Design as bricolage: anthropology meets design thinking

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*We identify a metaphor for the design activity: we view design as
bricolage. We start from describing bricolage, and we proceed to the
relationship of design to art. We obtain a characterisation of design that
enables us to show that both traditional and contemporary design are
forms of bricolage. We examine the consequences of 'design as
bricolage' for the relationship between design and science and for the
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Metaphors are powerful tools. Stemming from the biological,
bodily aspect of the human existence[1,2], they underwrite most
human thought[3]. Metaphors are tools for meaning, representation, understanding, science, and education[4]. Their potential has not gone
unnoticed by researchers in design. It has been advocated that metaphors
should be used as guiding principles in the design process[5]. We go a step
further: we advocate the use of metaphors as guiding principles in understanding the design process.

In this work, we identify a metaphor for the design activity. The metaphor
is that of design as *bricolage,* where bricolage is understood as analysed
by the French anthropologist Claude Lévi-Strauss. Departing from an
account of the relevant part of Lévi-Strauss's work, we proceed to the
relation of design and art. This preparation gives us a characterisation of
design in general, a characterisation of good and bad design in particular,
and it enables us to proceed to show the validity of our contention that
design is a form of bricolage. In effect, we show that design *in all its guises*
is a form of bricolage: we examine both traditional design and design as
a present-day profession. The results elucidate the relationship between

1 Lakoff, G *Women, fire and dangerous things: what categories reveal about the mind* University of Chicago Press, Chicago (1987)
2 Johnson, M *The body in the mind: the bodily basis on meaning, imagination, and reason* Chicago University Press, Chicago (1987)
3 Lakoff, G and Johnson, M *Metaphors we live by* University of Chicago Press, Chicago (1980)
4 Ortony, A (ed) *Metaphor and thought* (2nd edn) Cambridge University Press, Cambridge (1993)
5 Coyne, R *Designing information technology in the post-modern age: from method to metaphor* MIT Press, Cambridge, MA (1995)

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science and design; moreover, they show that design is a widespread, pervasive activity. (See note 1.)

1 *Bricolage*

Unfortunately, there is no exact equivalent in English of the French term bricolage. Tinkering is a candidate, but the analogy is poor. Even in French the term is rich in concepts and associations:

In its old sense, the verb *bricoler* applies to ball games and billiards, to hunting and riding, but always to invoke an incident movement: that of the ball that bounces, of the dog that strays away, of the horse that swerves from the straight line to avoid an obstacle. And, in our days, the bricoleur is still the one who works with his hands, using indirect means compared to those of the craftsman[6].

It is important that the incidental, in the guise of the use of indirect means, is the notion that has been retained: the bricoleur makes do with what's there, with what he encounters. In that, he differs from the engineer:

The bricoleur is adept at performing a large number of diverse tasks; but, in contrast to the engineer, he does not subordinate each one of them to the acquisition of raw materials and tools conceived and procured for the project: his universe of tools is closed, and the rule of his game is to always make do with 'what's available', that is, a set, finite at each instance, of tools and materials, heterogeneous to the extreme, because the composition of the set is not related to the current project, or, in any case, to any particular project, but is the contingent result of all the occasions that have occurred to renew or enrich the stock, or to maintain it with the remains of previous constructions or destructions[7].

Whereas the engineer creates the means for the completion of his work, the bricoleur redefines the means that he already has. He uses an inventory of semi-defined elements: they are at the same time abstract and concrete. They carry a meaning, given to them by their past uses and the bricoleur's experience, knowledge and skill, a meaning which can be modified, up to a point, by the requirements of the project and the bricoleur's intentions:

Such elements are therefore semi-particularised: sufficiently so that the bricoleur does not need the equipment and the knowledge of all trades and professions; but not enough to constrain each element to have a precise and determinate use. Each element represents a set of relations, at the same time concrete and virtual; they are operators, but they can be used for any operations of a certain type[8].

Lévi-Strauss provides a useful analogy. An image is a concrete object, and a concept is an abstract entity. But there is something occupying the space in-between, and this is the sign, as defined by Ferdinand de Saussure[9]: an assembled, two-sided entity consisting of a signifier (the image referring to something) joined to a signified (the concept pointed to by the image).

6 **Lévi-Strauss, C** *La pensée sauvage* Librairie Plon, Paris, ch 1 (1962) p 30 [Ref. 59, pp. 16–17]
7 **Lévi-Strauss, C** *La pensée sauvage* Librairie Plon, Paris, ch 1 (1962) p 31 [Ref. 59, p. 17]
8 **Lévi-Strauss, C** *La pensée sauvage* Librairie Plon, Paris, ch 1 (1962) p 31 [Ref. 59, p. 18]
9 **de Saussure, F** *Course in general linguistics* Duckworth, London. Translated from the French by Roy Harris (1983). Originally published as *Cours de linguistique générale*, Payot, Paris, 1916

A sign is a concrete object, unlike a concept; but it is also an abstract entity, since it can stand for something other than itself. Similarly, the bricoleur's means are concrete, since they have an objective existence; but they are also abstract, since they can play a variety of roles depending on the situation: they are signs. The bricoleur determines these roles by entering into a dialog with his inventory:

His first practical step is retrospective: he must turn to an already constituted set, formed by tools and materials; take, or re-take, an inventory of it; finally, and above all, engage into a kind of dialog with it, to index, before choosing among them, the possible answers that the set can offer to his problem. He interrogates all the heterogeneous objects that constitute his treasury, he asks them to understand what each one of them could 'signify', thus contributing to the definition of a set to be realised, which in the end will, however, differ from the instrumental set only in the internal arrangement of its parts… But the possibilities remain always limited by the particular history of each piece, and by what is predetermined in it due to the original usage for which it was conceived, or to the adaptations that it has undergone for other purposes… The elements that the bricoleur collects and uses are 'preconstrained'…[10]

Of course, the engineer asks as well, since his means, power and knowledge are limited, and since he has to overcome the outside world's resistance to his purposes. But the bricoleur asks his collection, whereas the engineer, like the scientist, asks the universe. And, more important, the engineer and the scientist seek to go beyond the constraints, pertaining to a certain state of knowledge, presented to them, whereas the bricoleur stays within them. The engineer and the scientist break down, decompose and analyse; the bricoleur reorganises. The engineer and the scientist abstract: they create and use concepts; the bricoleur uses signs.

This bricoleur's dialog with his materials and his work continues throughout the process, since his decisions to use something for a specific purpose have consequences that he cannot foresee. One element's possibilities interact with all other elements' possibilities, with the overall organisation of the artefact he makes. The results of these interactions are never what he expects, and he must respond to them:

The decision [to use an element] depends on the possibility to put another element in its place, so that each choice will involve a complete reorganisation of the structure, which will never be the same as he vaguely imagined, nor the same as some other, which he might prefer[11].

The bricoleur will interrogate, use, take stock, and interrogate again.

The final result of the bricoleur's efforts is never an ideal fit to the requirements of the project. The dialog that he enters with his means, the

10 Lévi-Strauss, C *La pensée sauvage* Librairie Plon, Paris, ch 1 (1962) pp 32–33 [Ref. 59, p. 18–19]
11 Lévi-Strauss, C *La pensée sauvage* Librairie Plon, Paris, ch 1 (1962) p 33 [Ref. 59, p. 19]

reorganisation that he imposes on them, results in a structure, serving the project that he has assumed, which, because of the contingencies of the process, is always at a remove from his initial intentions. The result is unique and unpredictable. And it is so in yet another way:

The poetry of bricolage comes to the bricoleur also, and above all, from the fact that he does not limit himself to accomplishing or executing; he 'speaks', not only with the things, as we have just seen, but also, through the things: relating, through the choices he makes among the limited possibilities, the character and the life of the creator. Without ever accomplishing his project, the bricoleur always puts into it something of himself[12].

Bricolage is therefore at the mercy of contingencies, either external, in the form of influences, constraints, and adversities of the external world, or internal, in the form of the creator's idiosyncrasy. This is in contrast to the scientific process: science brackets out events and secondary qualities to arrive at the essentials and primary qualities. It uses structures, in the form of its underlying theories and hypotheses, to arrive at its results, which take the form of events. Bricolage works the opposite way: it creates structures, in the form of its artefacts, by means of contingent events. To arrive at a definition, *bricolage is the creation of structure out of events*. (See note 2.)

2 Design and art

Design is related to art. This relation is what makes design what it is: design is not just about the creation of useful artefacts; it is equally about the creation of *beautiful* artefacts. Utility and aesthetics intertwine in the design process; but it is not clear how.

Let us turn to art first. Art, at least in its purest form, is disjoint from utility. 'Art for art's sake' considers only the aesthetic value of the work: everything depends on the aesthetic emotions that it raises on the beholder. But where do these emotions emanate from? We use Lévi-Strauss aesthetics to find an answer.

A work of art is a representation of something: in representative art, this is a part of the visible world; in non-representative art, it is a representation of something else, be it sentiments, thoughts, or ideas. But by representing something, the work of art enables the spectator to comprehend it. It reduces the represented entity to something that can be grasped by the beholder; it reduces its dimensions, literally and metaphorically, by projecting them to those of the medium of artistic expression; it functions as a model, albeit of a very particular kind, that allows somebody to understand. It creates an object that is homologous to something else. This is what differentiates science from art:

12 **Lévi-Strauss, C** *La pensée sauvage* Librairie Plon, Paris, ch 1 (1962) p 35 [Ref. 59, p. 21]

The former approach is of metonymical order, it replaces a thing by some other thing, an effect by its cause, while the second is of metaphorical order [it replaces something by the its homologue][13].

But the relationship between art and science points to the relationship between art, science and bricolage:

If the priority relation between structure and event manifests itself in symmetrical and inverse fashion in science and in bricolage, it is clear that… art occupies an intermediate position[14].

A work of art, by being a model of something, exhibits and reveals the structure of what it represents. But a work of art is not only structure imposed on events (art would then be science). It is a synthesis of the intrinsic properties of its subject with the extrinsic properties of its context. It is *what* is represented along with *how* it is represented. The *what* interacts with the world that surrounds it, with the artist, with the world of the artist: all these are the *how*, and all these are events. Art is, therefore, a synthesis of structure and event. Hence:

The event is only a mode of contingency, whose integration (perceived as necessary) into a structure gives rise to the aesthetic emotion, and this holds whatever the type of art under consideration[15].

This contingency takes three forms: occasion, execution and purpose. An event may be external to the artistic process itself, by being part of the circumstances surrounding the subject, that is, the occasion: in the case of painting, the lightning is such an event. But an event may be internal to the artistic process: these are events pertaining to the materials the artist uses, to the artist's style and skill, that is, the execution. Finally, an event may be external to the artistic process, but part of the circumstances surrounding the subject in the future, and not in the moment of artistic creation: these are events that pertain to the use of the work of art, that is, the purpose. The artist anticipates and embodies such events into his creation; his creation must meet them:

According to the case therefore, the process of artistic creation consists, within the immutable framework of a confrontation of the structure with the accidental, in looking for the dialog either with the *model*, or with the *material*, or with the *user*, taking into account whose message anticipates the working artist[16].

13 Lévi-Strauss, C *La pensée sauvage* Librairie Plon, Paris, ch 1 (1962) p 39 [Ref. 59 pp 24–25]
14 Lévi-Strauss, C *La pensée sauvage* Librairie Plon, Paris, ch 1 (1962) pp 39–40 [Ref. 59, p 25]
15 Lévi-Strauss, C *La pensée sauvage* Librairie Plon, Paris, ch 1 (1962) p 42 [Ref. 59, p. 27]
16 Lévi-Strauss, C *La pensée sauvage* Librairie Plon, Paris, ch 1 (1962) p 43 [Ref. 59, p. 27]

In academic art, execution and purpose are downplayed: execution is mastered and purpose does not enter into the consideration. In naïve art, matters of execution play a more prevalent role. In applied arts, where we find design, occasion is downplayed, and purpose is the dominant consideration. As for the execution, the artist must subjugate the materials to the

envisaged use. The more complete the mastery, the more industrial the art becomes. But then:

We meet again, in a different level, this dialog with the material and the means of execution by which we defined bricolage[17].

And this enables us to characterise design, art and bricolage.

We saw that art is the integration of structure and event. Bricolage is the creation of structure out of events. The space between the two is what constitutes design. It can be art, or it can be bricolage, or it can be something between the two. Its exact position is determined by the proportions of occasion, execution, and purpose that form the contingent events in the process. If events are exclusively of the execution and purpose type, design becomes bricolage. If events are exclusively of the occasion type, design becomes academic art. Design must have a purpose; execution also matters; and occasion matters as well.

Good design has a structure that fits into the structure of its context nicely; it is a structure corresponding to its context. The structure of the context must be internalised in some way to the structure of the design. Good design is the creation of a structure out of the integration of external structure and events. Bad design does not have a structure that fits into its context nicely. Bad design is cobbling, manufacturing a piecemeal solution for a problem. Bad design is this bricolage that does not manage to create a suitable structure.

We have, therefore, a characterisation of design. Furthermore, we have also a characterisation of *good* and *bad* design. And we saw that design is related both to art and to bricolage. But we do not know yet how design proceeds. However, we know how bricolage proceeds. And although design is not bricolage, we can show that both processes proceed in similar ways. Design is not bricolage, but we can see design *as* bricolage.

3 *Design as bricolage*

It is customary to make a divide in what constitutes design. The divide is largely a historical one: we distinguish between design in the era before its professionalisation and design after its professionalisation. Before becoming a distinct profession, design was practised by most members of a community. There was no design education, and, indeed, design was not held as a distinct activity. It was the era of *unselfconscious* design. Later, design became a distinct activity, it was institutionalised and achieved the status of a profession. This is the era of *selfconscious* design, and this is the situation today.

17 **Lévi-Strauss, C** *La pensée sauvage* Librairie Plon, Paris, ch 1 (1962) pp 44–45 [Ref. 59, p. 29]

These definitions were given by Christopher Alexander in the 1960s[18]. Other researchers have proposed other terms: *craft* or *vernacular* design, which is superseded by *design-by-drawing* and various *design methods*[19,20]. The distinction made, however, is the same. We follow Alexander's terminology here as more descriptive of the character of the differences between the two kinds of design; moreover, from a semantic point of view, it is easy to subsume design-by-drawing and other design methods under selfconscious design, thus obtaining economy of expression.

The distinction has consequences for the research programme on design. Most research on design focuses on selfconscious design. Unselfconscious design is usually used as a contrast to selfconscious design, or merely as an element in historical surveys. Of course, since today's design is selfconscious, the focus makes sense. Still, we show that both can be analysed, and that both can be described in the same terms. In particular, we show that both are the same activity applied to different means; both follow the same logic applied to different contexts.

3.1 Unselfconscious design as bricolage

Unselfconscious design is design without designers. It is the prevalent form of design activity in primitive and traditional societies, in which design professions do not exist. Artefacts are usually manufactured and designed by their prospective users. Houses are designed and built by their inhabitants, and not by architects.

Unselfconscious design has two major characteristics, which have been analysed cogently in the literature[18]: the force of tradition and the direct response to misfits.

Tradition guides and defines the design process. This is rigid; the designer has to follow design norms that may be thousands of years old. These norms are sometimes part of the culture's myth and lore; sometimes they are even part of ceremonial rituals. The personal element in the design process is carefully circumscribed: only a very limited and prescribed form of originality is allowed.

18 Alexander, C *Notes on the synthesis of form* Harvard University Press, Cambridge, MA (1964)
19 Jones, J C *Design methods* (2nd edn) John Wiley and Sons, Chichester, England (1992)
20 Lawson, B *How designers think: the design process demystified* (3rd edn) Architectural Press, Oxford (1997)

Unselfconscious design is direct. Its response to problems is immediate. This immediacy takes two forms. First, the designer works with materials taken from his immediate environment. The means for the construction of his artefacts are taken from his surroundings. Second, the designer responds immediately to design problems. He builds when he needs to build, he makes an artefact when he needs it. Moreover, he adjusts, fixes and maintains his artefacts at the moment when the need arises. A problem or a

failure leads to immediate action. And this interaction between trigger and action is a daily affair: he continually makes and re-makes his artefacts.

If tradition and directness are the main characterising factors in unselfconscious design, and if it is our contention that unselfconscious design is a form of bricolage, then the importance of tradition and directness in unselfconscious design must support our contention. It is indeed so. Even more, tradition and directness not only *support* the view of unselfconscious design as bricolage; they *make* unselfconscious design as bricolage.

Directness entails that the unselfconscious designer works with elements that are not of his own making. He uses what he finds in his environment, elements that may have a multitude of uses in his life, and he inserts them to the structure he creates. In this sense, his means are signs: they are not concepts, since he does not define them. They have meanings defined by their uses, the traditions they embody and their place in the conceptual structure of the designer's society.

The unselfconscious designer does not conceive and does not procure new tools and materials for his project. The universe of the means under his disposal is closed and his rule of the game is to always make do with 'what's available'. He must determine which of his tools and materials are suitable for his purpose; he searches his inventory and chooses among the possible answers. He does not decompose the problem: his purpose is not to examine it analytically; he reorganises his materials to create the structure of the envisaged artefact.

Directness also means that unselfconscious design is contingent. It is an immediate response to a problem. The designer perceives an event; the event triggers the design activity. The goal of the design process is to integrate the event, by creating, or maintaining a structure out of it. Design is a continual interplay between events and their handling by the designer; design is successful when it handles contingent events well; it is unsuccessful when it does not.

Hence, the unselfconscious designer, like the bricoleur, tries to make a structure out of events. And he does that, like the bricoleur, by using what's already available around him. He does not decompose, and does not analyse, but employs materials that function as signs, and whose exact meaning he instantiates in his work.

The bricoleur works with what's available; otherwise he would not be a bricoleur. The unselfconscious designer *must* work with what is available.

Otherwise he would not be allowed to design at all. This intrusion to the designer's work is the result of tradition. Tradition, then, *forces* the unselfconscious designer to be a bricoleur; it is not a matter of his own choice, but a matter of what is and what is not allowed. This limiting aspect of tradition takes three forms.

First, whereas directness entails that the designer works with elements not of his own making, it is tradition that determines these elements. The designer works with an inventory of objects found in his environment; tradition determines the constituents of his inventory. In effect, the designer selects the materials from what he sees around him; it is tradition that determines what he sees. It provides a way of looking at the world, a filter through which the designer sees the objects from which he can choose.

Second, the problems the designer encounters are part of his tradition. In unselfconscious design, the designer does not encounter novel problems; the problems he encounters are generations old. Unselfconscious design works in stable societies. Social change is slow, if any, and technological evolution is sluggish, if it exists. In these conditions, tradition can evolve and provide appropriate answers to re-occurring problems.

Third, provided the designer has a problem and the means to solve it, tradition determines the way he will solve it. This is the most conspicuous effect of tradition: it determines the form of the artefact; it is only through what it leaves unspecified that the designer can express himself. Tradition thereby creates vernacular styles, the hallmark of unselfconscious design.

The limiting role of tradition explains the success of unselfconscious design, as is seen in traditional architectural or artefact forms. We saw that a designer has to integrate three kinds of events: events pertaining to the occasion, to the execution and to the purpose. The difficulty in design stems from the difficulty of integrating these events to a coherent and elegant structure. Tradition prunes down these events; and, by reducing their number, it ensures that unselfconscious designers can produce good, and sometimes even brilliant, results. Since tradition determines what constitutes a problem, it limits the purpose contingencies. Since it determines what materials can enter in the designer's consideration, it limits the execution contingencies. Since it determines the way the designer perceives the situation, it limits the occasion contingencies.

Unselfconscious design presents a paradox: the quality of the result does not square with the designer's lack of design knowledge. Admirable results are reached by people who work without having any design qualifications.

Unselfconscious design is design without designers, but its designs surpass the capabilities of many present-day professionals. The paradox is explained if we think that, whereas tradition limits the designer's choice, and therefore limits the demands placed on him, the present-day designer does not have this aide. In fact, he must make his way beyond tradition; he must make a mark for himself by differentiating his work from the work of all other designers. He has to tackle the contingency, without any a priori limits set by tradition. In a sense, tradition designs through the unselfconscious designer. But the selfconscious designer has to design for himself.

The unselfconscious designer is a form of bricoleur. His means are not made specifically for the project; he takes them from his surroundings. His project is a response to external events, it is an effort to create structure out of events. He works his way through by following tradition. Tradition limits his means, his problems, and his way of tackling his problems, thus imposing on him a bricolage process. If the context in which this bricolage takes place is stable, and tradition can function properly, unselfconscious design can deliver enviable results; if the context is not stable, unselfconscious design cedes its place to selfconscious design.

3.2 Selfconscious design as bricolage

Selfconscious design is design conceived as, and practised as, a distinct activity. It is professionalised and institutionalised design. Designers need qualifications, which are provided by formal education in special schools. Having these qualifications, they can practise their trade as a distinct professional body.

The transition from unselfconscious to selfconscious design was a result of extensive social and technological change. Human societies grew in size and complexity; and, with them, the problems they faced. At the same time, technology evolved and provided the means to resolve these problems. Societies were no longer static: they were dynamic and evolving. New design problems were emerging that could be resolved by new methods using new means. Tradition broke down. Moreover, capitalism became the dominant mode of production. To increase output, design had to be separated from manufacture. Its primary *raison d'être* would thereafter be the increase of profits. More designs were needed; the designer was no longer the maker; design was professionalised[21].

21 **Forty, A** *Objects of desire: design and society since 1750* Thames and Hudson, London (1986)

In selfconscious design tradition no longer filters occasion, execution, and purpose contingencies. The designer is free to resolve them and use them in appropriate ways. In fact, he is not only free to resolve them, he is also

responsible for resolving them and using them in appropriate ways. Some innocence is lost.

The designer must be creative: he must give novel solutions to problems. He must see them in new ways, since he must make a difference in order to be professionally successful. The selfconscious designer sells his trade. He does not design for himself: he designs a product for others, a product which he must sell. For the product to be sold, it must be unique, it must differ in some way from other solutions to the same problem. For the product to be unique, the designer must see the situation in a new and novel way: he must see the situation differently from other designers. The designer must determine the occasion contingencies.

The designer must also create his own inventory of materials that he will bring to bear on the problem. The selection of materials is sometimes as important as the form of the product. Materials make possible forms that could not be realised without them. Furthermore, a material can be a factor of success by itself: many a product has had a welcome reception because of the materials it was built of. The designer must determine the execution contingencies.

Finally, the designer often defines the purpose of the artefact. This is more obvious when the artefact creates a need. Revolutionary artefacts are successful because they create and establish a need that was not conscious before. Even in non-revolutionary artefacts, establishing the problem is part of it. It is well-known that design problems are wicked problems, whose definition is part of the solution[22–25]. The designer has to elicit and establish the purpose of what he designs. The designer must determine the purpose contingencies.

This threefold liberation of the design process imposes significant demands on the designer. The designer must now possess special skills to handle the increased complexity of design problems. The lack of extraordinary individuals who are able to deal with the increased demands results in design failures. But design failures are expensive in a number of ways: economical, social, technological, and so forth. It is, therefore, imperative to find ways to handle design complexity. Design-by-drawing is such a way. In fact, it is the *major* way and it is the most distinguishing characteristic of selfconscious design.

Although a number of different design methods have been proposed, it is the use of diagrams that characterises selfconscious design. Diagrams may be two-dimensional models, free-hand sketches, depictions of relationships,

22 Reitman, W R 'Heuristic decision procedures, open constraints, and the structure of ill-defined problems' in *Human judgments and optimality* **Shelly II, M W and Bryan, G L** (eds) John Wiley and Sons, New York ch 15 (1964) pp. 282–315
23 Churchman, C W 'Wicked problems' *Management Science* Vol 14 No 4 (1967) pp B141–B142
24 Bazjanac, V 'Architectural design theory: models of the design process' in *Basic questions of design theory* **Spillers, W R** (ed) North-Holland, Amsterdam (1974) pp 3–19. Paper presented in the Symposium on Basic Questions of Design Theory held at Columbia University on 30–31 May (1974)
25 Rittel, H W J and Webber, M M 'Planning problems are wicked problems' *Policy Sciences* Vol 4 (1973) pp 155–169

of flows, of structures; no matter the exact nature of the diagrams he uses, and no matter the exact design method (if any) he follows, the selfconscious designer works with and through them. The object of design is primarily the diagram; this is translated to the real world object later on.

Diagrams offer distinct advantages, both in terms of information content and in terms of cognitive properties. In terms of the information a diagram conveys, it is said that 'a picture is worth 10,000 words', but this is an underestimate. Tufte reports on an exemplary picture that contains 17 000 numbers per square centimeter. With a surface of 390 square centimeters, it represents 6 630 000 pieces of data[26]. In terms of their cognitive properties, diagrams facilitate search and inference[27] and allow lateral transformations without a premature freezing of concepts[28]. The importance of diagrams in reasoning has given birth to the field of Diagrammatic Reasoning[29], which comprises an extensive and growing literature.

The designer's freedom and his use of diagrams set the scene for selfconscious design. Both of them seem to contradict the notion of design as bricolage: the designer's freedom contradicts the bricoleur's making do with what's available; the designer's use of diagrams contradicts the bricoleur's immediate handling of the object of his work. These observations are valid. However, they are not detrimental. Design in its selfconscious guise is still a form of bricolage.

Let us consider the designer's freedom first. And let us suppose that the designer is *completely* free. The bricoleur works with what's available, with what he can find around him. The designer can select the means of his work. He is free to create his own inventory. He can, therefore, create a new inventory for every design project he encounters. But this is only a part of the design process. Once the designer has created his inventory, once he has decided on how to work and with what to work, the universe of his tools and materials is closed and he has to design with them. Of course, it may turn out that his inventory is not adequate; the designer will have to adapt it. But after each adaptation, the designer works with his inventory as closed. And the more he proceeds with his design, the more closed his inventory becomes: changing it is costly and means rejecting parts of his work. It is easier to change it in the beginning than in the end of the design process.

Indeed, the opposite is impossible. The designer cannot keep changing his inventory: he cannot produce a structure by hopping from one universe of tools and materials to another. Apart from assembling them, he has to *work* with them. He has to use them and to arrange them in such a way as to

26 **Tufte, E R** *The visual display of quantitative information* Graphic Press, Cheshire, CT (1983)
27 **Larkin, J H and Simon, H A** 'Why a diagram is (sometimes) worth ten thousand words' *Cognitive Science* Vol 11 (1987) pp 65–99
28 **Goel, V** *Sketches of thought* MIT Press, Cambridge, MA (1995)
29 **Chandrasekaran, B, Glasgow, J and Narayanan, N H** (eds) *Diagrammatic reasoning* AAAI Press/The MIT Press, Menlo Park, CA (1995)

integrate the contingencies into a structure. The composition of his inventory is one more contingency that he has to integrate. In unselfconscious design, it was handed over to him. In selfconscious design, he has to create it himself; but it is still one more contingency. Conceived either as a problem, or as an opportunity, it is (only) one factor in the integrative process that constitutes design.

Furthermore, the assumption that, in selfconscious design, the designer is completely free, is specious. His resources are always bounded. His choices regarding his inventory are always limited. The tools and materials that he may use are constrained by all sorts of considerations: financial, environmental, social, regulatory, and so forth, depending on the situation. The composition of his inventory is, to a large part, determined by forces outside his control; it is not determined by him.

30 Barthes, R *Mythologies* Vintage, London. Translated from the French by Annette Lavers (1993). Originally published as *Mythologies*, Éditions du Seuil, Paris (1957)

31 Barthes, R *The fashion system* Jonathan Cape, London. Translated from the French by Matthew Ward and Richard Howard (1985). Originally published as *Système de la mode*, Éditions du Seuil, Paris (1967)

32 Csikszentmihaly, M and Rochberg-Halton, E *The meaning of things: domestic symbols and the self* Cambridge University Press, Cambridge (1981)

33 Douglas, M and Isherwood, B *The world of goods: towards an anthropology of consumption* (2nd edn) Routledge, London (1996)

34 Krampen, M *Meaning in the urban environment* No 5 in *Research and Planning Series* Pion, London (1979)

35 Preziosi, D *Architecture, language, and meaning: the origins of the built world and its semiotic organisation* No 49 in *Approaches to Semiotics Series* Mouton Publishers, The Hague (1979)

36 Preziosi, D *The semiotics of the built environment: an introduction to architectonic analysis* Indiana University Press, Bloomington, IN (1979)

37 Broadbent, G, Bunt, R and Jencks, C (Eds) *Signs, symbols and architecture.* John Wiley and Sons, Chichester, England (1980)

The designer's freedom is limited in yet another, subtler, way. His means carry meanings beyond his control. Designed artefacts are not only beautiful and useful things, they are also meaningful things. Artefacts are made to reflect status, personality, taste. They are not only inanimate objects, they are embodiments of myths, ideas, and ideologies[21]. Their utility far exceeds their use: they refer to a whole universe of significations. Artefacts and their components are signs[30,31]. And this holds for the whole gamut: from household artefacts and personal items[32,33], to urban and architectural works[34–37]. A corporate building is an emblem of corporate prowess; its materials are signifiers contributing to this image; office layout is a signifier of corporate culture; office furniture is a symbol of status and labour relations; and so on. Like the unselfconscious designer and the bricoleur, the selfconscious designer works with signs.

In the end, the designer is not so free; he is certainly not as free as he pleases; he does have to make do with what's available and what it means, even though the available variety and meanings are usually wider than in bricolage. The difference in the aspect of the designer's freedom, then, between unselfconscious and selfconscious design, is *quantitative* and not *qualitative*; and this dispenses with the contradiction between freedom and bricolage.

The contradiction arising from the loss of immediacy can also be resolved. The selfconscious designer does not usually work with the final artefact; he works with a model of it. But this does not mean that he works *differently*. He works with different *means*, but this says nothing about the nature of the work. The process may be the same, or it may be different, but this does not follow simply from the utilisation of different means. The same

process produces entirely different results when applied to different contexts; but this proves something for the contexts, and not for the process.

Selfconscious design is metaphorical. It proceeds by using analogies of the envisaged artefact. It uses models that are like it in some special way. Its power derives exactly from the power of these models. The designer can handle the models in ways that he could never handle the artefact. He can build and rebuild a building without initiating any change in the building site. He can see properties that cannot be seen before the artefact is finished and used. He can communicate his intentions, exchange opinions and assessments with minimal costs. The results of working with models are different than working with the artefact *per se*; but the actual working with models is not necessarily different than working with the artefact *per se*.

In fact, the designer works in the same way, but at a different level. In unselfconscious design, he works at the level of the artefact. In selfconscious design, he works at a level above it; he works at a *metaphorical level*. But the nature of the process in both levels, the metaphorical one and the literal one, is the same. The designer must take stock of the situation; he must enter into a dialog with his inventory to establish the means he will employ; he must integrate internal and external contingencies into a structure. In *literal design* (i.e., unselfconscious design), the structure is the finished artefact. In *metaphorical design* (i.e., selfconscious design), the structure is a model of the finished artefact. But in both cases the objective and the nature of the process is the same. Selfconscious design is, then, a kind of *metaphorical bricolage*.

This is in accordance with the view of design as a reflective conversation with the situation at hand[38]. In this view, design is a discussion conducted with the materials in the medium with which the designer works. It is a hermeneutic process, a process of iterative understanding[39]. The designer proceeds by interpreting the effects his actions have on the situation. He tries to understand the effect of his materials and of his tools, to define their place in a structure. He wants to create a structure out of his means and the results of his actions. He tinkers with the materials, takes stock of the results of his tinkering, and then tinkers again. He takes stock by seeing the situation in specific ways[40]. He subsumes the situation in normative positions that allow him to see it in a special light and under special norms, values, and expectancies, and interpret it and judge it accordingly[41]. In effect, he translates the situation; he perceives the situation as something else. The design is at a metaphorical level, since it is a model, and the designer uses metaphors on it in order to understand it. He modifies it and then tries to understand it again. The activity is a kind of metaphorical bricolage.

38 Schön, D A *The reflective practitioner: how professionals think in action* Basic Books, New York (1983)

39 Coyne, R and Adrian, S 'Is designing mysterious? Challenging the dual knowledge thesis' *Design Studies* Vol 12 No 3 (1991) pp 124–131

40 Schön, D A and Wiggins, G 'Kinds of seeing and their functions in designing' *Design Studies* Vol 13 No 2 (1992) pp 135–156

41 Rowe, P G *Design thinking* MIT Press, Cambridge, MA (1987)

4 Consequences

'Design as bricolage' has consequences beyond design itself. It has consequences on ideas on the relationship of design to other creative disciplines. The relationship of science and design, which has attracted research interest, is seen in a different light. The relation is similar to the one between literal and metaphorical design. Both employ the same process, but they employ it in different contexts and with different goals.

Design is a human activity, and as such it impinges on the human condition in general. Any characterisation of design has consequences for the subject of the human condition. The characterisation of design as bricolage means that design is a distinctive human activity, but not so distinct. Design is a more common activity than is usually thought.

4.1 Design and science

Design and science are distinct activities: in a nutshell, science is concerned with discovering facts about the world, while design is concerned with changing the world. But this, by itself, does not entail that the scientific process is fundamentally different from the design process. Some argue that this is indeed the case: that the cognitive process, the skills, and the actions involved in the practice of science are different than those involved in the practice of design[42–44]. Others, though, argue that both science and design follow similar modes of work[39,45]. The view of design as bricolage suggests a middle way: that science and design follow the same mode of work, but they apply it in different contexts.

This requires a return to Lévi-Strauss. In *La pensée sauvage*, he makes the distinction between two kinds of science: science as we know it and we practise it in the western societies, and the *science of the concrete*, which is the science of primitive societies. Although it has long been held that these two are fundamentally different, and that the science of primitive societies is not science at all, Lévi-Strauss shows that it is not so: both kinds of science work in the same way, both follow the same logic. The science of the concrete applies this logic to immediate sensory percepts, and it thereby becomes a *logic of the concrete*, while western science applies it to abstract concepts. A conspicuous example of the logic of the concrete is bricolage. And this brings us to the relationship between science and design.

We saw that science is the use of structures to subsume events; it explains events by reference to an underlying structure. Therefore, whereas bricolage creates structures out of events, science creates events out of structures. But both are equally logical; moreover, they are logical in the same way,

42 Cross, N 'Design method and scientific method' *Design Studies* Vol 2 No 4 (1981) pp 195–201
43 Cross, N 'Designerly ways of knowing' *Design Studies* Vol 3 No 4 (1982) pp 221–227
44 Eekels, J and Roozenburg, N F M 'A methodological comparison of the structures of scientific research and engineering research: their similarities and differences' *Design Studies* Vol 12 No 4 (1991) pp 197–203
45 Glynn, S 'Science and perception as design' *Design Studies* Vol 6 No 3 (1985) pp 122–126

they use the same logic, the difference being that the former works with the concrete, while the latter works with the abstract. And since design is a form of bricolage, its logic is the same with the logic of science. But whereas science applies its logic to the abstract, i.e., to concepts, design applies its logic to concrete objects carrying meanings, i.e., to signs.

The same result is reached by an alternative route. Interestingly, the route departs by views supporting the separation of science and design: it has been argued that, whereas the logic of science is deductive and inductive, the logic of design is deductive and *abductive*[46]. Specifically, abduction in design is of a special form called *innovative abduction*[47]. Other views on science, however, hold that science itself, when producing new hypotheses, that is, in its most creative aspect, is also abductive[48,49]. So science and design follow the same logic.

A problem with the view that science and design proceed in similar ways is that it contradicts findings on the cognitive processes employed by scientists and designers. It has been shown that scientists attack a problem by trying to discover the rule governing the situation; designers attack a problem by proposing solutions and reflecting on the discrepancies with the desired result; scientists work analytically, designers work synthetically[20,50]. Design as bricolage resolves the contradiction. Analysis and synthesis are different modes of working emanating from the same underlying logic applied to different contexts. Both scientists and designers work in similar ways, but they work with different means. Scientists work with the structures that science provides and they try to make the situation fit the structures. They work with the essence, and try to derive the contingent. They are after the rules, and not the events. Designers work with the events: they tinker with the situation, they propose solutions in order to arrive at a structure embodying the contingencies of the situation. Scientists and designers work differently; but they do not work in a different way.

4.2 The extent of design

Design has a wide reach. Today, most artefacts are the result of some design process. We should try to make beautiful computer programmes[51]. We should design software, especially as it becomes more and more ubiquitous[52]. What, then, is the extent of design?

To answer, we must return to the notion of design as bricolage. Design is a tinkering using materials which the designer cannot freely select, and which have meanings which he cannot freely specify, in order to make a structure fitting the structure of the context. Any activity having these features is a design activity.

46 March, J The logic of design and the question of value. In **March, L** (ed) *The architecture of form*, Vol 4 of *Cambridge Urban and Architectural Studies Series* Cambridge University Press, Cambridge pp 1–40 (1976)

47 Roozenburg, N F M 'On the pattern of reasoning in innovative design' *Design Studies* Vol 14 No 1 (1993) pp 4–19

48 Fann, K T *Peirce's theory of abduction* Martinus Nijhof, The Hague (1970)

49 Rescher, N *Peirce's philosophy of science* University of Notre Dame Press, London (1978)

50 Lawson, B R 'Cognitive strategies in architectural design' *Ergonomics* Vol 22 No 1 (1979) pp 59–68

51 Knuth, D E Computer programming as an art. In **Knuth, D E** (ed) *Literate programming*, No. 27 in *CSLI Lecture Notes Series*, Center for the Study of Language and Information, Leland Stanford Junior University, Stanford, CA ch 1, pp 1–16. Speech delivered in the presentation of the 1974 A. M. Turing Award of the Association of Computing Machinecy (ACM) (1992)

52 Winograd, T (ed) *Bringing design to software* Addison-Wesley, Reading, MA (1996)

Unselfconscious design falls into this set of activities. Selfconscious design also falls into this set of activities. But these two do not exclude the possibilities. Design is more extensive than that. For example, let us reconsider the relation between design, art and science.

Design is an art insofar as it shares with it the integrative function of structure and event. The source of aesthetic appreciation in art and design is the same. Design is related to science, to the science of the concrete. But this science is no less scientific than 'ordinary' science. They proceed in similar ways, in different contexts. Hence, design, art, and science are not inconsummerable. And this explains what many scientists attest: that good science is an art. Because if aesthetic emotions arise from the integration of the contingent in a structure, and if a scientific theory, a structure, to be successful must integrate the contingent, the events, then a scientific theory, when successful, is beautiful and satisfies our aesthetic sensibility. Furthermore, admitting that there is an underlying order in the universe (otherwise there would be no science), the structure of a scientific theory is a reflection of the structure of what it tries to explain. But this is what happens in design, and in art. A scientific theory is an artefact, more than that, it is a designed artefact, and as such it must be no less well designed than anything else that purports to satisfy our intellect, our sensibilities, and our needs, material or intellectual.

Somehow, we are able to experience aesthetic pleasure in a very diverse and extensive range of artefacts, conceptual or real: this is because such artefacts have been *designed*, in the meaning of the term analysed here. Design is the activity that not only provides a solution, but makes us happy and gives us enjoyment. Wherever we find ourselves in such a situation, we encounter an object of design; and this defines its extent.

5 *Discussion*

53 Rowe, C and Koetter, F *Collage city* MIT Press, Cambridge, MA (1978)
54 Colquhoun, A 'From bricolage to myth: Or how to put humpty-dumpty together again' *Oppositions* No 12, Spring (1978) pp 1–18
55 Alexander, C *The timeless way of building* Vol 1 of *Center for Environmental Structure Series* Oxford University Press, New York (1979)
56 Alexander, C, Ishikawa, S, Silverstein, M et al. *A pattern language: towns · buildings · construction*, Vol 2 of *Center for Environmental Structure Series* Oxford University Press, New York (1977)

Our account of the design process is descriptive. However, accounts of design as bricolage can be, and have been, used for prescriptive theories of design. Colin Rowe and Fred Koetter urge architects to assume the role of the bricoleur as a possible way out of the problems associated with modernism[53]. Alan Colquhoun interprets the work of Michael Graves as the result of architectural bricolage[54]. Christopher Alexander goes deeper. He argues that we always build by selecting, adapting and combining patterns. This timeless way of building, which in the past produced miraculous results, has been thrown into turmoil by professionalised design. We should recover our building potential by adopting and employing, until it becomes second nature and we return to our original 'master-builder' state, a pattern language[55,56]. Here bricolage spans from the descriptive to the

prescriptive (see note 3). The same motif can be observed in a much larger scale. Post-Modern architecture, conceived as a pluralistic approach, in which various heterogeneous and polysemous factors are integrated, is bricolage. This is prescriptive; but Charles Jencks justifies Post-Modern architecture as a movement that consciously recognises that architecture is a language and that the architect works with signs[57]. This, again, bridges the prescriptive with the descriptive. Similar extensions for the account of design presented here can be pursued.

Design as bricolage has four intertwined strands. First, design is a form of art. Second, design is a form of science. Third, design is extensive. Fourth, design arises from the interplay of structure and event. The contingent is as essential to the nature of design as is the structure that the designer tries to achieve. If there is no contingent, we do not have design, we have manufacturing.

As an interplay of contingent and structure, design is unpredictable. Design is what it is because it surprises us; and good designs surprise us by their ingenuity and their handling of contingencies. Creativity is this handling of the unpredictable. Design cannot be reduced to a deterministic algorithmic process. Efforts for design automation must take note.

A good designer accommodates the contingent. He integrates it into a structure. He works with signs, which he combines, recombines, and whose meaning he partially redefines. A designer works not only by analysing and decomposing, but by reorganising the materials he has. This provides hints for the qualities of good designers. For instance, a good designer is able to see things in different ways, to determine their meanings, to organise them in a structured whole, and to reorganise them depending on the result. He must be able to understand the occasion, the execution, and the purpose of his activities. This is far from an exhaustive list, but it can be enriched.

In this quest for what constitutes a good designer, there is a special affinity that the designer shares with the bricoleur, which deserves separate mention. The designer, like the bricoleur, does not only speak with his work, he also speaks through his work. There is always a personal element in design; and for design to be successful, the designer must recognise that and pour himself into the process. Design is not just a process; it is an *affective* process. The designer must make his materials disclose themselves; but he must also disclose himself through the design. If design is not affective, we do not have design any more: we have results. Design is

57 **Jencks, C** *The language of post-modern architecture* (6th edn) Academy Editions, London (1991)
58 **Lévi-Strauss, C** *La pensée sauvage* Librairie Plon, Paris (1962)
59 **Lévi-Strauss, C** *The savage mind* Oxford University Press, New York (1972)
60 **Maybury-Lewis, D** 'Science by association' *The Hudson Review* Vol XX No 4 (1968) pp 707–711
61 **Leach, E** *Lévi-Strauss* (4th edn) *Modern Masters Series* Fontana Press, London (1996)
62 **Paz, O** *Claude Lévi-Strauss: an introduction* Cornell University Press, Ithaca, NY. Translated from the Spanish by J S Bernstein, and Maxine Bernstein (1970). Originally published as *Claude Lévi-Strauss o el Nuevo Festín de Esopo* Joaquín Mortiz, México, DF (1967)
63 **Hayes, E N and Hayes, T** (eds) *Claude Lévi-Strauss: the anthropologist as hero* MIT Press, Cambridge, MA (1970)
64 **Lévi-Strauss, C** *Structural anthropology Volume 1* Penguin Books, Harmondworth, England. Translated from the French by Claire Jacobson (1968). Originally published as *Anthropologie structurale* Paris, Plon (1958)
65 **Lévi-Strauss, C** *The jealous potter* Chicago University Press, Chicago. Translated from the French by Bénédicte Chorier (1988). Originally published as *La potière jalouse* Paris, Plon (1985)

this result that does something more than simply solve the problem; it is the result that carries some part of the designer in it.

We have analysed the satisfaction a well-designed artefact gives to the beholder. The affective aspect of the design process allows us to explain its complement: the satisfaction a well-designed artefact gives to its designer. It is the affective requirement, this jump of faith that by putting himself in a situation the designer will create something out of it, the letting go and the immersion, that the designer must accept, and it is this that gives the designer the vicarious satisfaction from the contemplation of his work.

Acknowledgments

Notes

1 This work draws extensively from Lévi-Strauss's seminal work *La pensée sauvage*[58], translated in English as *The savage mind*[69]. Unfortunately, the translation does not do full justice to the original text; the elegance of its prose and some of the depth of its arguments are lost. In fact, 'the translation of *La pensée sauvage* led to such divergences between author, editors and translator that the translator's name has (at her request) been removed from the book'[60]. More pointedly, 'the text has the approval of Lévi-Strauss himself but has been described by an American critic as "execrable" and the translator who was originally commissioned by the English publishers has repudiated all responsibility!'[61] To alleviate the problem, at least in the context of this work, the excerpts from *La pensée sauvage* included here are not copied from, but based on the translation: we have made changes where the translated text is particularly problematic.

Also, the language of Lévi-Strauss, written more than 35 years ago, is not gender-neutral; hence, our rendering also uses the masculine. This required, in order to avoid inconsistencies, to adopt the third person masculine in this work. Clearly, we intend absolutely no gender bias whatsoever: *he* should be substituted by *he or she*, *his* should be substituted by *his or her*, *himself* should be substituted by *himself or herself*, and *bricoleur* should be substituted by *bricoleur or bricoleuse* throughout.

2 Although the material from Lévi-Strauss quoted here is taken from *La pensée sauvage*, the interested reader could do well to delve more in his work, since his ideas have remained remarkably stable during more than half a century of continuous refinement. The excerpts here, and their validity, should be seen in the context of this totality. Good general introductions to Lévi-Strauss exist[61–63], and some of his own works can be approached with relative ease[64,65].

3 Alexander's patterns are relationships among entities. He holds that what rests invariable is the relationships among entities, and not entities themselves. The idea that relationships, and not entities, are the elementary structures to which systems can be reduced is one of the main tenets of structuralism as exposed by de Saussure and Lévi-Strauss.