Distilling an image of nature from Japanese Zen gardens

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Humans are not only adapted to nature, but also adapt their domestic environment to suit their own needs. Here, I suggest that Japanese Zen gardens uniquely bridge these different formative spheres of our perceptual evolution by maintaining sufficient visual complexity through the use of natural components to satisfy our natural sensory and perceptual needs, while doing so in a completely artificial environment. Rather than nature being the 'best' design for human perception, I suggest that it is our perceptual and cognitive brain systems that are 'best' designs, suited for the ecological niches from which we evolved.
Key words: Japanese Zen gardens, visual perception, fractals

Die distillering van 'n beeld van die natuur uit Japanese Zen-tuine
Mense is nie net by die natuur aangepas nie, maar hulle pas ook hulle alledaagse omgewing aan om in hulle eie behoeftes te voorsien. In hierdie verband meen ek dat Japanese Zen-tuine 'n unieke brug slaan tussen die verskillende formatiewe sfere van ons perseptuele evolusie deur die handhawing van 'n voldoende mate van visuele kompleksiteit by wyse van die gebruik van natuurlike komponente om in ons natuurlike sensoriese en perseptuele behoeftes te voorsien, en vermag dit in 'n omgewing wat geheel-en-al kunsmatig is. In plaas daarvan om die natuur as die 'beste' ontwerp vir menslike persepsie te beskou, stel ek dit dat die ontwerp van ons perseptuele en kognitiewe breinsisteme die 'beste' is vir funksionering in die ekologiese nisse waarin ons ontwikkel het.
Sleutelwoorde: Japanese Zen-tuine, visuele persepsie, fraktale

Nature is the best designer* we know of. In the words of biomimicry specialist, Janine Benyus (1998), nature not only finds the way to create structure, but also finds the way to make the most of those structures and to let them disappear into systems that operate ubiquitously. This feat does not require the existence of intelligent design, but is the simple outcome of the evolutionary character of the physical world. The memeticist, Susan Blackmore (1999), interprets Darwin's conception of natural selection as an algorithmic proof of evolution. If varied structures are exposed to a process of selection and possess some form of heredity then they will certainly evolve. Structure will change in such a way that it uses resources optimally to maintain various functions. Thus arise the designs of nature, design here intended to be understood as sculpted through the forces of evolution to function optimally in given circumstances, design being nothing other than emergent structure. Evolution has had an enormous span of time over which to find the best design solutions to many problems, always combining various functionalities into single structures. For example, a lotus leaf not only has an optimal structure for photosynthesis, transport of various chemicals from and to the leaf surface and for regulating pressure and temperature, but even has microstructure embedded on its surface to use physical forces exerted by raindrops to continually cleanse the leaf surface. As humans we sense beauty in these structures since we perceive (at various levels) the elegance through which form matches function. This notion of beauty is, in my opinion, timeless, independent of momentary trends.

Not only individual organisms or systems of interacting organisms, but also the larger ecosystems up to the scale of entire landscapes are shaped through evolution. Landscapes form through selection processes at many spatial scales, in both organic and inorganic domains. The chemical composition of minerals and the nature in which they formed determine the way in which they erode, giving shape to the landscape and determining the biosphere of the organisms that will flourish in these minerals, themselves changing the patterns of erosion that physically shape their landscape.

If this exhausted the evolutionary dimensions of a landscape, we would find ourselves experiencing all landscapes as equally engaging. But from a human point of view, some landscapes are far more compelling than others (see the *Sakuteiki* classical text on Japanese gardening; Shimoyama 1976). Thus, in the human U*mwelt*, not all designs are equal. Our minds also adapted to a given ecological niche, thus biasing what we consider as a good environment or a good landscape. Perceptually, 'better' landscapes, in my opinion, are those matched to our ability to perceive our surroundings — a context of nature's design genius that I focus on in this paper. Classical Japanese garden design provides the main inspiration here for specifically looking at how naturalistic landscapes fit the form of our perceptual functions, benefiting from nature's good design. This is a personal preference, since intuitively I experience Japanese gardens — which are artificial constructs, properly described as naturalistic, not natural, gardens — as more closely resembling the experience of seeing nature as I did, walking around in the natural veldt of my childhood surroundings.

Evolutionary natural landscapes

Chinese literati from medieval dynasties developed a canon of aesthetic ideals that not only shaped their preference toward gardens, but also landscape painting (Keswick, 2003). In the latter, ideal scenery was based foremost on landmarks celebrated for their natural beauty: scenery of a river valley opening up towards the foreground, winding into a structurally more complex but partly visible middle ground, and narrowing dramatically into sharply rising mountains towards the back, disappearing in clouds of mist or reappearing as a soaring waterfall, the mountains appearing like the overlapping panels of a folding screen or the scales on the undulating body of a dragon. It is this type of scenic composition that perceptually set these landscapes in a class of their own; a collection of nature's apparently superior landscape designs. This type of natural scenery is actually unusual. In our more mundane encounter with nature there is a much more common exposure to scenery of overgrown bushes, perceptually facing a mostly impenetrable visual wall of foliage. Such scenery did not become perceptually elevated to the level of 'ideal' nature or 'ideal' landscape.

In classical Far Eastern landscape painting, visual metaphors of the bare essentials of the idealized universe were deliberately canonized into landscape. A style developed where god, human, and earth were expressed through dominantly vertical, diagonal and horizontal structures, respectively (Nitschke, 1993a). The same elements were simultaneously thematized as three compositional landscape zones: back, middle and foreground. The background typically includes steep mountain cliffs, peaks, clouds and mist. The remote scenery of the background symbolizes the literal and spiritual dwelling of the immortals. In the middle ground, nestled between boulders and gnarled trees, the graceful roof of a humble abode often signals the presence of persons aspiring towards wisdom, willing to remove themselves from the normal domestic comforts. The foreground might entertain human figures, travelers that have just set off on a journey towards the deeper parts of the valley. The foreground frames the landscape; flat sandbanks, foliage, a few rocks, or a level section of open ground, sometimes softly hidden in fog, sets the stage in which nature exists without judgment of good or bad. The entire landscape metaphorically summarizes the transitions encountered on the perilous path towards enlightenment.

Why does evolution select this type of scenery for perception? It is unlikely that any answer could properly address the question, but a study of visual stress reduction through fractal visual design in office environments offers some insight. Natural structures abound in fractal properties – fractal (Mandelbrot 1977) here is a term derived from the Latin word, *fractus*, meaning part – i.e. the shape of the whole is echoed in the shape of each of its constituent parts; the same structures repeat at many spatial scales. For example, semblances of the shape of an entire mountain recur in the mounds along each of its ridges, and again within the smaller rock clusters and other formations within each mound. Or consider a tree, where the shape of the entire tree reoccurs on many scales. Break off any branch and hold it up next to the tree and one finds many structural similarities between the two. It is thought that, since we evolved in a visual environment filled with fractal structures, our perception would have adapted to take advantage of this special, albeit ubiquitous, visual characteristic in the natural environment. Indeed visual cognitive science provides evidence that the human visual system more effortlessly parses fractal structure. More specifically, research shows that office staff and endurance workers, such as in cramped environments, like space stations that need to be occupied at length, showed much improved cognitive performance when working in a setting where walls and ceilings were covered in fractal patterns (Wise 204; Taylor 2002, 2008). This could be compared to giving the brain less background noise with which to cope, since the fractal surroundings would be handled with much less cognitive effort (and therefore less visual stress, or energy expenditure) in the brain. More surprisingly, not simply any fractal pattern would work equally well. Fractal patterns can be indexed according to their structural complexity, using their fractal dimension as an indication of how smooth or jagged their structures are. A very jagged tree shape has a much higher fractal dimension than the smooth shape of a single strand of seaweed. It was found that human subjects preferred photographed landscapes with a fractal dimension of around 1.4, which visually can be interpreted as structural complexity nearly halfway between very complex and very simple, but slightly towards the more simple (smooth and sparse). Surprisingly, African savannah landscape, with a few layers of faint, tiered mountains in the background, treetops and tree trunks in the middle ground and a partly open, partly grassy, overgrown foreground, most closely approached this fractal dimension (Wise 2004).

Does this research imply that humans evolved to leave the trees, become fully bipedal, just to yearn back and find some artificial solution to turn their future working environments back into the trees – in a devolution of perception? Not necessarily. It rather hints at the fact that evolution has hard wired our neural systems over a very large time span. We still use that same visual system, even if human civilization has vastly changed our daily visual environment and the perceptual demands in our everyday tasks. It is possible to tune the modern visual jungle to more aptly fit our hardwired brains. The researchers of these studies further speculate that the fractal complexity of the savannah landscape is not accidental. It suits human visual perception and its coupled human behaviour: a landscape with fractal dimension of 1.4 is structurally open enough to offer visibility of prey and predators in the medium and far terrain, while being structurally dense enough to provide cover for subjects, not only from where they are viewing their surroundings, but also if they were to venture out into the partly open, partly covered terrain; it is the visual ecosystem of a foraging animal that crosses open ground while it moves from tree to tree. I would like to suggest that painted scenery in classical Chinese landscapes intuitively exhibits a similar balance between structural openness and density. Like the savannah, it offers a visual landscape open to scrutiny but at the same time allowing sufficient refuge from an unexpected onslaught.

Both at the level of the garden and the layout of entire classical cities one finds a sensitivity to perceptual evolution in terms of the environment in which humans perform optimally. The layout of medieval Kyoto, the Japanese capital originally designed after some classical Chinese cities of its time, gives a compact example of how layout matched perceptual and therefore behavioral function. Both at the level of the city as a whole, and for individual gardens, a number of auspicious landmarks were deemed necessary in the creating of a prosperous living environment (Keane, 1996). A major element, such as fire, water, etc. was assigned as guardians to each of the four directions, with the yellow earth assigned to the centre of the city or individual estate. To the North East, a special guardian was needed to protect against the entry of evil. For

Kyoto, the location of the high Mt. *Hiei* towards the North East made for a very conspicuous guardian. Why this direction needed particular protection is not evident, although I am tempted to speculate that, since this is the location opposite to the setting sun, it is also the darkest location when night falls, and therefore less easily inspected and perhaps a likely place from which a predator might try to gain access. As for the other directions, the layout of Kyoto follows what Nitschke (2004) refers to as the 'armchair layout': it is literally as if Kyoto is seated in an armchair; from the back it is protected by rugged mountains, while flanked by rivers and lower hills on the sides; towards the South it opens up to wide plains, estuaries and a lake. This setting echoes the layout of our sensory organs. With no eyes at the back of our heads, it is comforting to sit facing away from the direction in which one is best protected. To the left and right, one needs less formidable cover, perhaps more sensory accessibility of your surroundings, while in front of you it is preferred to have good visual access to the unfolding of events. The greater your visibility in this region, the more timely the actions that you may decide to take. From North to South, the city of Kyoto slopes downward. Clean water and air rushes out from the back towards the Southern exit of the city. Accordingly the Northern city quarters, with the purest resources, were allocated to the nobility, and the more densely occupied urban and manufacturing quarters, sources of pollution, concentrated towards the city exit. The North-South slope secures a proper flow of water. It further slightly cantilevers the city towards the winter sun, since a South facing slope in the Northern hemisphere generally provides a healthier environment for human settlement due to its more agreeable climate. The structure of classical landscapes in the Far East thus approach what I would like to consider an optimal perceptual and inhabitable evolutionary realm.

Distilled natural landscapes

Both in painting and actualized landscapes, artists had room to enhance those visual aspects that made the already famed natural landscapes so perceptually interesting. For example, one finds that a range of partially overlapping steep, towering mountain peaks would be dramatized by a more deliberate pattern of alternating spatial overlap between the peaks; the spatial extent of sheer cliffs; the lace-like intricacy of rugged rock surface exaggerated for visual effect; the nearly supernatural complexity of towering peaks, appearing more like a billowing smoke stack than a mountain of rock. Thus in Chinese landscape gardens one observes a development towards increasingly intricate clustering of a multitude of rocks into massive conglomerations with maximum visual complexity, in sharp contrast to the geometrical gates and surrounding paved patios inside the walled in garden courtyards (Keswick 2003).

Chinese classical landscape painting profoundly influenced Japanese painting and landscape design (Slawson 1987). As with everything else that reached this terminus of the silk route, however, the Japanese did not simply imitated the trends from the mainland, but it quickly became distilled into a form adjusted to the existing preferences in the various parts of Japan. Major aspects of this metamorphosis can be seen in the tendency towards abstraction in Japanese landscape painting and gardening. The filigree of intricate detail of mountain slopes and rock formations makes way for the minimalist ink splash virtuosity of painters such as Sesshu. The fantastical rock formations cherished in China is simplified drastically, both in the number of rocks used in the garden courtyard, and also in the shape, texture and colour of rocks. The simplification is also evident in the sheer drop in the number of special namings for specific rock arrangement styles (Slawson 1987). The cultural emphasis on the living forces that inhabit every realm of nature provided a drive towards setting rocks to resemble the *iwakura* – naturally occurring rocks with slightly flattened tops believed to serve as pedestals on which the various nature spirits would alight; these pedestal rocks were prehistorically used as altars for placing meat and rice offerings to the gods (Keane 1996; Itoh, 1998). The spiritual concept of the rock pedestal thus firmly found its way into a predominantly Buddhist conceptualization of the ideal landscape. It is interesting to note that chert, often used as garden stones (for example, the stones in the well known Ryoanji temple garden in Kyoto), is a sedimentary mineral that formed as layers of millions of generations of plankton sunk to the sea floor to eventually become transformed, by heat and very great pressure, into geological formations that appeared as rocks – also pedestal rocks – as drifting tectonic plates millions of years later pushed the deep layers of submerged earth crust up into what we know as the rugged mountainous islands of Japan. These rocks truly possess the forces of living nature.

Figure 1
A rare outcropping of feltspar in the eastern foothills of Kyoto. This granite is so brittle that it can easily be crumbled by hand.

Instead of paved courtyards, raked beds of white gravel were the natural answer to sanitary and aesthetic needs of estates in the medieval Japanese capitals (Keane 1996; Nitschke 1993b). In the indigenous Japanese spiritual rituals, natural clearings of natural white gravel were used as divination sites, the gravel itself considered as a source of purification. Given that many wild animals use sand and gravel as a cleansing body scrub against skin parasites, this notion is not void of evolutionary sanitation benefits. It has also been argued that clearings of gravel naturally resist invasion by weeds, providing a relatively orderly space for rituals along riverbanks and the fringes of woodland forests. The incorporation of white stretches of gravel in *Shinto* shrines and garden courtyards is thus seen as the natural outcome of the evolution of the divination space, both in terms of providing a clear space that could be maintained with relative ease, and providing a sanitary, non-dusty space. The structure of Kyoto as a whole echoes this practice, since the riverbeds and valley plain of the city is a bed of this coarse white gravel. The gravel derives from the Eastern hills flanking Kyoto to the East. These mountains formed when deep magma erupted under great pressure, about 90 million years ago, cooling into domes of feltspar granite as it rapidly reached the surface. Kyoto at this time would appear like a scene from hell, the entire city steaming while the whitish alien domes of granite perched on the eastern flanks of what is now an urbanized valley. The feltspar is particularly brittle due to the rapid cooling (unlike the hard granite domes of the Paarl valley in South Africa, or the domes south of Louis Trichardt), hence the only remnant of the domes is the hills in their present cone shaped appearance. The softness of the rock causes fast erosion, and thus the gentle slopes of the hills (figure 1). Erosion results in the characteristic coarse gravel, called *shirakawazuna*, that washes out into the Kyoto valley basin (figure 2).

Figure 2
A close-up view of naturally decomposing feltspar in the eastern foothills of Kyoto.

The gravel had a profound effect on adding nutrients to the soil and water, and also functioned as a massive underground filtering mechanism, ensuring water of a very high quality to the citizens of Kyoto. Modern pollution of underground water has more or less permanently destroyed this valuable source of clean water. Perceptually the gravel gives a distinct appearance to Kyoto's gardens. The constituent minerals in brittle feltspar are individually discernible chunks of matt white, translucent creamy grey, green, and black, or its reddish-brown to yellow oxides, and golden flecks. As the gravel is raked and handled, it eventually breaks down, but throughout its use in the garden, it has a pleasing, hand-made appearance with gravel kernels of various sizes. When raked, the larger chunks usually remain at the top of ridges in the gravel, with smaller grains falling like powder into the spaces between ridges, thus lending a much more complex, in fact - fractal - visual character to an otherwise bland white space. Modern use of garden gravel significantly deviates from this subtle use of a naturally grained material, typically ending in a stark, flat, dead landscape canvas. A visit to any modern Zen garden is enough to confirm that this delicate aspect of the Japanese garden has sadly but surely been overlooked. Another problem is the scarcity of natural feltspar gravel. It is a heavily depleted resource in Japan.

Dense ochre coloured clay is another geological feature commonly found in the foothills around Kyoto. Used in the production of light ceramics, rooftiles, traditional flooring and earthen walls, this yellow clay is another quintessential ingredient of classical Japanese architecture. Japanese buildings are typically constructed as wooden scaffolds; spaces in the scaffold are either closed with sliding *fusuma* or *shoji* screen doors, or filled with woven bamboo lattices covered in compacted layers of a mixture of yellow clay, rice straw, sesame oil and sand; sometimes the wall exteriors are plastered white. Garden courtyard walls are nearly always also made from the same yellow clay, the wall similarly constructed as a wooden scaffold with bamboo lattices and a rammed clay mixture. Oil and sand mixed into the clay ensures its durability and allows a richly coloured patina to emerge over time, appearing much like the mysterious background landscape in Da Vinci's *Mona Lisa*. Visually, this method of construction ubiquitously incorporates a fractal motif into the design (figure 3). The wall at Ryoanji temple is a good example (figure 4). The wall visually frames the garden, an important design aspect. Without the wall (or a clipped hedge – a rare substitute for the courtyard wall) the naturally chaotic undergrowth of the wooded backdrop of the garden would be visible, distracting from the visual order created in the garden. Except in the case where considerable effort can be exerted to keep the undergrowth perfectly manicured, such as in the famous Moss temple, *Saihouji*, the courtyard wall thus serves as an important visual trimming device. It is often said that the wall was added as a means to ease the natural human fear of predators and the elements; that the wall removed the risk of exposure to wilderness while satisfying the yearning for wild nature (Keane 1996; Slawson 1987). I disagree with this view. Nature is not our enemy. In fact, our most dangerous adversary is *Homo sapiens* itself. I believe that, as a physical barrier, the wall serves to keep other humans out; it removes the threat of invasion by our most cunning predator while we are at or most vulnerable, sitting and pondering the potential harmony of nature. As a visual barrier, the wall hides the imperfections of the external world, conveying an impression that the perfection enclosed by the walls also extends infinitely beyond its confines, the world outside being part of this ideal heaven.

Figure 3
Complex stains (fractals) appear as an ochre clay wall ages (this photograph shows a wall in a tea room at the Nishimura residence in Kamigamo, Kyoto).

One thus finds that the geology of the surroundings in the city repeats in the confines of each garden (figure 4). The tree studded clay slopes of the hills recur as the courtyard wall

– clay set in between beams of wood - a protective barrier enclosing the gravel-strewn expanse of the valley. The stained clay walls appear like impressions of the wooded hills flanking the city. Here and there, the tranquil plane of gravel is pierced by the rough shapes of pedestal rocks, suggestive of the formations found along the rivers coursing mainly from North to South through the capital. Gardens are often deliberately constructed so as to include a backdrop of the mountains and hills surrounding Kyoto. This landscaping style, known as *shakkei* (borrowed scenery) is an effective means to greatly increase the perceived spaciousness of the courtyard. It confirms the intuitively sensed relation between the macro landscape of the valley and the miniature garden cosmos.

Figure 4
Chert stones, feltspar gravel and a naturally stained clay wall in the Ryoanji temple garden courtyard.

The classical texts on Japanese landscape design not only outline the preferred materials for gardening construction, but also describe the ideal spatial proportions in which to set design elements (Shingen 1466). The size of the largest stone in the garden, for example, is determined in relation to the size of the courtyard. The composition is therefore unlikely to suffer from a sense of overcrowding. Mathematical analysis reveals that in famous classical designs, like Ryoanji, the average distance between nearest rocks is about twice the average size of the two rocks (Van Tonder 2006). From visual cognitive science it is known that this type of visual arrangement results in a visual pattern where both foreground figure and background are equally salient; the attention of the viewer is neither pulled towards figure or ground, an elegant intuitive technique to engender the garden with a sense of mental harmony. Trees are also spaced and pruned so as to minimally obstruct visual access to other elements in the garden. In previous work it was shown that rock arrangements of garden like Ryoanji follow very exact (intentional) fractal arrangements. Considering also the fact that rock arrangements often open up towards the garden viewing location inside a temple building (Van Tonder *et al*., 2002), one is reminded of the discovery that humans cognitively perform best in visual surroundings resembling the savannah, with a visual balance between open and closed fractal structure.

One has to try your own hand at laying garden rockery before understanding how complex the design process actually is. The addition of each new stone redefines the compositional balance of the entire arrangement. Here the old texts provide indispensable advice – practical advice still followed by present day Japanese gardeners. One should conceive of rocks as the backbone of the garden, first setting the largest stones of each rock cluster, balancing the spacing between them with consideration for their shapes and sizes, and then adding consecutively smaller stones. Rocks should be placed in exactly the way they were found in nature (see the *Sakuteiki* text; Shimoyama 1976*)*, a statement that I interpret as a way to ensure that the relationship between the shape of the rock and its natural grain - a result of erosion that involves water and therefore the force of gravity (verticality) – remain in agreement with another. Disruption of this delicate structural balance upsets the fractal nature of the visual pattern of rocks. For the human visual system this disruption is intuitively very obvious (Van Tonder *et al.* 2002), even if the exact structure of the disruption may no be easily articulated. Rocks are buried very deep in the gravel plane. Roughly two thirds of a rock should be set below ground. This rule ensures that rocks visually appear as outcroppings of a much more extensive, natural solid bedrock that continues underground, even beyond the garden courtyard.

The elements of *ying* and *yang* are usually also found in the Japanese garden (Shingen 1466; see also the *Sakuteiki,* Shimoyama 1976; Slawson 1987). In the more opulent gardens of the *Edo* period (1606-1860) the presence of *ying* and *yang* elements often appear overbearing. So also, the number of rocks cramped into the available space, so one finds deviations from the classical texts on gardening. The original intention, however, was to incorporate the two opposing elements as a manifestation of the forces of nature, an opposite pair that occurs as a universal theme throughout nature. It embodies the concepts of male-female, rising-falling, strong-weak, light-dark, young-old, vital-decaying, and so forth. A subtle, most elegant instance of *ying-yang* elements in the rock garden can be seen in Ryoanji. Here, the dominant rock cluster, towards the left of the viewing verandah, resemble the rugged, sharply rising peaks of a vital mountain range, still forming as tectonic plates crash into each other, perhaps fuelled by the geological instability caused by magma in the deep layers below, an awakening volcano. This rock cluster is placed on the East of the courtyard, towards the rising sun. To the right, three loosely knit clusters of low, smooth rocks resemble the broken rim of a spent volcanic eruption, eroded by time, a sinking archipelago that will once again return to the bottom of the sea. The geometrical centers of both the *ying* and *yang* arrangements are exactly equidistant from the center of the main temple hall – an architectural feature that I am not likely to dismiss as accidental. The remaining rock cluster at the back of the courtyard is neither *ying* nor *yang*, but rather a bridge between the East and West clusters, perceptual glue that visually binds the composition into a harmonious whole, and also visually inserts the rock formation into the courtyard wall, suggesting that the rocks extend infinitely beyond the enclosed visible perimeter.

Conclusion

Nature's superior large scale design – witnessed in the geological makeup of the Kyoto valley – seems to have been sensitively incorporated into the microcosm of the garden courtyard. On the human scale, the ideal setting for effortless efficient perceptual functioning seems also to have been replicated in the Japanese garden. Cognitively, it offers the 'savannah' of our senses, an environment akin to the evolutionary cradle of our perceptual systems, but without the requirement that we devolve back into the trees. It hence also suits our mental functioning, in itself another of nature's supreme designs.

Throughout the ages many of the great literati, sages and leaders finally resorted to gardens as their refuge for life in its totality. The garden is a reconstruction of heaven, a physical archetype that expresses the intuitive understanding for the kind of environment in which human beings find nourishment for their most subtle hunger. The brain sciences are on the brink of understanding how systems of mirror neurons – cells responsible for our ability to anticipate and imagine our own actions, or the actions of others, enabling us to learn and mimic behaviors – and enable humans to apply abstract thought objects to other cognitive modalities, such as the auditory, visual and other domains, and vice versa. This is an essential component for creating and understanding metaphor, an effective means for combining experiences garnered through different senses into a complementary, richly meaningful mental world, the total of which is far more than the sum of its constituent subparts. I would like to speculate that the landscaped garden is a visual metaphor that gives the entire brain access to insight into obtaining and maintaining psychological harmony. The wealth of observed visual effects that form the backbone in teachings of classical gardening could therefore double as a set of guidelines towards complete mental health; a beautifully constructed naturalistic garden is also the visual metaphor of a harmonious mind; by observing this garden, the viewer learns how to improve their minds, and thus the wisdom in choosing the garden as a spiritual refuge. In the distant future the skill of gardening may come to be regarded as one of our most advanced forms of technology, namely, that of tuning the environment to provide harmonized mental and physical stimulus - technology in the image of nature's best design.

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Note

* Mentioning nature, evolution and design in the same breath is not an indication of a belief in 'intelligent design' or creationism. The use of these terms is intended to convey the idea that evolved structures are optimally matched to the functions they perform.

Works cited

Blackmore, S. 1999. *The Meme Machine*. Oxford: Oxford University Press.

Benyus, J. 1998. *Biomimicry: Innovation Inspired by Nature*. London: William Morrow & Co.

Itoh, T. 1998. *The Gardens of Japan.* Tokyo: Kodansha International.

Keane, M.P. 1996. *Japanese Garden Design.* Tokyo: Charles E. Tuttle Co.

Keswick, M. 2003. *The Chinese Garden: History, Art and Architecture.* Cambridge: Harvard University Press.

Kuitert, W. 2002. *Themes in the history of Japanese garden Art.* Honolulu: University of Hawaii Press.

Mandelbrot, B.B. 1977. *The Fractal Geometry of Nature*. New York: W.H.

Nitschke, G. 1993a. *Japanese Gardens*. Koln: Benedikt Taschen Verlag GmbH.

Nitschke, G. 1993b. *From Shinto to Ando: Studies in Architectural Anthropology in Japan.* London: Academic Press.

Nitschke, G. 2004. Personal communication.

Shimoyama, S. 1976. *Translation of Sakuteiki: The Book of the Garden* (Tokyo: Town and City Planners). Attributed to Toshitsuna Tachibana, late 11th/early 12th century.

Shingen, 1466. *Senzui Narabi ni yagyou no zu* (Illustrations for designing mountain, water and hillside field landscapes). Original teachings of the priest *Zouen* dating from the 11th century, transmitted by Shingen. Published in Sonkeikaku Library, Sonkeikaku Soukan series. Tokyo: Ikutoku Zaidan.

Slawson, D. 1987. *Secret Teachings in the Art of Japanese Gardens*. Tokyo: Kodansha.

Taylor, R.P. 2002. Fractal design strategies for enhancement of knowledge work environments, *Proceedings of The Human Factors and Ergonomics Society Meeting*. CD ROM: no page number.

Taylor, R.P. 2008. Reduction of physiological stress using fractal art and Architecture. Accepted for publication in "*Artscience: The Essential Connection*", to be published in *Leonardo* (MIT Press).

Van Tonder, G.J. 2006. Order and complexity in naturalistic landscapes: *Visual thought. The Depictive Space of Perception* (ed. L. Albertazzi). Amsterdam: Benjamin Press, 257-301.

Van Tonder, G.J., Lyons, M.J. & Ejima, Y. 2002. Visual structure of a Japanese Zen garden. *Nature* 419: 359-360.

Wise, J. 2004. Personal communication.

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