Natural/Unnatural

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A beautiful fountain near Stockholm leads the author to analyse what is natural and unnatural about a sculpture. The dichotomy is undermined by a careful examination of every work of art, every social construction, every harmful or useful molecule synthesised. So, if the natural and the synthetic are intertwined, why do we scientists and others alike favour the work of Nature? Some of the reasons derive from romance, status alienation, pretence, scale and spirit. Scientists, appalled by seemingly irrational and fearful responses to the synthetic, would be well advised to ponder the ways to deal with fear – not only with reason, but also with compassion and empowerment.

At Millesgården, on the island of Lidingö near Stockholm, the work of the great Swedish sculptor Carl Milles is splendidly displayed. During a recent visit there I saw one sculpture group, the Aganippe fountain, in a new light. Its theme is classical in origin, but Milles' interpretation is idiosyncratic. The spring of Aganippe, on the slopes of Mount Helicon in Greece, was said to inspire artists and poets. Milles portrays Aganippe as a female figure, recumbent but in motion at the edge of the pool, and reflected in it. From the pool rise several dolphins, arched in mid-leap. Three of the dolphins carry men on their back, who symbolise music, painting, and sculpture. Water rises from the beaks of the dolphins; this is after all a fountain, and Milles was a master designer of fountains. The Aganippe sculpture group always gave me pleasure when it graced a courtyard in the Metropolitan Museum of Art in New York. It has now been moved to Brookgreen Gardens outside Charleston, South Carolina. At Millesgården one sees a replica, containing somewhat fewer figures. It remains lovely.

A fountain's symbolism

Fountains are about water, its motions, divisibility and reunion in flow. They are also about artifice, the real and the imagined, the natural and the unnatural. It is this last distinction that I want to explore in this review, first by showing how the artist and scientist may confound this distinction for good reasons, and then by arguing that the distinction has some warrant after all.

One of the mounted figures that rises from the fountain represents sculpture. It is a man, balanced on the dolphin's back. He is life size, much larger than the stylised, diminished dolphin, and yet this disproportion does not matter. The man is dancing, and gravity's pull is light on him. Milles' art, his recurrent aim, was to defeat gravity. In bronze sculpture! The water, which emerges as several thin jets from the dolphin's snout, is angled upwards; it falls back, under the natural force of gravity, and sprays the young man. He reaches backwards, and on one outstretched hand rests (that is not the proper word for Milles' sculpture; more precisely 'is balanced') a horse. The horse is small, the size of the man's forearm, but it is real, and galloping in the air. On the horse's head, in final defiance of gravity, another, smaller man is balanced; flying, falling, flying.

Water and bronze

What is natural and what is unnatural about this work, which is both a fountain and a sculpture? Like all fountains, it is patently synthetic, artificial and unnatural. Someone has thought up a clever device, combining art and hydraulic engineering, to manipulate for aesthetic purposes one of the essentials of life and the Earth, water. Fountains are sculpture with the unique feature that water is used as a sculptural element. And a substantial part of their interest derives from that they overcome the tension of opposites between solid bronze or stone and moving, seemingly free water. How could these elements possibly be integrated? And yet in this kinetic sculpture they are.

The artifice is that the water does not 'want' to run up, nor does it want to run in controlled channels, much less through dolphin beaks. We conspire to manufacture elaborate mechanisms to channel water, pump it up, so that it can flow down naturally, and in seeking its own level, in some places, even run straight up. Pumps, meters, gates, valves – God, all those hidden mechanics of the artificial! What could be more synthetic than a fountain?

The fountain's figures are cast in bronze, their mechanical elements made from other metals. The bronze itself is artificial. Or is it? Bronze is an alloy of copper and tin, perhaps with a little lead and zinc, an alloy of sufficient importance in the history of mankind to have an age named after it. The alloy is both harder and more fusible than its component elements, which in turn are smelted from their ores, refined in a remarkable metallurgical process by men and machines. The ores of copper and tin – covellite,

General view and detail of one figure of the replica of Carl Milles' Aganippe Fountain on the island of Lidingö, near Stockholm, Sweden: the original fountain is now at Brookgreen Gardens, outside Charleston, South Carolina (author's photographs)

cuprite, cassiterite and others – are certainly natural. But they have not always lain in the Earth unchanged. They came into existence under the action of forces operating, perhaps more weakly, over a longer time (geochemistry) than human metallurgical intervention or, more strongly, in a shorter time (the nuclear transformations in the early seconds of the universe).

Aesthetic and scientific analysis

Thus here in Milles' fountain, natural ores, unnatural smelting and alloying technology are used by natural man in the patently unnatural act of sculpture to manipulate the most natural of elements, water, and to construct images of natural man and horse and dolphin. All these are perceived by my biological eye as a fountain that pleases me and that I can compare with Roman fountains I have never seen except through their unnatural images on natural but manufactured paper! Any imagined separation of the natural and unnatural can be confounded in the examination not only of Milles' fountain, but also in the careful analysis, aesthetic or scientific, of any object in our experience.

Scientists, especially chemists, will probably like this argument. They often feel beleaguered by society because they produce 'unnatural', and often downright dangerous materials. A cursory survey of the media shows a consistent use of negative descriptive terms whenever chemistry is mentioned. Adjectives such as explosive, poisonous, toxic, polluting are so closely conjoined with chemical names or nouns that they have become stock phrases. Whereas the words natural, organically grown and unadulterated are given positive connotations, synthetics seem at best conditionally good. Yet they are widely manufactured and bought. For they do shelter us, heal us, make life easier, more interesting and more colourful. Chemists encounter frustratingly conflicting signals from society – economic dependence and reward, coupled with an attitude from the media and some intellectuals that is abusive. I wonder if there are some parallels to the attitudes toward Jewish money lenders in Europe in the Middle Ages.

One might advise chemists engaged in pure research not to take upon themselves the burden of guilt incurred by the often greedy, sometimes unethical producers and sellers of a dangerous chemical. But that is a subject that deserves its own extensive discussion – rightly or wrongly (I think both) many chemists feel that the media and society are negative not about businessmen, but about chemistry and chemists.

One should also make the distinction between the words manmade (or womanmade), synthetic and unnatural. Common language words are not insulated from the alternative meanings that usage has built for them. As one moves from manmade to unnatural the number of such other meanings, with their associated negative connotations, clearly compounds. Nevertheless, I will use these words interchangeably, because I think they are so used in the dialogue around chemicals and people.

Natural and unnatural intertwined

So the scientists will welcome what seems to me undeniable, that in any human activity, art, science, business or childrearing, it makes little sense to separate the natural and unnatural. Both are inextricably intertwined, for there is an inherent ambiguity in any attempted separation.

The chemist will go on, as I will, to make the point that all substances – water, bronze, the patina on that bronze, Milles' hands, my eyes – all have a microscopic structure. They are composed of molecules. The component atoms, their arrangements in space, confer upon these macroscopic substances their various physical, chemical and biological properties. As subtle a difference as one molecule being the mirror image of another will affect whether it is sweet, or addictive, or a toxin. Much of the beauty of modern biochemistry is in the unravelling of the direct mechanisms of action of natural, biological processes – how precisely O_2 bonds to the haemoglobin in our red blood cells, and why CO binds better. That nylon replaced silk in women's stockings is not just a lucky circumstance – there are important similarities, on the molecular level, in the composition and structure (amide, carbonyl groups; pleated sheat structures; hydrogen bonding) of the two polymers. The singular intellectual achievement of chemistry in our time is the comprehension of the structure of molecules, covering the range from pure water to the alloy bronze or the protein rhodopsin in the cones in my eye.

But lest the scientist feel too comfortable, I will go on to defend the distinction between natural and unnatural. This division has good reasons for its historical persistence. No amount of supposed rationality will make the real intellectual concerns go away, and they persist for scientists as much as they do for other people.

Chemical words and concepts

In chemistry the natural/unnatural dichotomy has an interesting history. Early distinctions between organic and inorganic substances were swept aside by the demonstration, first by Wöhler in 1828 for urea, that naturally occurring substances could be synthesised from entirely inorganic, inanimate sources. Note the subtle difference of emphasis here – organic versus inorganic, not natural versus unnatural. Both organic and inorganic molecules required human manipulation to be shown to be identical.

The identity of substances remains to this day a subject of dispute and economic value. For instance, chemists will typically scorn health food stores adver-

tising (and selling at a premium) rose hip vitamin C as being different from synthetic vitamin C. The same chemist, call him A, will get very upset when a colleague, B, says that a synthesis of some molecule reported by A cannot be reproduced. What has probably happened is that a reagent in one synthesis contains some adventitious admixture of a catalyst, due to its mode of preparation. That 'dirty' catalyst made the reaction go for A, but was absent from B's reaction flask. Pure vitamin C, synthetic, is identical to natural vitamin C. But a bottle of vitamin C made from rose hips is certainly not identical to a bottle of vitamin C made by a chemical manufacturer at a parts per thousand level. I am not implying that there are important differences, simply that there could in principle be differences in substances that are perforce impure.

Chemists might reflect on the fact that despite the seeming irrelevance of the organic/inorganic and natural/unnatural divisions in chemistry, in their own language and social structure the dichotomy has a life of its own. For instance, people in the molecular trade talk of natural product synthesis, meaning the synthesis of molecules found in nature, to distinguish it from the synthesis of molecules never present on Earth before. Significantly, however, no chemist uses the term 'unnatural products', except as a joke. The slightly guarded humour of the phrase 'unnatural products' betrays, as humour often does, some of the ambiguous feelings chemists harbour on this subject.

The chemist also distinguishes the discipline of biochemistry, which concerns the nature and mechanism of basic chemical processes in living organisms. Biochemists often aim to understand the mechanism of such processes by reducing them to a sequence of individual chemical actions. But the organic, inorganic and physical chemists who study these individual fundamental steps would hardly be able to secure a job in a department of biochemistry! Synthetic chemists speak with approbation of biomimetic methods, namely those synthetic procedures which imitate natural ones. The prefix 'bio-' obviously carries some psychological and social value. Such professional divisions and specialisations persist in giving the natural/unnatural dichotomy life, even within chemistry.

Unscientific fears

The personal conduct of scientists is also revealing. The scenario that follows is a composite of several recent experiences. Not long ago I was the guest at lunch of an executive of a major chemical company. I was prepared for small talk, platitudes and some good science. Instead, my host proceeded to unburden himself in an emotional tirade against a few young people, the American equivalent of 'the green ones' in Europe, who had given him a hard time at a press conference that morning. We were at a luxurious, recently opened restaurant, proud of bringing *la nouvelle cuisine* to this corner of America. The chairs were of light wood, delicately caned, and the napkins felt like fine linen. One could see the touch of someone with training in *Ikebana* in the fresh flower arrangements.

These young people (he kept coming back to them) dominated the public discussion after he had presented a plan for building a new agricultural chemical manufacturing facility for pesticides and herbicides. They asked him if the chemicals to be produced were adequately tested for mutagenicity, and questioned the company's control of effluents. They reminded him, aggressively and, he thought, arrogantly, of a previous mishap at another facility of that company. He found their criticism full of fears, unscientific and irrational. It seemed they doubted the need for the pesticide, a deterrent to weevils; they thought natural methods of pest control were adequate. The older man, a distinguished chemist and obviously a good businessman, was upset, perhaps because he could not allow himself to be upset at the press conference. He fumed about the confused anarchy of these people, and also hinted at organised political motives.

The good wines, first a New York State Chardonnay, and then a superb Saint-Emilion, did settle him a little. After the white wine he was able to joke about the then current Austrian wine adulteration scandal. In time, the pleasure of telling a receptive visitor about a find he had made in an antique store, an unusual Indian basket (we shared an interest in American Indian art), took over. After lunch we strolled in the gardens around the house, admiring especially the purple and black tulips then in bloom.

Preference of the natural

One does not need a business executive and a fancy modern restaurant for this scenario. I suspect that the strongest defenders of the lack of a separation of the natural and unnatural go home to houses with picture windows and not with large photographic enlargements of exotic landscapes in place of those windows. In their homes grow real plants, not artful plastic and fabric imitations. No solarium will substitute for their real Algarve tan; they will avoid plastic shingles on their house and wood grain imitations in their dining room furniture; they will complain about what the European Community is trying to do to their beer. It seems clear to me that the scientist or technologist who complains about other 'unreasonable' people not being able to see the impossibility of separating the natural and the synthetic, none the less testifies to the hold such a separation has on his or her own psyche in daily life.

So let us think about why it is that we prefer the natural, no matter who we are and what we do. I see many interconnected psychological, emotional forces at work – among them six that I can label: romance, status, alienation, pretence, scale, spirit.

Romance

In the second act of Tchaikovsky's opera 'The Queen of Spades', a masque or pastorale, 'The Faithful

Shepherdess', is interpolated, which does not exist in Pushkin's original story. Daphnis and Chloe sing of the pleasure they take in nature, in a marvellous Mozartean duet. The tradition of the pastorale is as old as that of fountains, for romance derives from an unrealistic striving for what no longer is or cannot be, or even what one wishes to put at a distance. The irony of these unreal, unnatural but entrancing constructions, supposedly about the natural, is that pastorales were fine for everyone except the people who had to make a living in the pasture. The courts are gone, but romantic traditions persist. A reaching out for nature, for real wood, the smell of hay, the feel of the wind in the sails, still determines our desires. It doesn't matter that the real stable smelled bad, or that train stations were dirty, noisy structures. I see Ingrid Bergman saying goodbye to Leslie Howard at the train station, and I know all train stations. I feel them within me. My mind's stable smells just right.

Status

The real success of the synthetic is due to some combination of lower cost, greater durability, more versatility, or even new capabilities, relative to some natural materials. This is the polymer century, when large synthetic molecules have replaced one natural material after another: nylon in place of cotton in fishing nets, fibreglass instead of wood in boat hulls. The replacement or new use (polyethylene as a food wrap, for example) is invariably a democratising process, for a wider range of materials is made available more cheaply to a larger group of people. Sanitary water delivery and waste disposal, a wider spectrum of colour, better shelter, the elimination of much death in childbirth and infancy, are now available to many more than those who could enjoy such luxuries and essentials 100 years ago. Although we still have a long way to go, this is what chemists and engineers can really be proud of having achieved.

But human beings are (nicely) strange. When they have some of anything, they want more. Or they simply want something better than their neighbours'. When the synthetic becomes inexpensive and available to all, a curious inversion of taste occurs: the arbiters of elegance decree that the 'natural' carries more cachet. If a cotton shirt is supposed to feel more luxurious than a blend which is 'permanent press', sure enough the shirt begins to feel that way. A wood floor is certainly perceived as being nicer than linoleum, and the rarer the wood the better. Perhaps I have been too negative here. Perhaps what we want is not so much to be superior to someone else, as to be somewhat (not too much!) different. The natural provides, in its infinite variability, that opportunity to be slightly different.

Alienation

We are distanced from our tools, and from the effects of our actions. We see it in routine work on an assembly line, in selling lingerie, even in scientific research. We work on a piece of something, not the whole. To be efficient we work repetitiously, so that we may even lose interest in the whole. Mountains of paper insulate us from the human beings affected by our actions. Around us proliferate machines whose workings we do not understand. I doubt that there are many among my colleagues who could do what Mark Twain's Connecticut Yankee in King Arthur's Court could do, that is to reconstruct our technology from all those partial differential equations we know. We press buttons and elevators come (or do not come). Worse, we press buttons and missiles are launched, and only the victims see the blood.

The synthetic, artificial or unnatural is almost always a factory produced multiple, inexpensive because mass produced. To be mass produced it must be stamped, cast or pressed repeatedly. The objects so made appear identical. In principle their design could be good, in practice design is sacrificed for economy. The typical mass produced object shows little of the history of its making, neither in design nor in execution. Tetracycline antibiotics, for instance, are isolated from a culture of living organisms, chemically modified, purified and packaged by remarkable, inventive tools and devices, but a bottle of 50 tetracycline pills hides the ingenuity behind that multiple product, its manufacture by human beings using tools of their own design.

There is something deep within us that makes us want to see the signature of a human hand on a product. Yet there are clever ways to individualise mass produced items. I think of the colour variations on the prints of F. Hundertwasser (hardly inexpensive) or the cheerful ceramics that Stig Lindberg designed for Gustavsberg in Sweden in the 1950s. They should be encouraged.

Pretence

The false has a negative connotation in all things of significance to human beings. To tell a lie, to pretend to be what one is not, is not to be good. Much of the synthetic world of chemicals is not only unnatural in the sense of being manmade, it also often pretends to be what it is not. In part this is a natural consequence of replacing something familiar with something else, not very different, but stronger, more resistant to heat and so on. So plastic plates carry the patterns of porcelain, and sheet plastic in furniture often imitates the wood grain. Napkins emulate linen, lace and embroidery. There is the ancient profession of marbling. I was once told by a young man who was apprenticed in this honorable craft that to be good at it one should not only study marble but also think, while painting, of the geological forces that shaped it. Now some of this is fine, but too much imitation, a dissembling that accumulates, inevitably leads to revulsion. One longs for the authentic, the real.

Scale

There can be too many of one thing, and too many, period. The first plastic ashtray, or titanium jewellery,

or (in the USSR) portrait of Lenin, looks interesting, but as more and more of them invade our visual environment, they quickly begin to bore us. The repetitive nature of its production (the key to its economic success) is often the only feature that a mass produced object then stylistically communicates to us.

Sometimes the very superabundance of artificial objects in our environment, rather than the repetition of one and the same one, repels us. The typical American motel room, for instance, offers us little respite from the artificial. The variety of plastics and synthetic fibres in the furnishing of such a room is astonishing and even intellectually interesting, as an exemplar for a course about polymers, or in thinking of the problems such a room will pose for future archaeologists. But one is hardly attracted to that setting.

Spirit

What makes scientists, indeed all of us, because scientists are no different from other people, seek out the natural? No simple psychological or sociological explanation suffices. I believe that our soul has an innate need for the chanced, the unique, the growing that is life. I see a fir tree trying to grow in an apparent absence of topsoil, in a cleft of a cliff side of Swedish granite near Millesgården, and I think how it, or its offspring, will eventually split that rock. The plants trying to live in my office remind me of that tree. Even the grain in the wood of my desk, though it tells me of death, tells me of that tree. I see a baby satisfied after breast feeding, and its smile unlocks a neural path to memory of the smiles of my children when they were small, to a line of ducklings forming after their mother, to that tree. As A. R. Ammons says, 'my nature singing in me is your nature singing'.

Fear of Nature and of technology

These six overlapping, interpenetrating categories seem to me to contain some of the many reasons for asserting a claim to the primacy of the natural. Some arise from the weaknesses of human beings, some from their strengths. What still seems to bother other technologists and scientists is that the separation of the synthetic, artificial or unnatural from the natural, and the assignment to it of negative connotation, is made by some of their fellow human beings on the basis of some irrational (to the straw man technologist I have set up) fears.

So we must talk about fear. Nature is certainly fearful, and often hardly benign. The need for shelter and protection from natural forces, perfectly neutral but for that very reason inimical to anthropocentric us, is one of the primary motives in development of technology. Fear of nature, its real or imagined dangers, is also a source of religion and literature.

Fear is an emotion. If we should want to alleviate it, or remove it, reason or knowledge play a certain role, but far from the major one. The person who is afraid must also feel that he or she gains control. Compassion is essential. For example, most of us, especially city dwellers, would be afraid to be alone and lost, on a dark night in the forest. We have read as children what happens in dark forests. We hear signs of the forces out there: if those forces are inherently mysterious, and we cannot control them, they seem all the more threatening. If a woodsman then tells us that the animals are not really dangerous, but cannot explain just why they are shrieking so, we are not much comforted.

Let us turn to a fear of what we as men, women, scientists and technologists have added to what is already fearful in nature. Why do some scientists, who (sometimes) know how to deal with the fears of their own children, refuse to recognise the real fears that people have of nuclear war, pollution, ecological disasters, or manmade threats in general? Need I rehearse the disasters which form the real basis for such fears? Affectations of superrationality are not the way to respond to such fears. Telling a person who worries about the carcinogenicity of certain ubiquitous food additives that the risk to him or her from drinking a glass of wine (the source of another carcinogen) is 10 times larger is about as comforting or psychologically perceptive as telling a child who has woken from a nightmare of being run over by a locomotive, 'don't worry about runaway locomotives, the chance of a dog biting you is much greater'.

Over thousands of years we have come to terms with the dangers of Nature. We fear it less, and this is to the credit of science, for science has helped us understand it a little better, from the behaviour of wolves to spring floods. Of course, in its random, lively way, Nature shakes us up, now and then, with a volcanic explosion or AIDS. But we have added to its repertoire of dangers our own manmade ones: Chernobyl, thalidomide, Bhopal, lakes ecologically destroyed by acid rain. These dangers are not only real, but have a hold on our imaginations that magnifies that reality, just as the books we have read on dangerous forests or ghost stories do. Because these man-provoked disasters occurred under the control of people who were supposed to be rational and expert, the authority of experts in general is undermined. And the danger is regarded as insidious, since it is out of the control of ordinary people. No wonder that the next infusion of the synthetic or manmade is viewed with fear, and the word 'unnatural' causes such negative connotations.

I would argue that the irrational fear which some scientists see behind opposition to the synthetic or artificial can be seen as a rational response, or at least accepted as an understandable reaction of thinking and feeling human beings. The fear manifests itself in a separation of natural and unnatural, and a further typecasting of the unnatural as bad. It leads to ambivalent attitudes towards the producers of

the unnatural, and also towards the unhampered extension of knowledge.

Response to fear

I think the response to that fear must encompass at least: reason; empowerment (granting people control); and compassion. Understanding and empowerment derive from education; obviously scientists must explain to people more of what they do. Science is observation and common sense logic; it can be taught. Although some scientists think it is more difficult and requires greater intelligence and creative inspiration to acquire new knowledge than to teach it, perhaps just the reverse might be true.

Scientists are badly served by the assumption that they, and they alone, speak for reason. First of all, this is just not true; the wide variety of modes of personal behaviour associated with success in acquiring knowledge within science speaks against it. So does the range of political or ideological beliefs of good scientists. Second, a claim to stand for reason alone is dehumanising and impoverishing. The creative forces behind the new and the deep in science or art are sparked by other features of our psyche. Emotions, the irrational, matter just as much as cool reason.

Empowerment requires access to knowledge and a democratic system of government. The best of present systems of governance are just an approximation to the ideal of democracy. Still, no amount of knowledge, no matter how skillfully and widely taught, will assuage fear of the synthetic unless people feel that they have something to say, politically, in the use of the materials that frighten them.

I suspect empowerment plays the dominant role in personal risk assessment. We feel safer driving a car rather than flying in an airplane, despite accident statistics to the contrary. Why? Because it is we who are driving, but someone else is flying the plane. Much of the fear of nuclear power generation and of other technological dangers, real or unreal, derives not so much from ignorance of the processes as from the feeling that we are not near control.

Compassion is easy to extend to children and the bereaved, less so to an adult worried about a hypothetical disaster. Scientists confronted by fear of technology often neglect to react with compassion. Instead, they tend to argue the points one would focus on in the laboratory; for instance, is the analytical procedure showing the presence of a pollutant at a certain level reliable or not. The scientist who responds this way only succeeds in sounding defensive. There is a place for rational discourse on analytical procedures, but after one gains the confidence of the worried person through sympathy. Compassion and empathy must be the first response.

Scientists need to distance themselves from anger provoking 'irrational fear' characterisation. I believe this can be done by a dialogue into which both science and art are drawn. The natural/unnatural distinction is obviously undermined by much great art. The discussion of the Aganippe fountain makes this clear, as would an analysis of a Japanese ceramic or Tchaikovsky's Queen of Spades. Compassion, empathy, understanding will also come if scientists muse a little as to why one part of themselves is drawn to the natural, while another part argues that the natural and unnatural are inextricably mixed.

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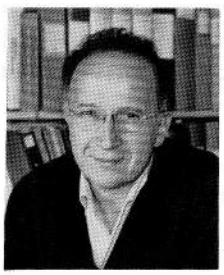

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