Expo 2010 in Shanghai waren ganz oder teilweise aus Bambus gebaut, wie zum Beispiel die Pavillons von Indonesien, Indien, Vietnam, Spanien und Norwegen sowie das Deutsch-Chinesische Haus. Während viele Länder auf der Expo ihre High-Tech Kapazitäten zur Schau stellten, zeigte die Präsentation der Bambusbauten auf der Expo die Aktualität und Bedeutung des Bauens mit diesem natürlichen und erneuerbaren Baumaterial. Das Buch ergänzt dies durch kurze Hinweise auf die Schau der Produktideen des International Network of Bamboo and Rattan (INBAR), Beijing, auf die Ausstellung der "Flechtwelten" in Colburg, Deutschland sowie auf die "Big Bambu" Environmental Installation des New York Metropolitan Museum of Art aus dem Jahr 2010. Insgesamt eine faszinierende, gut illustrierte Schau der besten in den letzten Jahren publizierten Ideen zum Thema Bauen mit Bambus und sicherlich eine wertvolle Anregung für Architekten und Ökologiefreunde. Sehr empfohlen.

Florian Steinberg

Stadtentwicklung

Ng, Edward. Designing High-Density Cities for Social & Environmental Sustainability, London-Sterling 2010, 342 S., £65 (www.earthscan.co.uk)

Dieses Thema ist ja eigentlich ein Klassiker der modernen Stadtplanung: wie dicht können und sollen Städte sein? Doch in den Zeiten der Beachtung des "ökologischen Fußabdruckes" unserer Städte wurde diese Frage nochmals aktualisiert: nun ist die Energiespardebatte dazu gekommen und die Reduzierung des Verkehrsaufkommens ist in die Diskussion eingeflossen. Weisen Städte wie Singapur, Hongkong, Shanghai oder Manila ein Zuviel an menschlicher Dichte auf und wie sollte damit umgegangen werden? Da dieses Buch von einem in Hongkong arbeitenden Architekten herausgegeben wurde, ist die hier vertretene Position erwartungsgemäß eher ein Manifest für Verdichtung. Das Buch ist in vier Abschnitte unterteilt, die mit (i) dem Verständnis von verdichteten Städten, (ii) dem daraus resultierenden Stadtklima, (iii) diversen Umwelteinflüssen der Verdichtung, sowie (iv) der Lebensqualität in hoch verdichteten Städten zu tun haben. Die hier wiedergegebenen Studien zu Strahlungen/Sonnenreflektion und Wärme, zu Fallwinden und anderen Themen, welche die Lebensqualität der Nutzer in hochverdichteten Städten stark beeinflussen können, deuten darauf hin, dass für Mediziner, Umweltplaner und auch Architekten

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Einzelheft ab Nr.88 € 10,– (zzgl. Versand)
Doppelheft € 18,– (zzgl. Versand)
Einzelheft bis Nr.87 € 6,– (zzgl. Versand)

Mitgliedschaft im Herausgeberverein: € 65,– im Jahr, Studenten € 40,– (jeweils inkl. TRIALOG-Abo)

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Abo-Preise: (1 Jahrgang, 4 Ausgaben, zzgl. Versand)
Standard-Abo: € 35,–
Institutionen-Abo: € 45,–
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hier noch viele zu klärende Aspekte existieren, die weit über ökonomische Erwägungen hinausgehen und ihnen auch zuwiderlaufen können. Gerade für die Immobilienwirtschaft sollten diese Fragen deshalb von höchster Relevanz sein. Es fragt sich, wie viel Dichte sich vermarkten lässt, wie die Nutzer auf eine immer stärker verdichtete Umwelt reagieren werden, ob sich Wohnungen und Büros in solchen hoch verdichteten Städten vermarkten lassen und bis zu welchem Preis. Sowohl die Städte Asiens wie Lateinamerikas haben sich weit in diese Richtung entwickelt, während andere Regionen da noch weit hinten an stehen. Die Zeichen für Verdichtung stehen positiv und dieses Buch ist sicherlich ein wichtiger Beitrag dazu.

Florian Steinberg

United Cities and Local Governments, Committee on Urban Strategic Planning (ed.) Local leaders preparing for the future of cities – Policy paper on urban strategic planning (includes regional reports and case studies), Barcelona, 134 p. (www.cities-localgovernments.org).

Diese Publikation der Weltorganisation der Städte und Gemeinden (mit Sitz in Barcelona) ist ein Beitrag zur Konsolidierung ihrer strategischen Planungsarbeit und belegt, dass Planung wieder ‘in’ und aktuell ist. Die UCLG Regionen – Afrika, Asien, Eurasien, Europa, Lateinamerika, Mittelmeer und Nordamerika – kommen hier alle zu Wort und stellen ihre Planungssituation, ihre städtischen Herausforderungen sowie Fallbeispiele vor. Die Regionalverbände machen Vorschläge, wie zielgerichtete Planung zur Lösung der urbanen Problematik beitragen kann. Der Wert dieser Publikation liegt in der Selbstdarstellung der UCLG Mitglieder und ihrer Darstellung aktueller Problematiken. Viele UCLG Mitglieder werden sich an Workshops und Seminare erinnern, bei denen ähnliche Fragen diskutiert wurden.

Die Publikation beginnt mit einer Definition der strategischen Planung und erörtert, wie in diesem Kontext relevante Aspekte wie etwa 'soziale Gleichheit', 'kulturelle Werte', 'Kommunikation', 'Nachhaltige Entwicklung', 'Natürliche Ressourcen', 'Stadtform', 'Bodennutzung' oder 'ökonomische Produktivität' in die strategische Planung einfließen sollen. Als wichtigste Herausforderungen werden folgende Aspekte genannt: die demographischen Veränderungen, die Migration, die Globalisierung des Arbeitsmarktes, Armut und nicht erfüllte Millennium Development Goals, soziale Segregation, die räumliche Transformation der Städte in Zeiten der Umweltkrise und des klimatischen Wandels, die Energiekrise und mögliche Grenzen des Wachstums, die Metropolenbildung sowie der Aufstieg der Städte und Gemeinden als politische Einheiten. Die Tatsache, dass der Einfluss der öffentlichen Hand wegen reduzierter Steuereinnahmen schwindet, bedeutet, dass Städte und Gemeinden stärker auf Partnerschaften mit dem privaten Sektor und der Bevölkerung setzten müssen. Diese Zusammenstellung wichtiger Aspekte und Dimensionen bzw. der Schwierigkeiten von Planung zeigt, wie wichtig technische Hilfe und Netzwerke wie das UCLG sind.

Was diese Publikation allerdings nicht bietet, ist eine Kurzbeschreibung eines strategischen Planes und der Erfahrungen, die mit strategischer Planung in den dafür bekanntesten Städten in Europa, USA, und Lateinamerika gemacht wurden. Dies überrascht etwas, denn in Barcelona befindet sich u. a. der Sitz des Centro Iberoamericano de Desarrollo Estrategico Urbano (CIDEU), welches viele Städte in Spanien und Lateinamerika, darunter auch die bekanntesten Fallbeispiele einer strategischen Planung, beraten hat.

Florian Steinberg

Carmen Mendoza, Mbongeni Ngulube and Raquel Colacios (eds). “Reflections on Development and Cooperation”. Editors Carmen Mendoza, Mbongeni Ngulube and Raquel Colacios. Published by Escola Technica Superior d’Arquitectura ESARQ (UIC), Immaculada 22, 08017 Barcelona, Spain. January 2011. 142pp.

This book has been used as a vehicle for the research findings of students reading towards a Master’s degree in International Cooperation, hosted by the Universitat Internacional de Catalunya (UIC). This includes sectors in “Housing Urbanization and Sustainability in Development Contexts”, and “Sustainable Emergency Architecture”, being part of the Mundus Urbano study programme of International Cooperation and Urban Development, presented jointly by the Universities of Darmstadt (TUD), Rome (Tor Vergata), Barcelona (UIC), and Grenoble (UPMF). In line with its stated philosophy of internationalism, it draws its student body, as well as its teaching staff, from a broad spectrum of internationally-based academics, something which, it is believed, will facilitate the creation of international professional networks.

It should also be noted that the book is graphically well presented, and has been printed in four-colour litho, on heavy, superior quality paper. This might be anathema to the radical purists of previous generations used, as they were, to more austere means of publication, but this is perhaps an indication as the amount of money flowing into development coffers today.

The book contains a selection of twelve essays, divided into four chapters which move from Deconstructing Development to Discussing Urban Development, Cooperation and Risk Management and, predictably, finishes with Design Approaches for Cooperation.

Given the international nature of course, staff and student body, it was surprising that the essays that follow were not written from an overwhelmingly-modernist viewpoint. Mbongeni Ngulube, a Zimbabwean architect and urban designer, trained in South Africa and, more recently, a research fellow at the UIC, opens the volume by discussing a number of examples drawn from both his personal and professional life to illustrate the seemingly self-perpetuating paradox of development projects which, having been imposed from the top-down, only manage to produce increasing dependency and poverty in target communities. Having critically engaged developmental theory, he then puts forward, somewhat tentatively, an alternative approach described as "self improvement", which sounds suspiciously like the sweat equity of yore.

Writing in the context of cities in the Middle East, architects George Kassab, from Beirut, and Natasha Aruri, a Palestinian activist, postulate that Capitalism, and most particularly Neo-Liberalism, have amplified class, economic and cultural divisions in most cities around the world, a finding that ought find resonance in post-Apartheid South Africa. However, Kassab then puts forward the idea that a cosmopolitan approach to development might assist in the healing process, and re-establish solidarity across socio, economic and cultural differences, something not supported by the South African experience.

Aruri, on the other hand, accuses foreign-led development agencies of being more responsive to the agenda of donor countries than to local needs. That is self-evident to anyone who has had to deal with either North American or European Union funders, but she then argues, that development professionals ought to support those agencies which pursue ground-level policies while denouncing injustices in the system. The fallacies of both arguments should be more than self-evident to any development professional with more than a few years of practical experience in the field.

A similar refrain is repeated by Australian engineer, Christopher Gowers, who argues that, in order for foreign agencies to implement effective development projects, they need to enter into local partnerships and alliances. His analysis reveals the complicity of local government and planning institutions in Barcelona, with both national and international interests to promote the growing global status of the city, and share in its financial rewards, normally to the detriment of existing social networks and historical neighbourhoods. His research appears to be perfectly sound. His proposed solutions are substantially less so and are based more on idealism than upon proven resolutions in other case studies.

Having suffered in recent years more than its fair share of natural disasters, Bangladesh offers an apt case study for local planner Md Mostafizur Rahman and engineer Amit Kumar, both of whom have extensive experience in the field of disaster management. Of the two, Rahman is possibly the more rooted in development theory, and in his paper he tackles some of the most pressing development issues of our time: disaster prevention, preparedness and response. Again this should ring a strong emotive bell in local South African planners, where an unwillingness, or maybe an inability by local authorities to govern, often upgrades a normal, everyday housing crisis into a major disaster. Kumar, on the other hand, is more rooted in his practical experience, and many of his proposals have an air of authenticity.

Of similar relevance is the essay by Spanish architect Cristina Castelao, who joins with Mbongeni Ngulube to point out the levels of vulnerability experienced by informal communities subject to the risks of disaster. This is offset, however, by the fact that many communities often develop internal mechanism of stress management to cope with the potential trauma.

Jonathan Minchin examines the role that the transfer of technology could play in the process of sustainable development through the use of computerized data banks, something which is normally self-evident to most design professionals who regularly use such data bases as Specifile, but which Mr Minchin feel an obvious need to highlight. The paper also conveniently ignores such difficult questions as culture resistance and the mechanics of social acceptance that such transfers would normally involve.

Victoria Swan draws upon personal experience in the English health care system to propose a cross-disciplinary methodology in order to assist interaction between the design and health care disciplines. As any architect who has ventured into hospital design will gladly admit, this area is a veritable minefield, and any contribution to its resolution should be welcomed. However, we need to question whether Ms Swan has yet achieved the depth of personal experience to be putting forward such recommendations.

The volume is supported, at regular intervals, by contributions made by more established academics, who give it a greater degree of intellectual substance. Jacqueline Polvora makes a number of important points in her "Contributions from Anthropology", a subject which has been largely ignored by the other writers; Kelly Shannon talks about "Reaffirming the Agency of Urban Design", which reminded me, in my own mind, of the words of Victor Papaneck, who, in "Designs for the Real World", questioned whether humanity might not be better off if the design professions were to stop designing altogether; and Carmen Mendoza who, at long last, talks about "Reflections on Urban Design as a Tool to Reinforce Spatial Identity", something which every contributor should have been making reference to, but which, woefully, everyone ignored. These three papers lend an aura of academic respectability to a volume which is essentially about experimental student work.

The volume, in many ways, asks more questions than it is willing to provide answers for, but then, that is normally the nature of student projects. Although they seldom realize this, students are often capable of placing their collective finger upon many inherent weaknesses in an argument, and although I would have difficulty in defending many of their proposals, there is no doubt that much of their research is valid and well done.

The book also forefronts the Programme of Development and Cooperation at Catalunya, and the valuable role it continues to play in the education of future generations of development planning professionals, and for this we should see it as a "work-in-progress".

Franco Frescura

Impressum

Herausgeber von TRIALOG ist TRIALOG e.V., der Verein zur Erforschung des Planens und Bauens in Entwicklungsländern www.trialog-journal.de

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Vertrieb: Südost-Verlag Service (SVS) GmbH
ISSN Nr.: 0724-6234; V.i.S.d.P.: Kosta Mathéy

Redaktion: Kosta Mathéy, Silvia Matuk
Redaktionelle Mitarbeit: Peter Gotsch, Klaus Teschner
Proofreading: Bryin Abraham
Satz / Layout: Irina Herzog
Druck: E & B printware Karlsruhe
Titelbild: Amos Rapoport, Foto: Silvia Matuk

Die in TRIALOG veröffentlichten Artikel repräsentieren nicht zwingend die Meinung der HerausgeberInnen und der Redaktion. Nachdruck ist mit Angabe der Quelle und Zusendung eines Belegexemplars gestattet. Artikel, Ankündigungen und Informationen bitten wir an die Adresse des Vereins oder an folgende Kontaktpersonen zu richten:

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TRIALOG Kto. No. 4835-605, BLZ 500 100 60
Postbank Frankfurt am Main, SWIFT: PBNKDEFF
IBAN: DE23 5001 0060 0004 8356 05,

TRIALOG 106 kostet 10,- € zzgl. Versand.
Stand: September 2011

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TRIALOG ISSN 0724-6234