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- **Transhumanism and futurist philosophy**
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- **Smart drugs (nootropics) and intelligence increase technologies**
- **Machine intelligence, personality uploading, and Artificial life**
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- **Rational, market-based environmentalism**
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Extropy Institute

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EDITORIAL

> Architecture is not a business, not a career, but a crusade and a consecration to a joy that justifies the existence of the earth.
> [Henry Cameron in Ayn Rand's *The Fountainhead*, p.81]

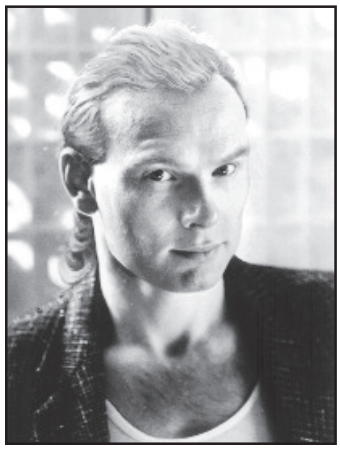


Photo by Nanc Clark

Our desire to live up to our name — *Extropy* — impels us to continuously break new ground. In this issue we do that in two ways:

1. By extending the range of topics covered. Understanding and creating a future fit for posthumans requires more than thinking about life extension, expansion into space, and skyrocketing computer power. Fred Stitt's **"Evolutionary Architecture and Extropian Consciousness"** introduces a whole new area of endeavor to be analyzed from extropic standpoints. Extropian individuals want to bring order out of chaos, shaping and defining both their own bodies and minds and the outside world. The same drive might be expected to lead us to design the environments in which we work and play optimally to assist and reward us. We have presented writing on the aesthetic aspects of an extropic life in the past, and I intend to devote more space to these topics, bringing more balance to our coverage.

We always appreciate your feedback on topics yet to be covered. In upcoming issues we expect to cover future possibilities for composing transhuman and posthuman children and new family structures; bodily modifications; a state-of-the-art life extension program; genetic imperatives and transhuman possibilities for restructuring relationships; and plenty more on computers, nanotech, uploading, economic and political processes and structures too.

2. As a glance through the issue will reveal, *Extropy* is also leaping forward in terms of graphic appeal. While the insight, boldness, optimism, ingenuity, and sheer thrill of the ideas always comes first, a slicker look helps cognitive digestion and makes it more likely new readers will pick up the publication.

The graphical upgrade results from several sources. Readers' comments resulted in the size of the type growing to improve legibility, and the number of fonts being restrained from boundless expansion. I am also delighted to welcome on board our new Art Director, Nancie Clark, whose skills and resources have added to the visual dimension of this issue.

I want to draw your attention to the Readers' Survey. FIlling it out and returning it will help us acquire more advertising to keep this publication alive and thriving. Dave Krieger (who put it together) and I will be grateful to those who send this in.

Finally, we welcome all the new readers this issue, may of whom heard about *Extropy* in the recent "Meet the Extropians" article in *Wired*. The back issue listing on p.40 will give you an idea of our range of coverage.

Upward and Outward!

Max More

P.S. We've chosen a location for the Extro-2 conference, and we have secured an eminent Keynote Speaker. See elsewhere in this issue for details.

EXTROPY — a measure of intelligence, information, energy, life, experience, diversity, opportunity and growth. Extropians are those who consciously seek to increase extropy. The Extropian Principles are: (1) Boundless Expansion; (2) Self-Transformation; (3) Dynamic Optimism; (4) Intelligent Technology; (5) Spontaneous Order. [See *Extropy* #11 for Extropian Principles v.2.5]

TRANSHUMANISM — Philosophies of life (such as Extropianism) that seek the continuation and acceleration of the evolution of intelligent life beyond its currently human form and human limitations by means of science and technology, guided by life-promoting principles and values, while avoiding dogma and mysticism. [See *Extropy* #6]

UTILITY FOG

Part Two

J. Storrs Hall, Ph.D.

To recapitulate Part One:

Active, polymorphic material ("Utility Fog") can be designed as a conglomeration of 100-micron robotic cells ("foglets"). Such robots could be built with the techniques of molecular nanotechnology. An appropriate mass of Utility Fog can be programmed to simulate most of the physical properties of any macroscopic object (including air and water), to roughly the same precision those properties are measured by human senses. The major exceptions are taste, smell, and transparency.

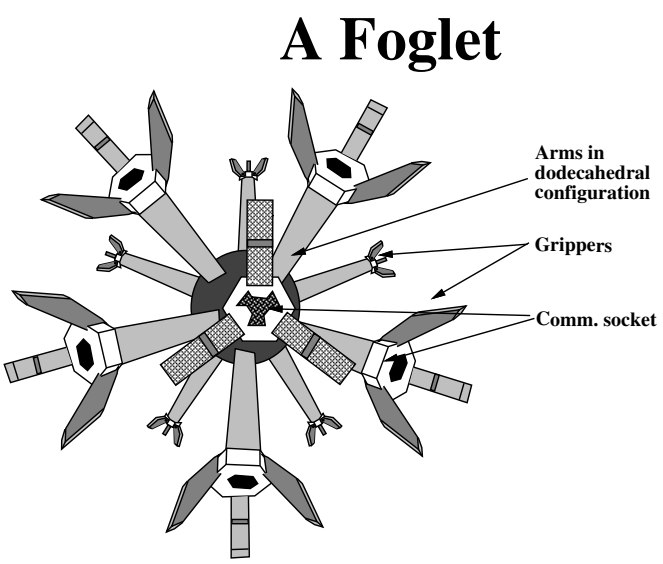
The computing power represented by Fog is sufficient for uploading into a relatively small batch, by most estimates. An intelligence uploaded into Fog could take on any physical form it pleased, and vary that form at will. In an environment filled with Fog, objects (including intelligent ones) can have virtual existence, moving as patterns instead of existing as a collection of specific Foglets.

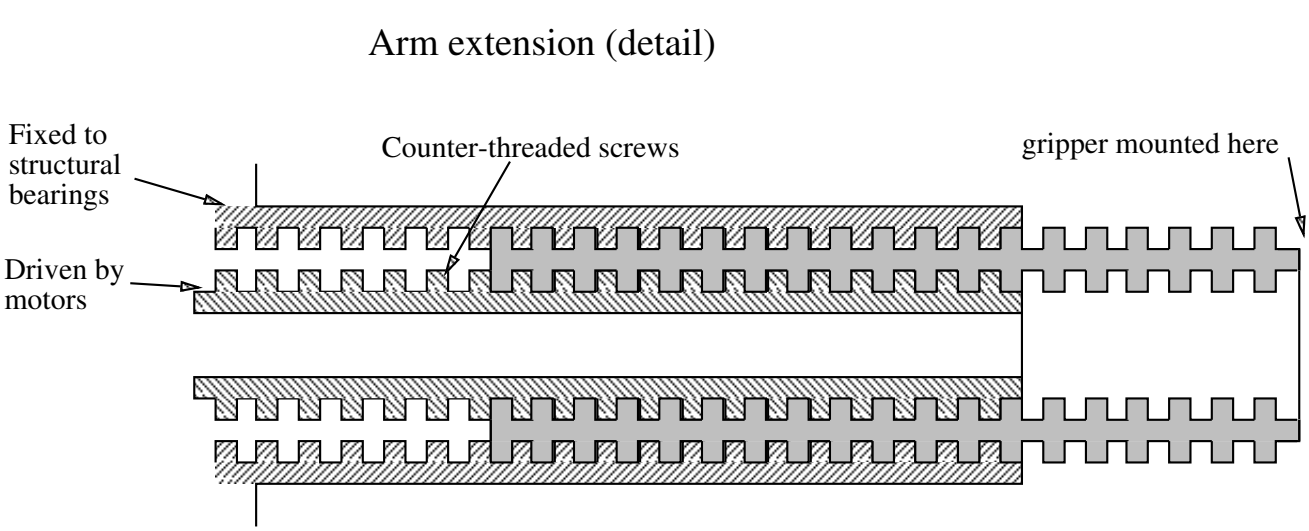
Foglets and Fog

Compared with a true molecular assembler, a Foglet will be huge and overpowered, able to control its motions to no better than a tenth of a micron instead of a tenth of a nanometer. It will have an armspread on the order of microns or more. A 10 micron armspread is about as small as it would be feasible to make a Foglet. There is no obvious upper bound on size, except to reduce the resolution and verisimilitude of the simulation. 'Foglets" whose appearance didn't matter and which were simply to manipulate objects, could be on the order of inches or even feet. It would probably be workable to have Foglets 10 or even 100 times as large as the design presented here, and would simplify some of the engineering problems. They would be visible to the naked eye, if you looked closely, but then so are the pixels on your television.

Most currently proposed nanotechnological designs are based on carbon. Carbon is a marvelous atom for structural purposes, forming a crystal (diamond) which is very stiff and strong. However, a Fog built of diamond would have a problem which nanomechanical designs of a more conventional form do not pose: The Fog has so much surface area exposed to the air that if it were largely diamond, especially on the surface, it would amount to a "fuel-air explosive".

Therefore the Foglet is designed so that its structural elements, forming the major component of its mass, could be made of aluminum oxide and/or quartz, refractory compounds using common elements. The structural elements form an exoskeleton, which besides being a good mechanical design allows us to have an evacuated interior in which more sensitive





With atomically-precise surfaces the screws should be almost completely frictionless.

nanomechanical components can operate. Of course, any macroscopic ignition source would vaporize the entire Foglet; but as long as more energy is used vaporizing the exoskeleton than is gained burning the carbon-based components inside, the reaction cannot spread. Once we get out of Earth's atmosphere, of course, we can use diamond again, assuming we can get the carbon in sufficient quantities.

Each Foglet has twelve arms, arranged as the faces of a dodecahedron. The arms telescope rather than having joints. The arms swivel on a universal joint at the base, and the gripper at the end can rotate about the arm's axis. Each arm thus has four degrees of freedom, plus opening and closing the gripper. The only load-carrying motor on each axis is the extension/retraction motor. The swivel and rotate axes are weakly driven, able to position the arm in free air but not drive any kind of load; however, there are load-holding brakes on these axes.

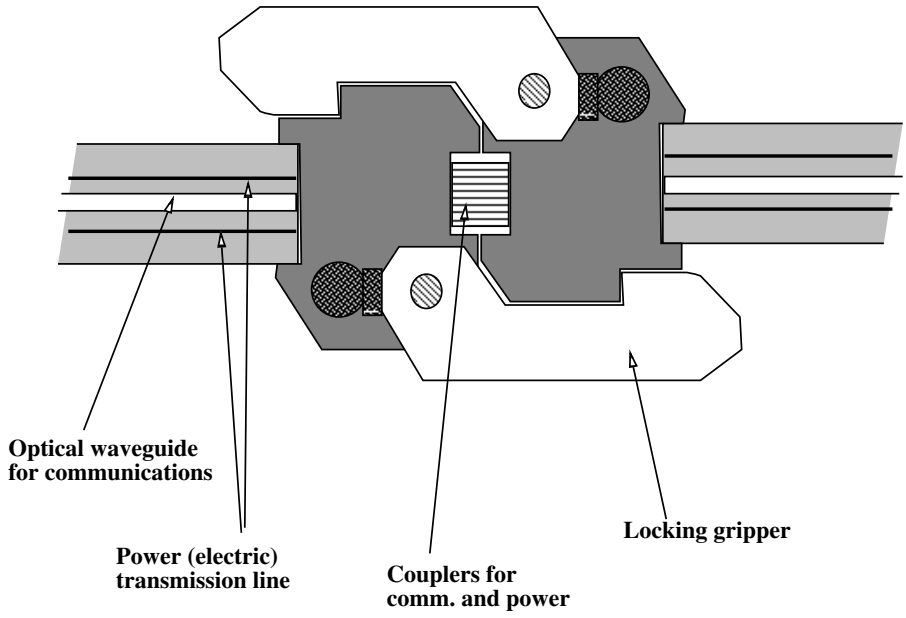
The gripper is a hexagonal structure with three fingers, mounted on alternating faces of the hexagon. Two Foglets "grasp hands" in an interleaved six-finger grip. Since the fingers are designed to match the end of the other arm, this provides a relatively rigid connection; forces are only transmitted axially through the grip.

When at rest, the Foglets form a regular lattice structure. If the bodies of the Foglets are thought of as atoms, it is a "face-centered cubic" crystal formation, where each atom touches 12 other atoms. Consider the arms of the Foglets as the girders of the trusswork of a bridge: they form the configuration known as the "octet truss" invented by Buckminster Fuller in 1956. The spaces bounded by the arms form alternate tetrahedrons and octahedrons, both of which are rigid shapes.

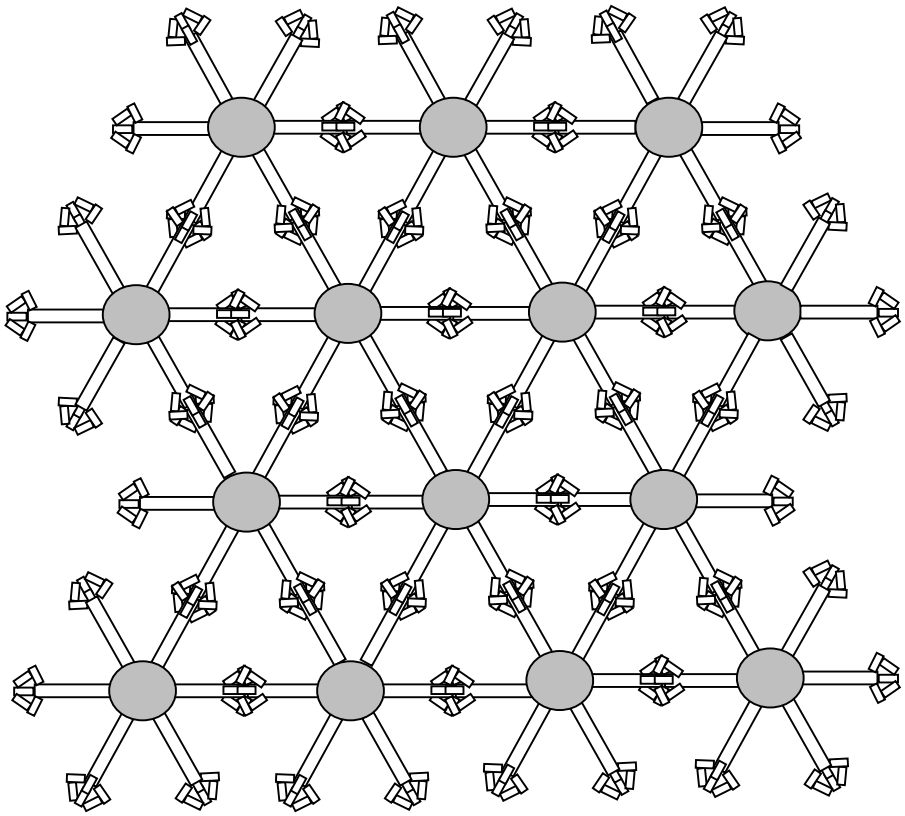
The Fog may be thought of as consisting of layers of Foglets. The layers, and the shear planes they define, lie at 4 major angles (corresponding to the faces of the tetrahedrons and octahedrons) and 3 minor ones (corresponding to the face-centered cube faces). In each of the 4 major orientations, each Foglet uses six arms to hold its neighbors in the layer; layers are thus a 2-dimensionally rigid fabric of equilateral triangles. In face-centered mode, the layers work out to be square grids, and are thus not rigid, a slight disadvantage. Most Fog motion is organized in layers; layers slide by passing each other down hand-over-hand in bucket brigade fashion. At any instant, roughly half the arms will be linked between layers when they are in motion.

The Fog moves an object by setting up a seed-shaped zone around it. The Foglets in the zone move with the object, forming a fairing which makes the motions around it smoother. If the object is moving fast, the Fog around its path will compress to let it go by. The air does not have time to move in the Fog matrix and so the motion is fairly efficient. For slower motions, efficiency is not so important, but if we wish to prevent slow-moving high-pressure areas from interfering with other airflow operations, we can enclose

The Foglet-to-Foglet Grip



One Layer of Foglets



(out-of-plane arms not shown)

the object's zone in a self-contained convection cell which moves Foglets from in front to behind it.

Each moving layer of robots is similarly passing the next layer along, So each layer adds another increment of the velocity difference of adjacent layers. Motors for arm extension can run at a gigahertz, and be geared down by a factor of 100 to the main screw in the arm. This will have a pitch of about a micron, giving a linear extension/retraction rate of about 10 meters per second. We can estimate the inter-layer shear rate at this velocity; the foglets are essentially pulling themselves along. Thus for a 100-micron interlayer distance Fog can sustain a 100 meter-per-second shear per millimeter of thickness.

The atomically-precise crystals of the Foglets' structural members will have a tensile strength of at least 100,000 psi (i.e. high for steel but low for the materials, including some fairly refractory ceramics, used in modern "high-tech" composites). At arms length of 100 microns, the Fog will occupy 10% of the volume of the air but will have structural efficiency of only about 1% in any given direction.

Thus Utility Fog as a bulk material will have a density (specific gravity) of 0.2; for comparison, balsa wood is about 0.15 and cork is about 0.25. Fog will have a tensile strength of only 1000 psi; this is about the same as low-density polyethylene (solid, not foam). The material properties arising from the lattice structure are more or less isotropic; the one exception is that when Fog is flowing, tensile strength perpendicular to the shear plane is cut roughly in half.

Without altering the lattice connectivity, Fog can contract by up to about 40% in any linear dimension, reducing its overall volume (and increasing its density) by a factor of five. (This is of course done by retracting all arms but not letting go.) In this state the fog has the density of water. An even denser state can be attained by forming two interpenetrating lattices and retracting; at this point its density and strength would both be similar to ivory or Corian structural plastic, at specific gravity of 2 and about 6000 psi. Such high-density Fog would have the useful property of being waterproof (which ordinary Fog is not), but it cannot flow and takes much longer to change configuration.

Foglets Internals

Foglets run on electricity, but they store hydrogen as an energy buffer. We pick hydrogen in part because it's almost certain to be a fuel of choice in the nanotech world, and thus we can be sure that the process of converting hydrogen and oxygen to water and energy, as well as the process of converting energy and water to hydrogen and oxygen, will be well understood. That means we'll be able to do them efficiently, which is of prime importance.

Suppose that the Fog is flowing, layers sliding against each other, and some force is being transmitted through the flow. This would happen any time the Fog moved some non-Fog object, for example. Just as human muscles oppose each other when holding something tightly, opposing forces along different Foglet arms act to hold the Fog's shape and supply the required motion.

When two layers of Fog move past each other, the arms between may need to move as many as 100 thousand times per second. Now if each of those motions were dissipative, and the fog were under full load, it would need to consume 700 kilowatts per cubic centimeter. This is roughly the power dissipation in a .45 caliber cartridge in the millisecond after the trigger is pulled; i.e. it just won't do.

But nowhere near this amount of energy is being used; the pushing arms are supplying this much but the arms being pushed are receiving almost the same amount, minus the work being done on the object being moved. So if the motors can act as generators when they're being pushed, each Foglet's energy budget is nearly balanced. Because these are arms instead of wheels, the intake and outflow do not match at any given instant, even though they average out the same over time (measured in tens of microseconds). Some buffering is needed. Hence the hydrogen.

I should hasten to add that almost never would one expect the Fog to move actively at 1000 psi; the pressure in the column of Fog beneath, say, a "levitated" human body is less than one thousandth of that. The 1000 psi capability is to allow the Fog to simulate hard objects, where

forces can be concentrated into very small areas. Even so, current exploratory engineering designs for electric motors have power conversion densities up to a billion watts per cubic centimeter, and dissipative inefficiencies in the 10 parts per million range. This means that if the Empire State Building were being floated around on a column of Fog, the Fog would dissipate less than a watt per cubic centimeter.

Moving Fog will dissipate energy by air turbulence and viscous drag. In the large, air will be entrained in the layers of moving Fog and forced into laminar flow. Energy consumed in this regime may be properly thought of as necessary for the desired motion no matter how it was done. As for the waving of the arms between layers, the Reynolds number decreases linearly with the size of the arm. Since the absolute velocity of the arms is low, i.e. 1 m/s, the Reynolds number should be well below the "lower critical" value, and the arms should be operating in a perfectly viscous regime with no turbulence. The remaining effect, viscous drag (on the waving arms) comes to a few watts per square meter of shear plane per layer.

There will certainly be some waste heat generated by Fog at work that will need to be dissipated. This and other applications for heat pumps, such as heating or cooling people (no need to heat the whole house, especially since some people prefer different temperatures), can be done simply by running a flow of Fog through a pipe-like volume which changes in area, compressing and expanding the entrained air at the appropriate places.

Communications and Control

In the macroscopic world, microcomputer-based controllers (e.g. the widely used Intel 8051 series microcontrollers) typically run on a clock speed of about 10 MHz. They emit control signals, at most, on the order of 10 KHz (usually less), and control motions in robots that are at most 10 Hz, i.e. a complete motion taking one tenth of a second. This million-clocks-per-action is not strictly necessary, of course; but it gives us some concept of the action rate we might expect for a given computer clock rate in a digitally controlled nanorobot.

Eric Drexler's carefully detailed analysis (in *Nanosystems*) shows that it is possible to build mechanical nanocomputers with gigahertz clock rates. Thus we can immediately expect to build a nanocontroller which can direct a 10 kilohertz robot. However, we can do better.

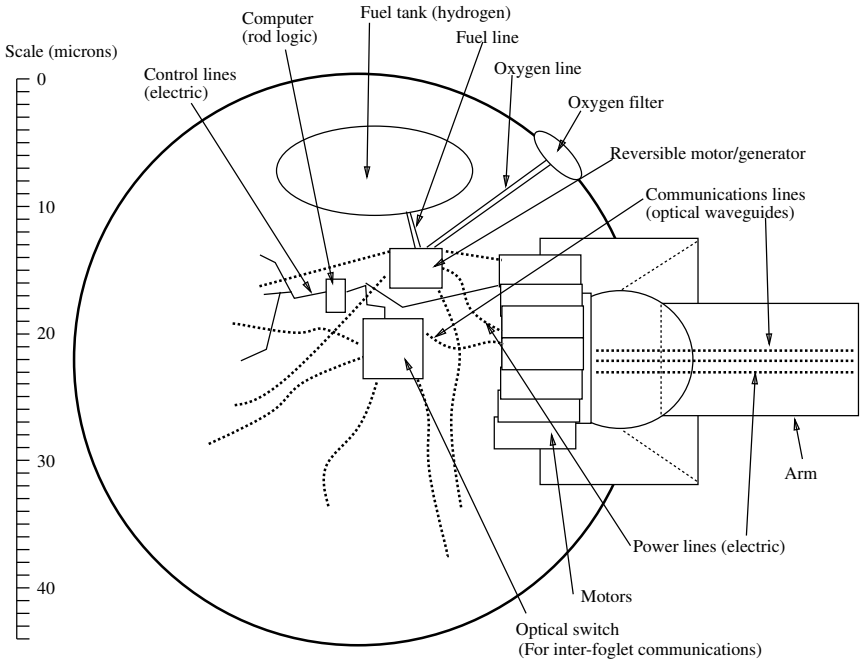
Since the early microcontrollers were developed, computer architecture has advanced. The 8051's do 1 instruction per 6, 12, or 18 clock cycles; modern RISC architectures execute 1 instruction per cycle. So far, nobody has bothered to build a RISC microcontroller, since they already have more computing power than they need. Furthermore, RISC designs are efficient in hardware as well as time; one early RISC was implemented on a 10,000-gate gate array. This design could be translated into rod logic in less than one tenth of one percent of a cubic micron.

The Fog robot, or body for an upload, can be formed of a collection of nano-engineered parts held together by a mass of Utility Fog. The parts might include "bones", perhaps diamond-fiber composites, having great structural strength; motors, power sources, and so forth.

Each Foglet is going to have 12 arms with three axis control each. In current technology it isn't uncommon to have a processor per axis; we could fit 36 processors into the Foglet but it isn't necessary. The tradeoffs in macroscopic robotics today are such that processors are cheap; in the Foglet things are different. The control of the arms is actually much simpler than control of a macroscopic robot. They can be managed by much simpler controllers that take commands like "Move to point X at speed Y." Using a RISC design allows a single processor to control a 100 kHz arm; using auxiliary controllers will let it do all 12 easily.

But there is still a problem: Each computer, even with the power-reducing reversible logic designs espoused by Drexler, Merkle, and I, is going to dissipate a few nanowatts. At a billion foglets per liter, this is a few watts. This is in the same range, volume per volume, as a human body, and is no problem for naive-mode objects smaller than elephants. However, for space-filling applications, a

Foglet Internals -- schematic (more or less to scale)

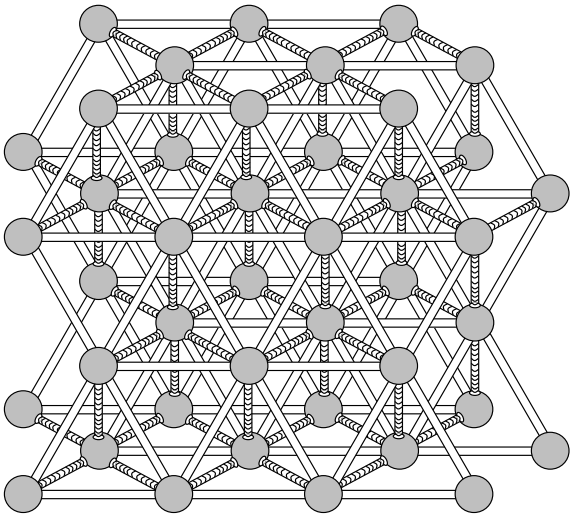


houseful of Fog is getting uncomfortably close to a megawatt. This can be made workable as long as the computers can go into a standby mode whenever the Fog is standing still. Concentrations of heavy work, mechanical or computing, would still require cooling circulation to some degree, but, as we have seen, the Fog is perfectly capable of doing that.

What about all the other computing overhead for the Fog? Besides the individual control of its robotic self, each Foglet will have to run a portion of the overall distributed control and communications algorithms. We can do another clock-speed to capability analogy from current computers regarding communications. Megahertz-speed computers find themselves well employed managing a handful of megabit data lines. Again we are forced to abandon the engineering tradeoffs of the macroscopic world: routing of a message through any given node need theoretically consume only a handful of thermodynamically irreversible bit operations; typical communications controllers take millions. Special-purpose message routers designed with these facts in mind must be a part of the Foglet.

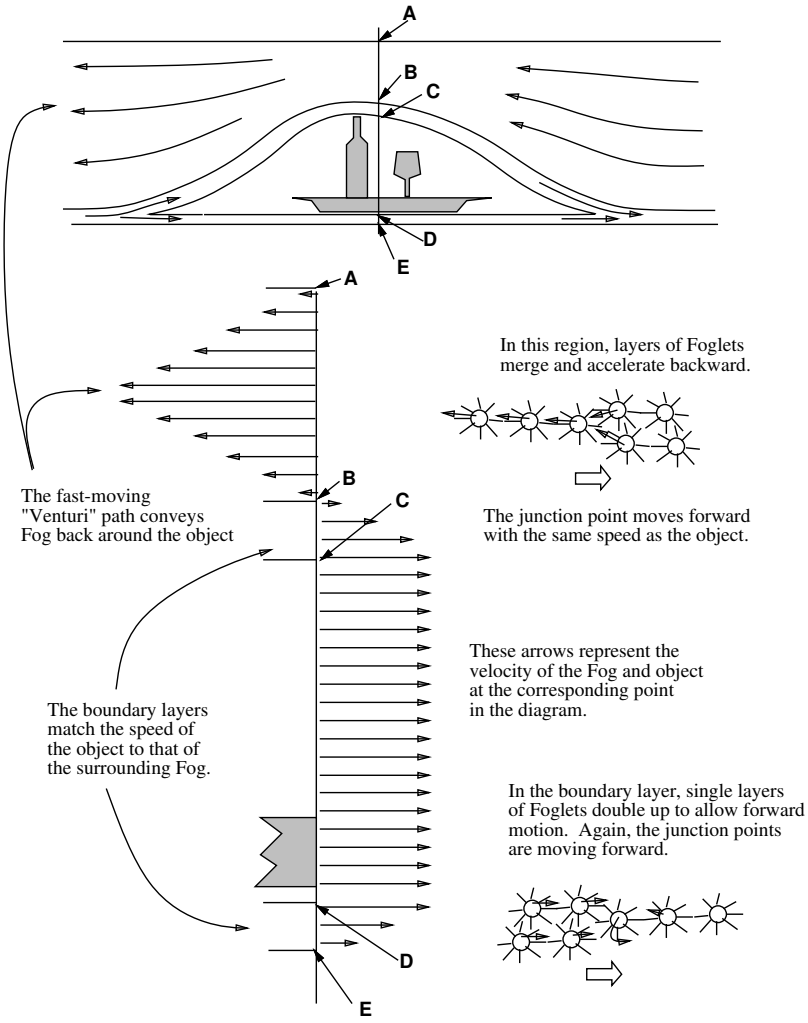
If the Fog were configured as a store-and-forward network, packets with an average length of 100 bytes and a 1000-instruction overhead, information would move through the Fog at 50 meters/second, i.e. 110 mph. It represents a highly inefficient use of computation even with special-purpose hardware. It will be necessary to design a more efficient communication protocol. Setting up "virtual circuits" in the Fog and using optical repeaters (or simply mechanically switching the optical waveguides) should help considerably.

Three layers of Foglets



This shows the lattice structure assumed by a mass of Foglets. Only three of the Foglets in this picture are shown with all their arms. Grippers are not shown at all.

The flow of Fog around a moving object



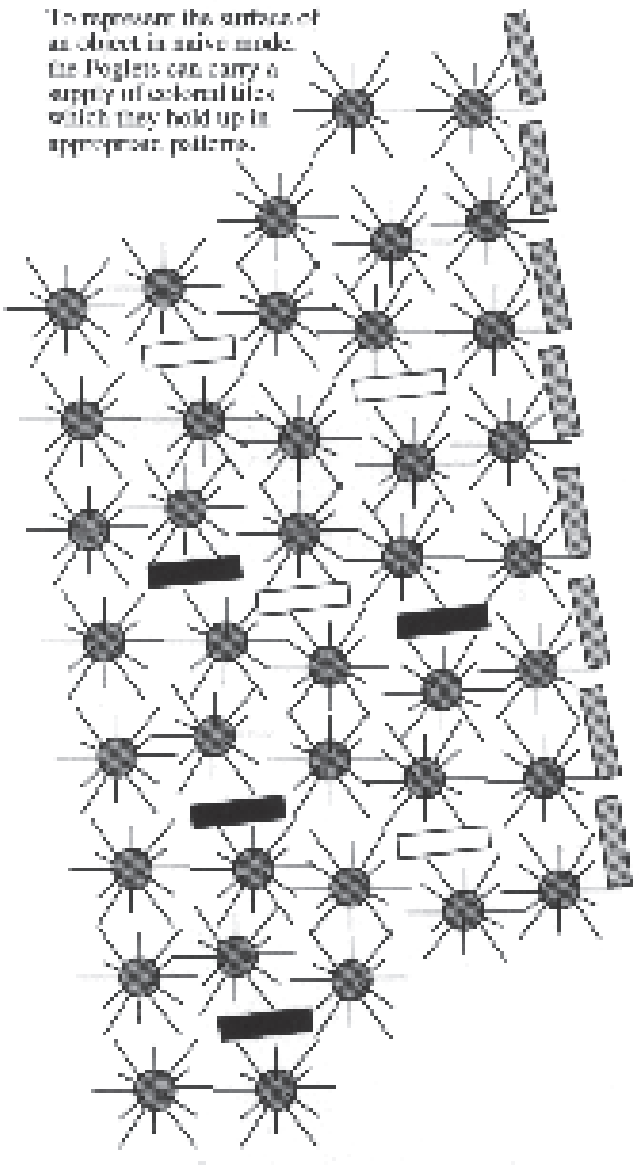
Synergistic Combination with Other Technologies

The counterintuitive inefficiency in communications is an example, possibly the most extreme one, of a case where macroscopic mechanisms outperform the Fog at some specific task. This will be even more true when we consider nano-engineered macroscopic mechanisms.

The Fog robot, or body for an upload, can be formed of a collection of nano-engineered parts held together by a mass of Utility Fog. The parts might include "bones", perhaps diamond-fiber composites, having great structural strength; motors, power sources, and so forth. The parts would form a sort of erector set that the surrounding Fog would assemble to perform the task at hand. The Fog could do directly all subtasks not requiring the excessive strength, power, and so forth that the special-purpose parts would supply.

The Fog house, or city, would resemble the Fog robot in that regard. The roof of a house might well be specially engineered for qualities of waterproofness, solar energy collection, and resistance to general abuse, far exceeding that which ordinary general purpose Fog would have. (On the other hand, raw Fog would, if desired, have excellent insulating properties.) Of course the roof need not be one piece — it might be inch-square tiles held in place by the supporting Fog, and thus be quite amenable to rearrangement at the owner's whim, incremental repair and replacement, and all the other advantages we expect from a Fog house.

Another major component that would be special-purpose would be



power and communications. Working on more-efficient protocols such as suggested above, the Fog would form an acceptable communications link from a person to some terminal in the same building; but it would be extremely inefficient for long-haul, high bandwidth connections such as that needed for telepresence.

Power is also almost certainly the domain of special-purpose nano-engineered mechanisms. Power transmission in the Fog is likely to be limited, although for different reasons from data transmission. Nanotechnology will give us an amazing array of power generation and distribution possibilities, and the Fog can use most of them.

The critical heterogeneous component of Fog is the Fog-producing machine. Foglets are not self-reproducing; there is no need for them to be, and it would complicate their design enormously to give them fine atom-manipulating capability. One imagines a Fog machine the size of a breadbox producing Fog for a house, or building-sized machines filling cities with Fog. The Fog itself, of course, conveys raw materials back to the machine.

Getting There From Here

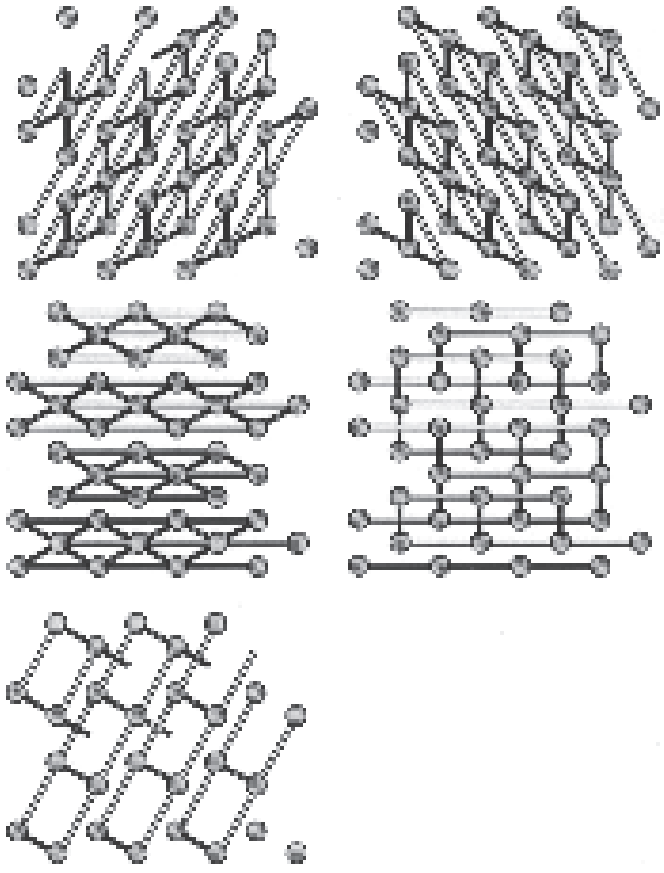
The Fog is actually one of the simpler of the nanotech devices. It does not have to live between your cells, like medical nanorobots; it doesn't have to manipulate single atoms, like assemblers. It is physically large; we didn't have to push any theoretical design limits to get everything inside. The motors, computers, and communications are all well within the limits of conservatively applied engineering principles.

It's a bit ironic that the hardest part of the Fog is the part we can do right now: the software. To be lived in, Fog needs to be very reliable. Physically, that's not too hard; a Foglet that breaks down becomes a tiny speck of dust, and can cleaned out of the way like all the rest of the dust by the remaining Fog. Furthermore, an individual Foglet that tried to be doing the wrong thing wouldn't accomplish much either. But let a distributed control program get loose and all sorts of mischief could happen.

Of course, this isn't a problem for the Fog alone. Almost any believable scenario for future technology involves ever more complex software performing ever more important functions. Already banks, phones, air traffic control, and a host of other institutions that lives depend on are run by complex, real-time, distributed programs. Perhaps the prospect of living physically embedded in Utility Fog will enhance the perceived need for simplicity, reliability, and predictability, ultimately improving the quality of all such systems.

Acknowledgments

I'd like to thank and acknowledge technical criticism and suggestions from, among countless others, Eric Drexler, Ralph Merkle, and Carl Feynman.



Methuselah's Kitchen

An Interview with Roy Walford, M.D. (Part One)

by David Krieger

with Max More

At 69, Roy Walford, M.D., is the author of two prior best-selling books,* Maximum Life Span *(1983) and* The 120-Year Diet *(1988). He received his M.D. degree from the University of Chicago in 1948 and has been professor of pathology at the UCLA School of Medicine since 1966. Author of over 250 scientific articles, Walford was a delegate to the last White House Conference on Aging, is a member of the National Academy of Sciences Committee on Aging, and is considered to be one of our leading gerontology experts.

For more than 20 years, Walford's life work has been studying the effect of low-calorie, nutrient-rich diets in animals at his UCLA lab. In 1993 he completed two straight years of studying the effects of diet on aging in humans in Biosphere 2, a sealed environmental laboratory for the study of micro- and artificial ecologies, located in the Arizona desert. The goal of Biosphere 2, funded by controversial Texas billionaire Ed Bass, is to improve humanity's knowledge of managing ecosystems in preparation for the habitation of space. The results of Dr. Walford's Biosphere studies have been published in Proceedings of the National Academy of Sciences.

In* The Anti-Aging Plan, *Walford and his daughter, chef Lisa Walford, present an easier, more convenient cookbook and menu guide for humans who want to prolong their enjoyment of food. Max More and I interviewed Dr. Walford in his Venice, California, residence. We started by talking about the book-signing by him and Lisa that I had attended two days earlier, at A Clean Well-Lighted Place for Books in Cupertino, California:

The previous night we had the weirdest book-signing that I've done so far on this tour. We went to a place called the Grain Walks Café, which had asked for a book-signing, which the publisher set up. I was thinking it was like a combination of a Starbuck's and a bookstore. When we got there, it was just a kind of hippie café on Folsom Street in San Francisco—a bunch of people sitting around in apache haircuts and things like that, and eating French-fried potatoes and ketchup; so Lisa and I walked in and thought, "What are we doing here?"

At one end there was a microphone on a stand, with a trio up there playing a guitar and singing. And we thought, "What are we doing here? This is a weird book signing." There was no bookstore or anything. We went over to the guy who was running it, and he said, "Well, you know, maybe I should have set this up in a bookstore someplace." And then some people were there who had been there the previous night because they had the date wrong, because they announced it wrong in the newspaper. Finally, somebody came in that I'd known in the '60's from the Living Theatre, Mel Clay, who's running a theater here; so we had a nice conversation. Finally, the singers were done; the owner gets up and says, "Everybody be quiet now. And the next act is Roy and Lisa Walford." [laughs] So I stood on up there at this microphone, like I'm supposed to be a stand-up comedian.

But actually, it went pretty well. Everybody quieted down. I thought, "Well, I don't have any jokes, so I'll just smile and talk informally." It went over quite well, actually. But it was just strange.

Max: You didn't start criticizing the French fries and the stuff they were eating?

Yeah, I did. "Oh, look what that person's eating," as the waiter brought it in, and stuff like that. It went over real well.

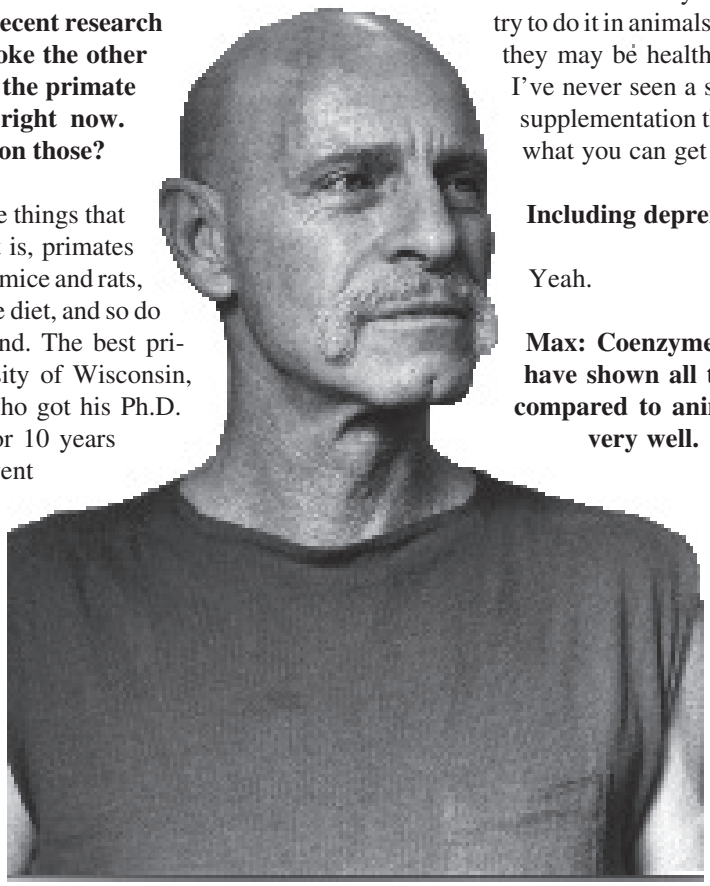
So what were the circumstances leading up to the new book, and what was the motivation for the revision?

The main motivation was that the menus and recipes in *The 120-Year Diet* were just too difficult. You had to spend too much time in the kitchen, so I got a lot of complaints about it. We thought we'd write a book that just dealt with that. It was supposed to be just a cookbook originally, but it then got extended into updating some of the other items, mainly because the publisher wanted them updated; but then the Biospherian experience came along, so that was worth putting in. But, still, the main idea was to make it feasible—

Something that's more realistic for more people?

Yes. So that's the main emphasis; the rest is secondary.

It also has some of the more recent research results. For example, you spoke the other night at the bookstore about the primate studies that are underway right now. Would you care to comment on those?



Well, they're showing the same things that I found in the Biosphere. That is, primates behave the same way, so far, as mice and rats, on a low-calorie, nutrient-dense diet, and so do humans. They go hand-in-hand. The best primate colony is at the University of Wisconsin, which is run by Weindruch who got his Ph.D. under me, then was about 8 or 10 years with me at UCLA, and then went off and was two years at the NIH, as an administrator, and then went to be an associate professor at the University of Wisconsin. So he has, I think, the best primate colony. The other primate colony is at the NIA, which I think is not as good because they don't seem to be restricting them very much. But they're also finding some results.

Max: How long have they been doing those experiments?

I think a total of about five years. They're using rhesus monkeys and squirrel monkeys. Rhesus monkeys have a maximum lifespan of 30-35 years, and squirrel monkeys 18 years. So, it's still long-term, but they'll get results sooner than humans.

Max: Were these studies before puberty or afterwards?

Afterwards.

The preliminary results are based on things like biomarkers of aging?

Yes.

You talk a little bit less in this book than in your previous books about supplementation. Has there been anything new since *The 120-Year Diet* on specific nutrients that you feel more inclined or disinclined to recommend? For example, DHEA. I believe in *Maximum Life Span*, you said that DHEA might be the mechanism by which the high-low diet produces its effects. Do you think that DHEA supplementation is worthwhile at this time?

Well, the problem with all of the supplementation is that nobody has extended maximum life span by any kind of supplementation. Until somebody does that, I think it's much less ideal than calorie limitation, which does extend maximum life span. You can make all sorts of plausibility arguments for DHEA and antioxidants and everything else, but when you actually try to do it in animals, not very much happens. I think they may be healthier, but they don't live longer. I've never seen a survival curve with any kind of supplementation that is in any way comparable to what you can get with calorie limitation.

Including deprenyl?

Yeah.

Max: Coenzyme Q10? I know comparisons have shown all the animals that have had it, compared to animals that haven't, are doing very well.

Well, they looked better, but they didn't live longer, actually. You got a more squared survival curve, but finally they died off. That [experiment]'s worth repeating; maybe they just died off by accident, the CoQ10 animals; but nevertheless, there still is not, to this day, a real good survival curve.

Max: Just to clarify about DHEA, you say that that failed to extend lifespan, or it hasn't really been tried yet?

No, it hasn't been tried. I think Richard Weindruch tried it, and didn't get much. The main thing that he was doing with that was that it interfered with how much they were eating. They couldn't quite tell whether the extension was due to their eating less because they were on DHEA, or a DHEA effect.

DHEA was suppressing appetite?

In that experiment, which Weindruch did. So, as I say, you can make a lot of plausibility arguments, but nobody really does the critical experiments; in part because it's very difficult to get funded with something as straightforward as that.

You mentioned that caloric restriction has been getting a lot more mainstream attention; you said that you're going to be

the keynote speaker at an upcoming meeting of the American Society for Gerontology. Why do you think the acceptance has been so hesitant? You mentioned some of the comparison to societal attitudes in *Star Trek* at your talk the other night; why do you think people aren't more excited, or, specifically, the medical and research establishment, aren't more excited about these results, or haven't been until now?

Well, they're just getting to be excited. They haven't been, for one thing, because the nutrition community is kind of a closed community; they don't like people doing nutrition studies if you're not of that community, and this whole area has been developed by gerontologists. So for some reason, the nutrition community has never paid any attention to it, even though it has now kind of a vast literature, and obviously deals with nutrition. If we go in the other room, I can show you some great big thick nutrition books, and there isn't a mention of any of this work in, I think, any big modern textbook of nutrition—and I've seen nutritional reviews, not directed to this subject, in which it's listed, if they discuss it at all, under malnutrition.

The nutritional community has a fixed idea that if you don't get what they call the RDA of calories, then it's malnutrition. But the response to that is, if it extends lifespan and prevents disease and keeps all the physiological parameters better, then it's nonsense to call it malnutrition. But they can't get that out of their heads; they haven't been able to. I think that's changing, but that's been a problem in the past.

It's almost encoded in their terminology; they use "food value" as a synonym for caloric content.

Yeah, a lot, yes. And of course, most low-calorie diets, in countries where there's not enough food, they're also malnourished; [the nutritionists] mix the two up.

At what age did you begin having your interest in studying aging and the prevention of aging? What experiences led you to adopt that as your goal?

Seventeen. I was just interested in a lot of things, and I thought I wanted to live longer to do them all or experience them all. You could call it the sophomoric approach of a young person, but that was how it started. I wrote an article on it in the high school magazine, *The Literary Parade*, so I have proof that I was interested at a young age. Then I went to CalTech and was torn between going into physics and math and philosophy as a package, or into biology and aging; I'm not quite sure why I went one way instead of the other.

Are you aware of the literature on nanotechnology and some of the more invasive methods proposed for eventually being able to reverse aging, and what kind of credence do you give to it?

Well, I'm not aware of it in detail, not in sufficient depth to have a real opinion.

Do you feel that we'll ever be able to completely conquer aging and, essentially, live as long as we want to?

Well, I don't see why not. There are two answers to that. One answer is that it's now known, if you look at Caleb Finch's book[1], which spells it out well, that not all animals age. It was thought for a long time that, except for maybe one-celled organisms or something like that, that everything aged, but that's not true. One example is lobsters; they just keep getting bigger and bigger. They don't undergo reproductive senescence, which would be a criterion of aging. They get bigger and they have more and more eggs; there's no decline in egg production. They finally get too big for their ecological niche; they get picked off then by accident, I suppose, but they don't undergo any fundamental aging. The other animal that doesn't seem to age are pelagic birds. The reason that that's thought to be the case is that, if you band them, and they fly off around the world and then come back, and you look at the banding, the older birds have not sustained a higher death rate than the younger and middle-aged birds. So it seem, if they were old and feeble or whatever, they'd have a higher death rate with the larger birds, but that isn't the observation.

So there's quite a few animals that don't seem to age. If that's the case then, in a sense, there's no reason why we have to age, or other animals; it's some kind of a mechanism that's evolutionarily advantageous to preservation of the species, but not to our individual desire.

Max: Of the species you mentioned that don't age, why would they be an exception in evolutionary terms? Have they not been around very long, and so haven't died out yet?

I don't know the answer to that yet.

So, there's quite a few animals that don't seem to age. If that's the case then, in a sense, there's no reason why we have to age...; it's some kind of a mechanism that's evolutionarily advantageous to preservation of the species, but not to our individual desire.

You mentioned a moment ago about reproductive senescence in lobsters. You said in your talk at the bookstore that mice that have undergone menopause have experienced a resumption of reproductive ability after being placed on a calorie-restricted diet. What benefits can be expected for humans who start fairly late with the caloric restriction, say, after age 60?

Well, their rate of aging from then on will be retarded, so that depends on what kind of shape they're at when they're 60. It's that beneficial, at least.

Second, some things that they have will be reversed, like arteriosclerosis. It's reversible if you go on the right diet. The Biospherian cholesterol got down to 123. If you get it that low, you reverse arteriosclerosis. So I think anybody who's facing bypass surgery is kind of foolish not to go on this kind of diet. For one thing, with bypass surgery, after the surgery, if they don't substantially modify their eating habits, it just comes back. The new graft, or whatever, also becomes arterioscle-

rotic, so in about five years they're back where they started. So you can reverse arteriosclerosis.

You probably can mitigate auto-immune disease substantially; and, I don't think you can cure, but you can keep diabetes under considerable control. That isn't rejuvenescence, but it's a very positive effect on disease parameters. So it can retard the rate of aging, and very possibly affect disease parameters, at age 60 or at any age.

Do you have any literary or novelistic ambitions, aside from your poetry? Do you think you might be interested in telling a story about what a society of long-lived people might be like?

I will eventually write a book called *The Long-Living Society*, because I think that when that happens it will be a kind of social revolution, and nobody's written a book about that yet.

Please elaborate; what kind of differences do you think will exist?

Well, I think values will increase quite a bit. The reason for that is that, on the whole, people who are very old are much more value-oriented and independent. I think they'll be harder to be controlled by government; and I suspect this will carry over when people are simply long-lived, even though they're not necessarily functionally old. My best story about that is the oldest man convicted for marijuana possession, in Miami. He was convicted, but the judge let him off because of his age. He didn't get sentenced or anything. The old guy's comment on it as he left courtroom, at least as reported in the newspapers, was "To hell with them and their laws." This is an attitude that you find in very old people; they figure, "Fuck it," and they're very uncontrollable. They are controllable because they're feeble, or sick and poor, but they're not controllable, a lot of them, in terms of—

Their will being dominated.

—yeah, being dominated by the media and by this, that, and the other, so I think that, as people reach those ages but are still functionally intact, they'll be less controllable by the brainwashing techniques of the government and the media. That will induce a lot of changes. Perhaps, in a way, I think we'll be much more ecologically oriented. If you live long, and you actually see what's going on, then people become more interested in the environment.

The knowledge that it will be you as well as your grandchildren who's going to have to deal with the consequences.

And there are other changes, because, if people really live that long, they'll be changing careers, and you really have to get reeducated about every thirty years if you're going to make it, as I am now doing in the whole video/multimedia technology. I didn't grow up like most kids do nowadays, tapping away on a computer when you're seven, so I have to make a considerable effort to get on top of all that exploding technology. In the course of doing that, that also throws me in with a lot of kids and others that are doing it. So there's kind of a disappearance of the generation gap.

Max: What is the Reality Club?

The agent, John Brockman, who's the agent for a lot of scientists who write books—he's pretty much cornered the market on popular science writing in terms of the literary agency—he decided to form a "Reality Club," which is mainly a bunch of New York intellectuals, beginning with the people he knows, and once a month they meet someplace and somebody gives a talk. It might be at the New York Academy of Sciences or whatever. It's kind of a revolving social club, and to be a member of the club, you have to give a talk there.

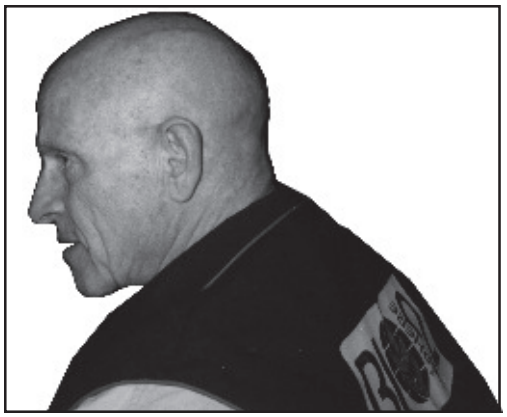
It's not necessarily limited to New York; I gave a talk there once, so I'm now a member of the club. If I happen to be in New York when they're having a session, I may go to the club, but most of the people who've written successful popular science books, I think, are members of the club.

Max: Lynn Margulis, the biologist, is a member, I think.

And Drexler, of course.

Out of that, he decided to publish something called *The Reality Club*—a series of books[2]. Other members include Mary Catherine Bateson, William Calvin, Gerald Feinberg, Dorian Sagan, Stewart Brand, and Benoit Mandelbrot.

I believe it's in *Maximum Life Span* that you mention that, even if we do manage to completely eliminate aging and disease, there's still death by accident to contend with. Readers of *Extropy* generally consider cryonic biostasis as a last resort in those kinds of situations. Do you have any opinions about the feasibility of cryonics?



Nancie Clark

Well, I think it's feasible, certainly, because I freeze individual lymphocytes in my own laboratory and keep them for years and years and years on liquid nitrogen. My father died in 1962, but I've still got his cells frozen, so I can say he's not quite dead. So there's nothing the matter with it in concept, in theory.

I don't quite buy the concept that the people who are frozen now are going to be revived; I think they've had an awful lot of protein damage, because you can't freeze a whole organ very effectively. I think if you want to take the attitude that science eventually can unscramble an egg, then okay. I don't have any objection to it or comment on it.

So, in principle, I think cryobiology is fine, and we will eventually be able to do it very smoothly and successfully, and put humans or other complicated animals to sleep and wake them up and so forth. That has nothing to do with the accident deal, though, because when the people are awake, or even when they're frozen, there's

going to be a certain incidence of accidents that will affect the survival curve. The survival curve is not going to be completely horizontal at 100%; it's going to be a downside which you can calculate, by accidents, it'll have that kind of a slope [draws a monotonically-decreasing asymptote in the air], like the fate of restaurant drinking glasses.

What I had in mind with regard to accident was, in the progress of technology there may eventually be repair techniques for whatever kind of damage people sustain in those kinds of situations—

Well, that'll lower the incidence of fatal accidents.

Max: Is biostasis or cryonic suspension something you've considered for yourself—

[Smiles.] Not at the moment.

Max: No, I mean when you might need it.

No, I know what you're saying. No, I haven't signed up for it. I don't think it's advanced enough that I want to do that.

In all of your books, you talk a bit about how the RDA standards are developed. Overall, what's your opinion of how the FDA is being run recently? David Kessler has been in charge of the FDA for something like six years or longer. What are your views of or your reactions to the Kessler FDA.

I think they're too conservative. Certainly, in terms of the aging area, they're too conservative, because they prevent people from getting things that you can get in Europe very readily. And they're not harmful, particularly. They've made too much out of thalidomide; that's justified their whole actions since that time, and that's gone too far... so I think they're too conservative.

More broadly, do you think that government agencies try a little too hard to take care of people, more than perhaps is good for them?

[Thoughtful pause.] Well, not necessarily. I think one would have to be more specific about that.

I was thinking more specifically of the actions of the FDA preventing people from obtaining nutrients, for example—and that seems to be a fairly common result of bringing the government in: "I'm from Washington; I'm here to help you" is one of the things people dread...

I think that has to be settled issue by issue, so I don't have an overall opinion on that. I don't know what I think about health care, for example. It's pretty universal in Europe, and it seems to work fairly well; I don't know why it's such a big problem here. So it depends on the issue.

If the government doesn't take care of the environment a little bit, there won't be any logs left in the whole country, so I think they should probably be more aggressive about preventing the logging industry from stripping all the logs away. So it's an issue problem.

In your remarks at the bookstore, you mentioned *Star Trek* as a negative example of realistic ideas about the progress of anti-aging in the future. Do you read or enjoy a lot of science fiction? Is that one of your pastimes?

I don't read a lot of it, but I read some.

Who are your favorite authors in that field?

Some of the cyberpunk writers. Roger Zelazny, too, although he's not a cyberpunk writer. William Gibson, Ursula K. LeGuin. I haven't read too much lately; I've just been too occupied. So I'm behind there.

The *Star Trek* example is a further illustration of something that I experienced about five years ago. I went to the IMAX theater in San Diego. Just by chance, I went in to see the movie, about space travel 500 years from now—even beyond *Star Trek.* And people were going out on these weird spaceships to other galaxies, and the voice-over said these people were very courageous and self-sacrificing in starting out, because it was only their children's children's children and so forth who would get to the other end—that they'd only be living 80 to 90 years. And I thought, "That's really crazy. Why don't they imagine that the biology of aging would get something done in 500 years?" [chuckles] It never occurred to them. People have this weird blank.

And then, I was thinking about two months ago, that *Star Trek* illustrates the same thing. But it's more dynamic, and everybody's experienced it. I think that, of just about everybody that I've talked to, anyway, it's never occurred to them that this is kind of an anomaly, that Captain Kirk ages at the same rate, and the other people in the series, as we do now.

Max: Some people have a block about this. Do you think it's just that they haven't thought about it, or do you think they're actively resisting in some way this possibility?

I think they actively resist it because of the culture that, for thousands of years, has had to deal with the inevitability of death, and has found various reasons for not thinking about it, or thinking about it in some unrealistic way like most religions, promising life after death. That takes care of it—if you're going to heaven, then you don't have to worry about aging and death. And then the philosophers have done different numbers with it. The Stoics maintained that life would get boring if you lived too long, and so forth. I think these are just reactions to not being able to do anything about it. If you look through literature, there are two schools; some of them really treat aging in a bad way, and others deal with it in a more realistic way. The Grimm brothers treat it badly; Andersen does pretty

I think the farther ahead one tries to predict something, the less value your training as a scientist becomes in making that prediction. So you might as well ask the guy who drives a truck, and not me, if you want to predict that far...

well in dealing with this. There's a whole history about that.

Speaking of the inevitability of death, in *Maximum Life Span* you mention Hans Moravec's conjectures about what's come to be called uploading—basically, moving consciousness to a machine platform. That raises the possibility of backup copies. With that as a hedge against accidental death, what do you think is the real maximum life span that's achievable? Do you think someone can stick around until the heat death of the universe?

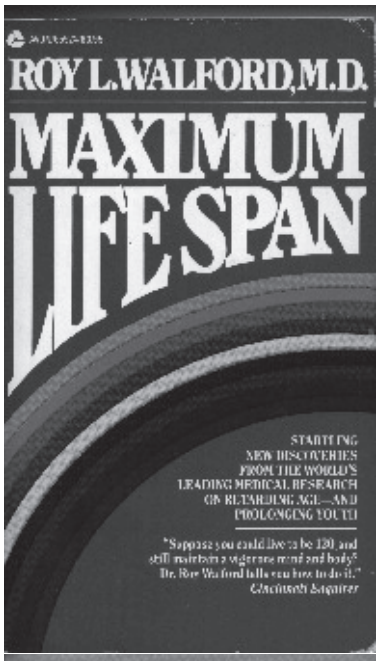
Well, I think, theoretically, one could stop aging. If lobsters can do it, we should be able to do it, eventually. And then the only thing left would be accidents. I kind of doubt that you could stick around until the heat death of the universe, because it would be pretty difficult to reduce the accident rate to such a negligible value that that wouldn't take you off eventually.

If the present accident rate remains the same, then I think the end of the survival curve is about 600 years—although there would still probably be a long tail of a few people. So I think, you know, 500 years or 400 years is probably realistic at the moment.

Max: That seems to be assuming that accident rates will remain the same. Do you think there's a chance that technology will possibly reduce those, by reinforcing our skulls, or the backup copy option? Is that a realistic possibility?

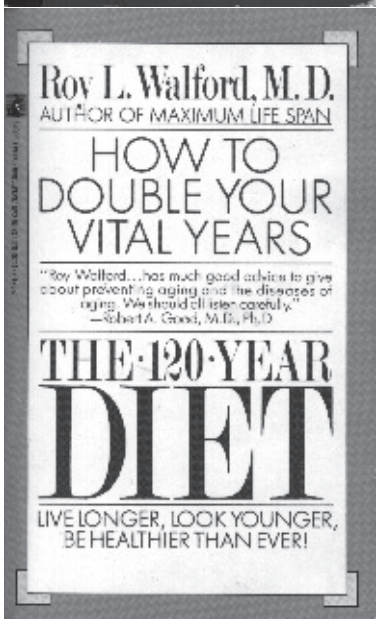
I think so, but I think the farther ahead one tries to predict something, the less value your training as a scientist becomes in making that prediction. So you might as well ask the guy who drives a truck, and not me, if you want to predict that far in the future. That's the answer; so I don't try to predict that far, because I don't think my expertise has any meaning in that kind of prediction.

There are examples of that: Einstein, Niels Bohr, and Lord Rutherford all predicted in 1937 that we'd never get power from the atom, for example; C.P. Snow tells that story. The predictions about computers have been, obviously, way off, in terms of how many there would be. It was predicted in 1950 by a commission, I think, put together by Roosevelt, or the government anyway, that there would be 200 mainframe computers by 1970. There were actually 100,000 or something like that. Predictions by experts become increasingly unreliable as you stretch the time into the future.



Max: I was going to ask, what do you see yourself doing 20 or 30 years from now? What would you like to be doing?

Mathematics. I started out in physics and mathematics, but I don't know—I'd like to get rid of everything else and just think about mathematics, but that's kind of the idea. It's kind of paradoxical, because most mathematics is done when you're 20 or 25, so I'll see; but I've always liked math, pure math.



Max: So you want to have a period of video technology and then math?

I want to get into art and literature for about 20 years; and then after that, I don't know what I'll do. Something like that. Maybe I'll sit around and think I'm a mathematician, but I don't know. You asked, so that's it.

[In Part Two of this interview, Dr. Walford speaks candidly about both the physical and the emotional climate inside Biosphere 2, the controversy over changes in management at Biosphere, and his hopes for our future in space.]

NOTES

[1] Finch, Caleb Ellicott. *Longevity, Senescence, and the Genome*. Chicago: University of Chicago Press, 1990.

[2] Brockman, John. *The Reality Club*. New York: Lynx Books, 1988.
— *Speculations*. 1st ed. New York: Prentice Hall Press, 1990.
— *Doing Science*. 1st ed. New York: Prentice Hall Press, 1991.

Evolutionary Architecture and Extropian Consciousness

Fred A. Stitt

Director, San Francisco Institute of Architecture

We will live in an age in which our buildings are grown rather than built.
They'll react actively to resist damaging forces such as weather, fire, and earthquakes.
Some will float; some will fly; some will be grown beneath the sea.
Some will be on other planets and some will be starships.
Some will be permeated with sensory devices and biorobots; every component will anticipate and respond to human direction.

All these buildings will maintain a degree of conscious intelligence and the ability to quickly adapt and change in whole or in part.

This new architecture will be the inevitable result of technical competence, part-icularly in biotechnology and nanotechnology. Much of it doesn't have to wait for the more far-reaching technologies; much of it is achievable today.

But if the design of these buildings is left in the hands of today's architectural elite, there will be no aesthetic competence.
The buildings born of brilliant technology will be lifeless lumps, neither inspired nor inspiring.
In terms of enhancing human life, they'll be better left unborn.

There is a choice…

Like no building that ever existed...

Imagine waking up one morning in your brand new home — a home unlike any ever seen on the planet.

As you move from space to space, you're surrounded by intensely beautiful forms and patterns. The experience is more like being inside a piece of music than being in a building.

As you make the morning transition from sleep to wake to work, everything in your home is your helper. Light appears where you need it. The things you need are where you need them as you need them. There's a pervasive logic underlying and surrounding everything you see and do — the home is a perfect extension of yourself.

Your home wards off distractions, discomforts, and functional irrationalities. It helps you focus your mind. It raises your consciousness. It inspires. When you sit down to work, your home actively helps you find and express the best that's within you.

When you step outside, you look back to see the totality of your home — an imaginative extension of the landscape. It seems to grow from the earth like a natural object but also reveals the most advanced construction technologies.

Above all, the home is yours and yours alone in plan, concept, and expression. Most houses are expressions of fear of being different from the neighbors. Your home has been designed by you and your architect to express and enhance the most unique aspects of your personality, life, and work. It's individual because you're individual, and it's unique in the same ways you are.

Most important, your home is designed to support, enhance, and reward your consciousness. Unlike the houses where you were raised, the schools you attended, the workplaces you've labored in . . . this building makes it a pleasure to be awake and alive.

A nice picture… Does it really exist?

Remarkably, it does. Dozens of architects are creating buildings like this. And at the San Francisco Institute of Architecture, we're training many more young architects who will be creating the greatest buildings of the next century.

A new architecture, with old political enemies

This architecture is all the more remarkable because it exists despite the efforts of hundreds of architecture schools, dozens of critics, and thousands of architects to make it not exist. It may seem crazy to the readers of this journal; there are a lot of architects and educators who despise the very idea of the kind of environment I've just described.

I taught architecture during the late '80's and early '90's at UC Berkeley. I have taught and lectured widely to architects and students across the country, and I can say flatly that almost any student of architecture who tries to design creative, inspiring, architecture will be discouraged from doing so. If the student persists in trying to learn how do do such work, he or she will most likely be flunked in design classes and will eventually be thrown out of school.

Yes, it's just like *The Fountainhead. Fountainhead* opens with the dean of the architecture school telling Howard Roark that he had better lay off, bend a little, and do buildings that look like everybody else's work or he's going to be kicked out. The dean was making a political statement, and when Roark refused to bow down, he made a very basic self-affirming statement in response.

As an architect who is very much in touch with the profession, I can say *The Fountainhead* was amazingly accurate in its depiction of the architectural profession. It was accurate when it was written in the 1930's, and it's still on target. Nothing has changed as far as architectural politics, education, and professional standards go. In fact, in many ways, things are worse.

That doesn't mean there isn't some great work being done. It just means that the best architects and their clients manage to do their best work despite widespread ignorance and resistance.

The ideological schism described in *The Fountainhead* is still real. Today's most influential architects and critics are typically mystics, subjectivists, and collectivists. Some of the most influential in this century such as Le Corbusier, Philip Johnson, and today's dominant aesthetic theorists, were supporters or collaborators with the Nazis. The dominant philosophy in today's most fashionable architecture schools is Deconstructionism. Heidegger, a philosopher midwife for Deconstructionism, considered Nazism the to be the highest social expression of his world view and was an active Nazi for most of his adult life. The architectural expressions of Deconstructionism, are, as you might expect, not especially rational, humane, or exciting.

By contrast, the finest advocates of our most humane and creative architecture, such as Frank Lloyd Wright (the model for the fictional Howard Roark), have been uncompromising standard bearers of reason in philosophy, freedom in human affairs, and innovation in architectural design and technology.

Why good architects are hard to find

Frank Lloyd Wright was the most rational and inspired architect of our time . . . and was also the most despised by other architects. Eventually they ended up reluctantly imitating superficial aspects of his work and discarding the most important parts. These imitations became the movement of bare-bones, glass-box Modern Architecture.

There isn't space here to describe how Frank Lloyd Wright designed his buildings. But you should know that he evolved a method of design that was totally divergent from what most architects are ever taught or ever heard of. They can't understand his work, or the work of those of similar mind, because they can't grasp the principles of creativity and organic, evolutionary design.

In terms of creativity; most architects are trained to design by copying existing buildings. They were trained that way one- and two-hundred years ago, and they're still trained that way. If you ever wondered at the sameness and lack of originality in most buildings you see; that's the root reason. As copyists, they never experience a full-blown creative act. They never experience what it's like to create a totally original solution to a problem. After enough years of this, they don't even think about such a thing as being desirable or possible. To them, an original creative architect is an inexplicable freak of nature, to be wondered at, perhaps feared, but certainly not to be understood.

In terms of judgment, most architects are taught to bow to the judgment of others. In school, their designs — if original and exploratory — are trashed by guest critics, instructors, and other students. Usually they're too young to know how to respond to the jargon of the older faculty and students and gradually relinquish independent judgement. They learn to mouth the same jargon in the same way about the same things. It's terribly sad to see.

The buildings of Frank Lloyd Wright and those who have followed are called "Organic." The word is applied because the buildings are so intricately organized — every part relates to the whole as the whole relates to the part — like great, complex symphonic music. "Organic" is used in the sense of integrated: buildings integrated to their purpose and the physical and psychological needs of their users; integrated with the site and surroundings; integrated within in terms of materials and engineering systems; integrated in terms of uninhibited expression of the highest values of their owners and designers.

Since the word "organic" has so much common identification with compost piles, veggie gardens, and curvelinear forms, some architects prefer words like Evolutionary, Visionary, or Futurist to name their work.

Education towards a new architecture

By its nature, Organic or Evolutionary architecture is usually highly original. Originality is not the goal, it's part of the means to create the best solutions to unique problems. And since one of the goals of such architecture is to stimulate the conscious awareness and creativity of its users, innovation is a natural part of the values being expressed as well as part of the process of expression.

The making of a creative school of architecture is similar to making this kind of architecture.

It's fairly easy to create a great new school. Much of it is just to do the opposite of the existing schools. Where traditional schools repress self-directed consciousness and creativity, reward it instead. Where schools set up endless regulations and roadblocks to learning; eliminate the roadblocks. Provide open enrollment, reasonable fees, and an education that respects the student's time and intelligence. This may be unusual, but as I discovered in establishing the San Francisco Institute of Architecture, it's the reasonable and, hence, fairly simple thing to do. (Of course, if you were in a situation where you had to ask permission from higher authorities to do such things, that would be a different story.)

Above all, for a school to be functional, it must enhance human consciousness by rewarding it. When minds are rewarded, they open up, they function. The processing power of the frontal cortex is only dimly comprehended, but calculations I have accepted put it on the order of four quadrillion bits of data per second.

This immense processing power is applied by most people in pursuing dysfunctional concepts, dead-end belief systems, mind-numbing superstitions and religions, and general self-repression.

Self repression is learned in school — public education — that provides what is essentially one year of education spread out over ten or twelve years of trivia, distraction, withholding of data, and abject boredom that makes learning synonymous with torture. Students learn early on to repress their own immense intellectual potential or they're subjected to every kind of emotional torment from professional educators.

The public school situation is a macrocosm of the circumstance of children who were liberated from mental hospitals years ago under the Reagan administration in California. Many of the children, when objectively tested before their release, were found to have intelligence that was far above average. They had been confined to institutions because their intellectual behavior was frightening to their "normal" parents. Many of them adapted to what was expected of them at the institutions. learning to mimic the behavior of imbeciles because that was the behavior that would be accepted and rewarded by their keepers.

Architecture that rewards consciousness

The most fundamental reward of Organic/Evolutionary architecture, is that it enhances consciousness by rewarding it. The more enjoyable a work of art, the more you activate your consciousness to take it in; and the more you activate your consciousness, the more pleasure you experience just in the simple act of being more conscious.

People shut down large parts of their nervous systems when consciousness only brings them ugliness and pain. The mind recoils from grinding visual and audio noise, from confusion, bleakness, and boredom.

Conversely the human nervous system opens up to receive music, drama, scenes of natural beauty… The internal structures of such art reflect the internal logic of human neural activity.

Just as a drug can't have an effect if it can't find internal molecular receptors that complement and match the drug, neither can people perceive that which is not already structurally encoded in the brain. On the sensate level, for example, certain layers of nervous tissue towards the back of the visual cortex are activated only by the experience of attributes of vertical and horizontal lines and edges. If the vertical receptor layer is cut out, for example, the nervous system cannot perceive vertical images.

The nervous system contains such an enormous complex of linked memories, structured data processing, integrated sensates and percepts . . . that it responds, with pleasure, to experiences with external structures that match human internal organization. Thus the pleasures of mathematics, creating new ideas, poetry, and fantasizing. (The schools, of course, manage to turn the natural childhood pleasure of such activity into pain… that's their job.)

When experiencing non-natural, albeit great artificial environments, there's the added sense of pleasure that these are the creations of human beings; a reminder that people can do great things. For those to whom human potential is a high value, this is a source of intense emotional pleasure.

Similarly, each individual develops a hierarchy of values, a set of beliefs of what is good or bad for his or her existence, and every person responds emotionally when those values are affirmed or threatened.

Art is the preeminent mode of value expression. Art is treasured for the powerful emotional pleasure or pain it can induce. In addition to value expression, an art work has to be integrated enough to be experienced as a totality, and often the skill and complexity of that integration offers an esthetic experience in itself. Aside from simple integration, if there's no value expression to connect with, there's no emotional impact. The expression has to be through symbol, metaphor, or analogy or the expression will just be literal — a statement of the artist's likes and dislikes, instead of a *showing* that bypasses analysis and gets right to the emotions. (The literal statement: "I ad-

mire genius", can be greeted with a nod or a shrug; but the literary dramatization as in *Fountainhead* or *Atlas Shrugged* reaches much deeper into the nervous system.)

Buildings as expressions of abstract values

As in all the arts, there's a hierarchy of intellectual and emotional satisfaction in the experience of man-made environments.

A building that is just a functional shell like a typical warehouse discount store for example, can be appreciated if not thrilled to, for its plain efficiency. A theater, can be appreciated for technical expertise in distributing sound and for design competence in enhancing the stage performances. Such a building can be satisfactory as a well-done background, if not as a major emotional thriller in itself.

But every now and then a building does so much more than satisfy functional needs that it attracts people by the thousands as an art object. The famed *Falling Water*, the house on the waterfall by Frank Lloyd Wright is one such building. So is the Guggenheim Museum (a great building despite it having been much reduced in scope and quality by a corrupt New York City building department). So are the ancient temples of Karnak, the Parthenon, and Pantheon; the Gothic Cathedrals of Europe; and so on.

The sensory/emotional experiences of these buildings are not unlike that of full perceptual openness triggered by natural settings. When on the ocean and experiencing the totality of fluid rhythms, wave sounds, and the feel and smell of the sea winds — that's a dynamic, integrated (organic) experience that opens up the senses and the mind. People experience much the same when skiing, hiking through mountain vistas, resting at country streams, strolling in the woods . . . The senses are rewarded, receptors open up, and the experience of opening is accompanied by pleasurable endorphin flow.

When experiencing non-natural, albeit great artificial environments, there's the added sense of pleasure that these are the creations of human beings; a reminder that people can do great things. For those to whom human potential is a high value, this is a source of intense emotional pleasure.

One may disdain the irrational impulses behind the religious buildings of the world but the greatest of these buildings were designed to uplift the human spirit as promotions of their particular religions. They do the job. From Japan to India to Iran, they offer concentrated experiences of aesthetic pleasure that move people to tears whether they're religious or non-religious. Many people believe the aesthetic experience they're having has a supernatural origin, many others know better, but that doesn't diminish the pleasure of being engulfed by beautiful environments.

It's recent in history that great architecture became affordable by people other than aristocracy or priesthoods. Now many hundreds and eventually thousands and millions of individuals will live and work in their own concentrated experiences of aesthetic pleasure.

The Extropian connection

Some of the greatest architecture to come will be virtual — full experiential compositions that engage every audio, visual, and tactile receptor in the body.

Some will be portable and variable — grown, used, and recycled as needed — by mechano- or bio-nanotechnology environmental fabricators. (To a degree, this potential already exists in that buildings, ships, and virtually any other object can be grown and shaped to any purpose in sea water by means of mineral attraction to wire mesh that is charged with low-voltage current. The electrolytic accretion growth can be reversed too, just reverse the current and the cemented molecules will dissipate.)

Nanotechnology will create opportunities in environmental control so extraordinary that most human imaginations I know, and I know the best, still can't grasp all the implications. But there's one implication that's rather frightening.

If nano replicators and "make anything" machines aren't designed with built-in aesthetic integrators, the objects they make may be profoundly ugly, disorganized, and boring.

There's an interesting warning of what can happen in Japanese architectural history. Japanese houses were designed and built by carpenters who followed quite special principles of design, proportion, composition, and construction (similar in many ways to those of Frank Lloyd Wright and the Organics). The result was a nation of homes that were amazingly beautiful and ennobling, no matter how small or humble.

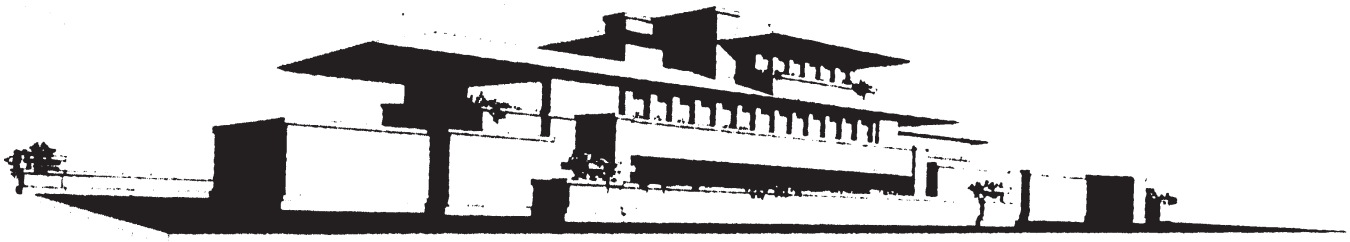
In the 19th century, the Japanese switched to an imitation of Western architectural education and sent their young architects to Europe to learn imitative classical architecture. Carpenters stopped designing the houses and the aesthetic principles were forgotten. The result has been generations of western-style architecture that is appallingly clumsy, disorganized, and brutal compared to the serene beauty of what was discarded.

It was the SYSTEM that was discarded and that's where the new Japanese buildings fell apart experientially. Similarly, if there are no fundamental organizing principles to organize the appearance of nano-made objects and environments, we'll have a universe of the ugliest stuff you've ever seen. Of course many who haven't enjoyed the mind-expanding pleasure of aesthetic experience will say: "So what!" Which is the whole point and the whole problem. Like freedom and creativity, those who don't know what it is, can't value it or appreciate what it means NOT to have it. The loss to future generations could be incalculable.

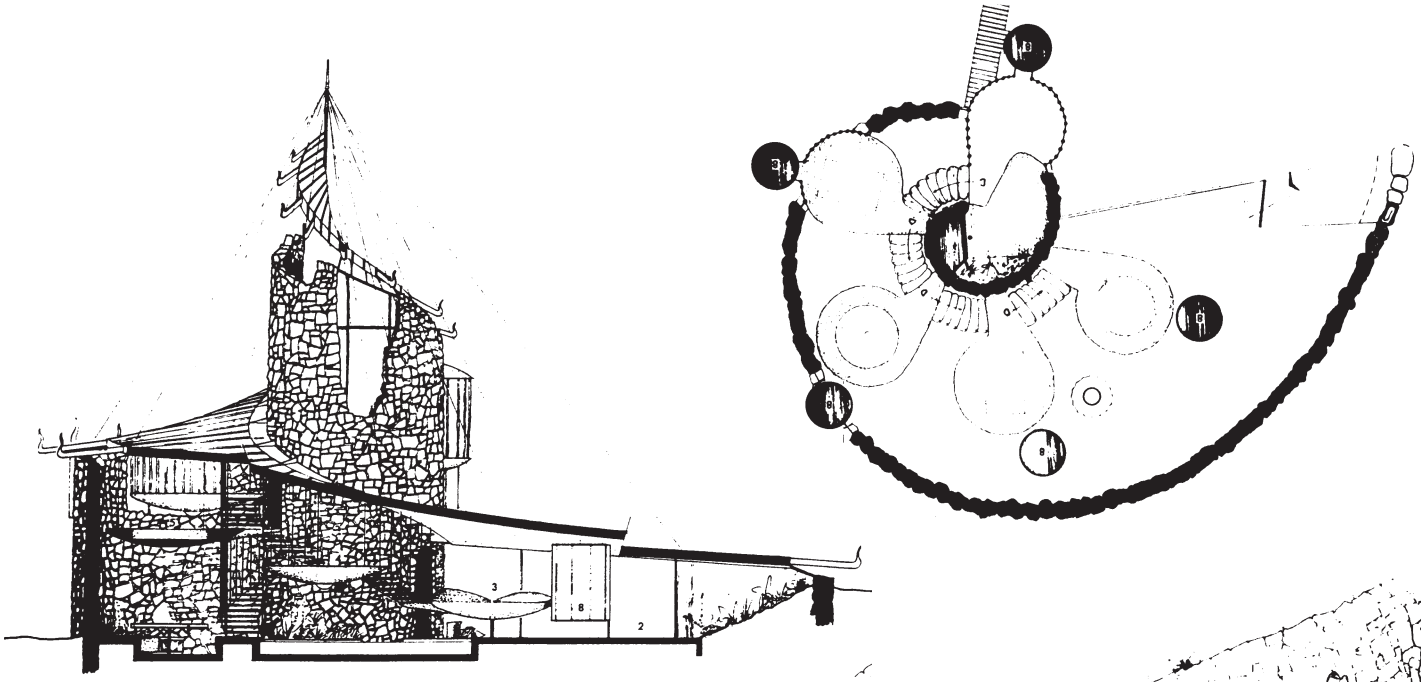
An album of organic and evolutionary architects

The drawings that follow illustrate a few works of the many architects who provide teaching, consulting, and moral support to the San Francisco Institute of Architecture

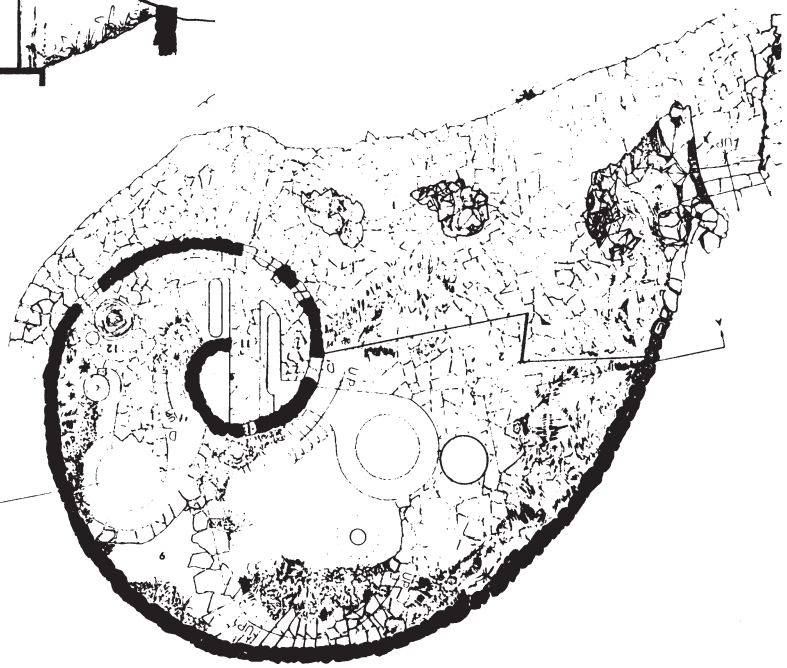
For more information about the San Francisco Institute of Architecture, write to SFIA, Box 749, Orinda, CA 94563. 510-254-9395. Fax 510-254-9397

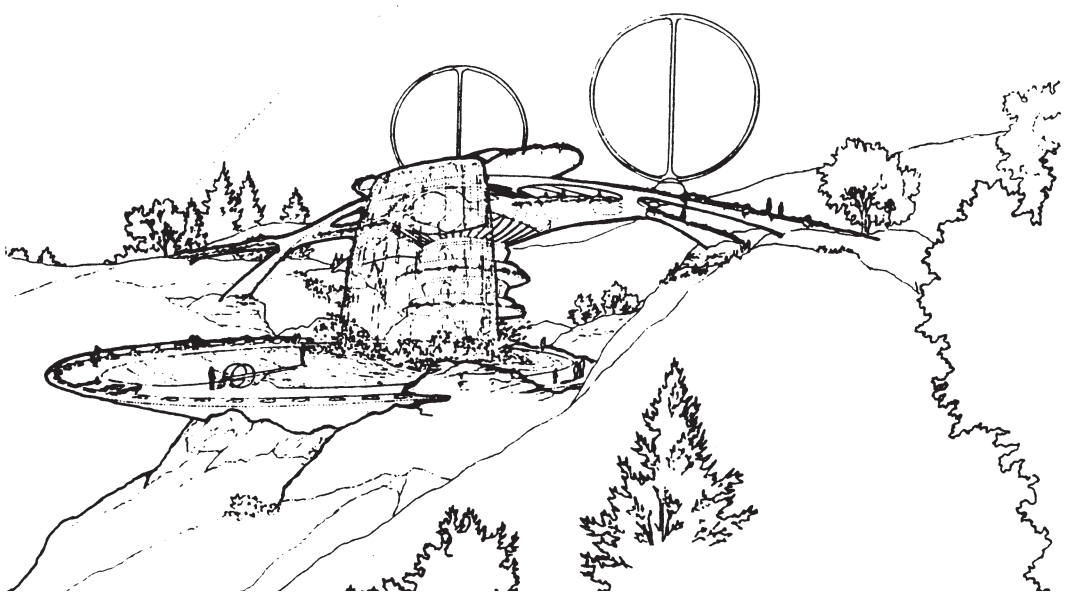


Reinventing architecture.
Frank Lloyd Wright questioned every common tenet of architectural design, looked for every functional and aesthetic problem in the buildings around him and started testing new solutions. The result was a new architecture that set the standard for generations to come. Contrary to common belief, Frank Lloyd Wright did not force designs on clients on a "take it or leave it" basis. He went to great lengths to understand the psychology of individual clients and to accommodate personal idiosyncrasies.



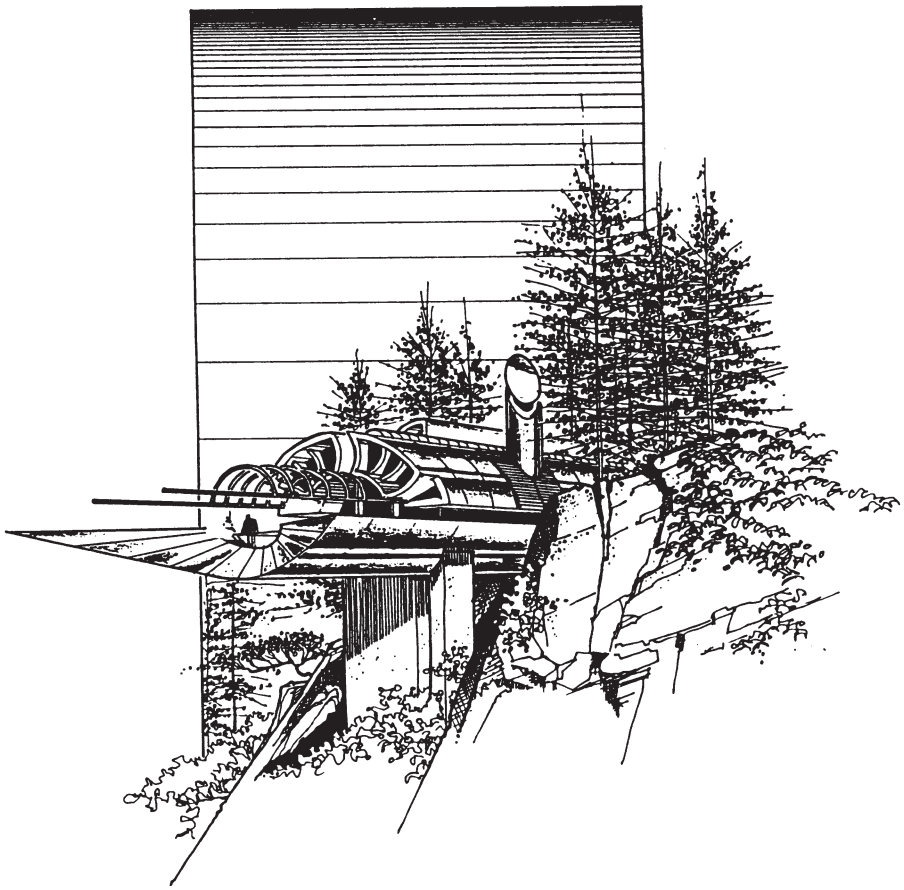
Reinventing architecture... again.
Bruce Goff, protege of Frank Lloyd Wright, focused on creating totally individual new forms to suit each client. The clients for this house wanted a totally open, flowing space, tropical plants, a pond for tropical fish. The circular bedrooms float within the main space and can be open or closed as needed.





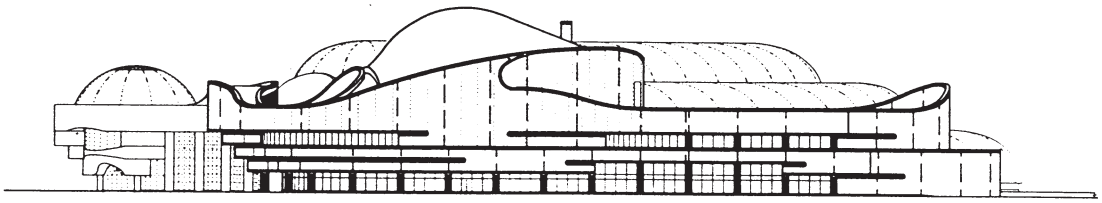
An autonomous house for Marina County that generates its own electricity supply with solar power and windmill generators, has its own wastewater treatment which includes a waterfall, and is supported on hinge foundations designed to ride out any earthquake.

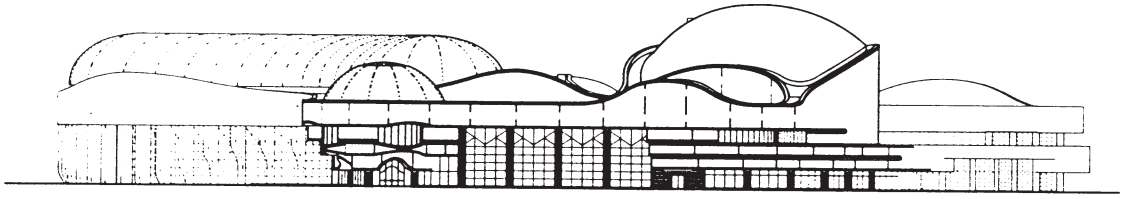
Eugene Tsui, Designer, instructor, San Francisco Institute of Architecture.



High-tech hillside home for Berkeley, California

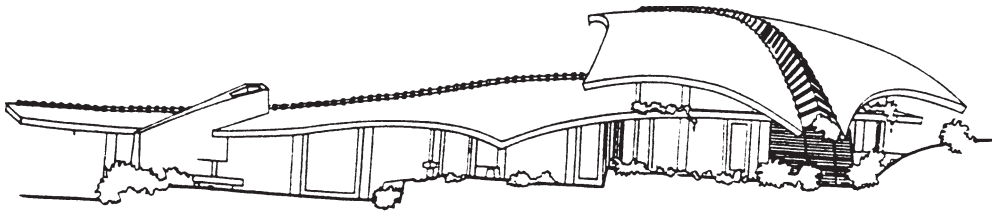
Arthur Dyson, Architect, Fresno, CA. Lecturer in Architecture, San Francisco Institute of Architecture





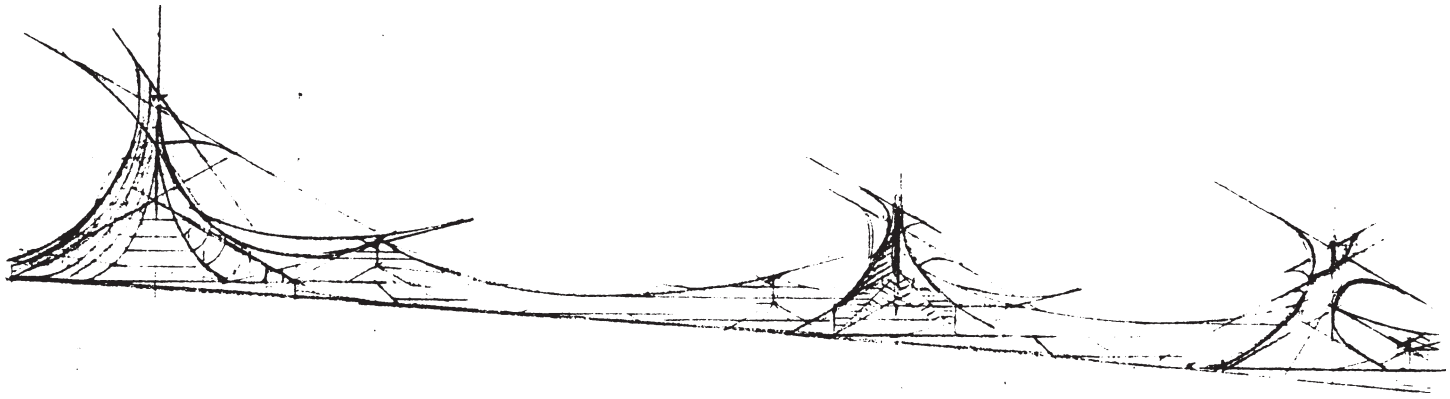
The Museum of Civilization, Ottawa, Canada. An extraordinarily complex building which was designed totally from the inside outwards as dictated by the needs of the users of each room. All drawings for the project were created on computer from start to finish.

Douglas Cardinal, Architect.



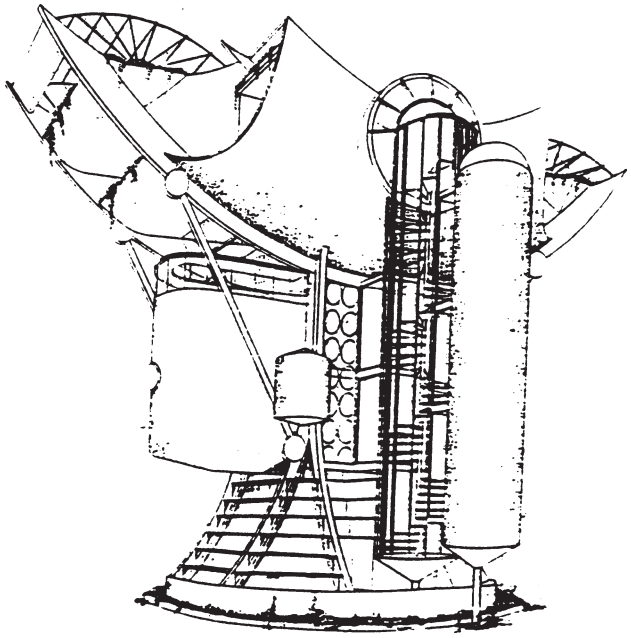
Residence for San Diego.

Kendrick Kellogg, Architect. Lecturer, San Francisco Institute of Architecture



Tropical island beach pavilion project. The design is intended to enhance the experience of tropical breezes, vegetation, and the ocean while providing complete solar protection. Light-weight components can be readily assembled and disassembled as needed.

Fred Stitt, Architect. Director, San Francisco Institute of Architecture



Residence for Albuquerque, New Mexico.

Bart Prince, Architect. Guest lecturer, San Francisco Institute of Architecture

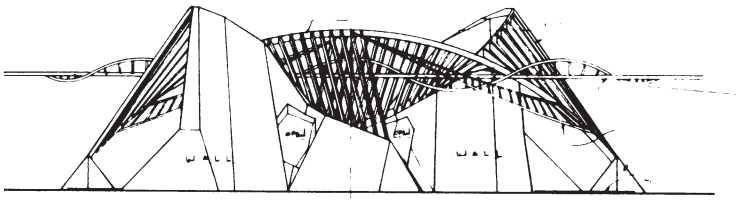
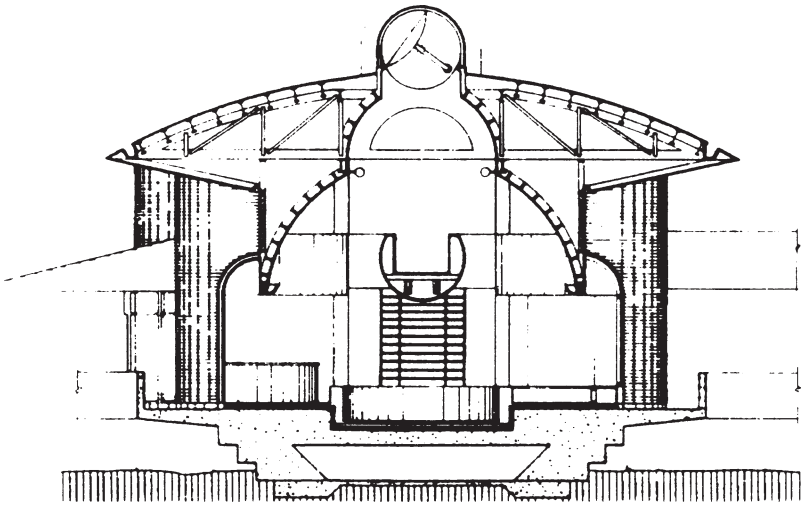


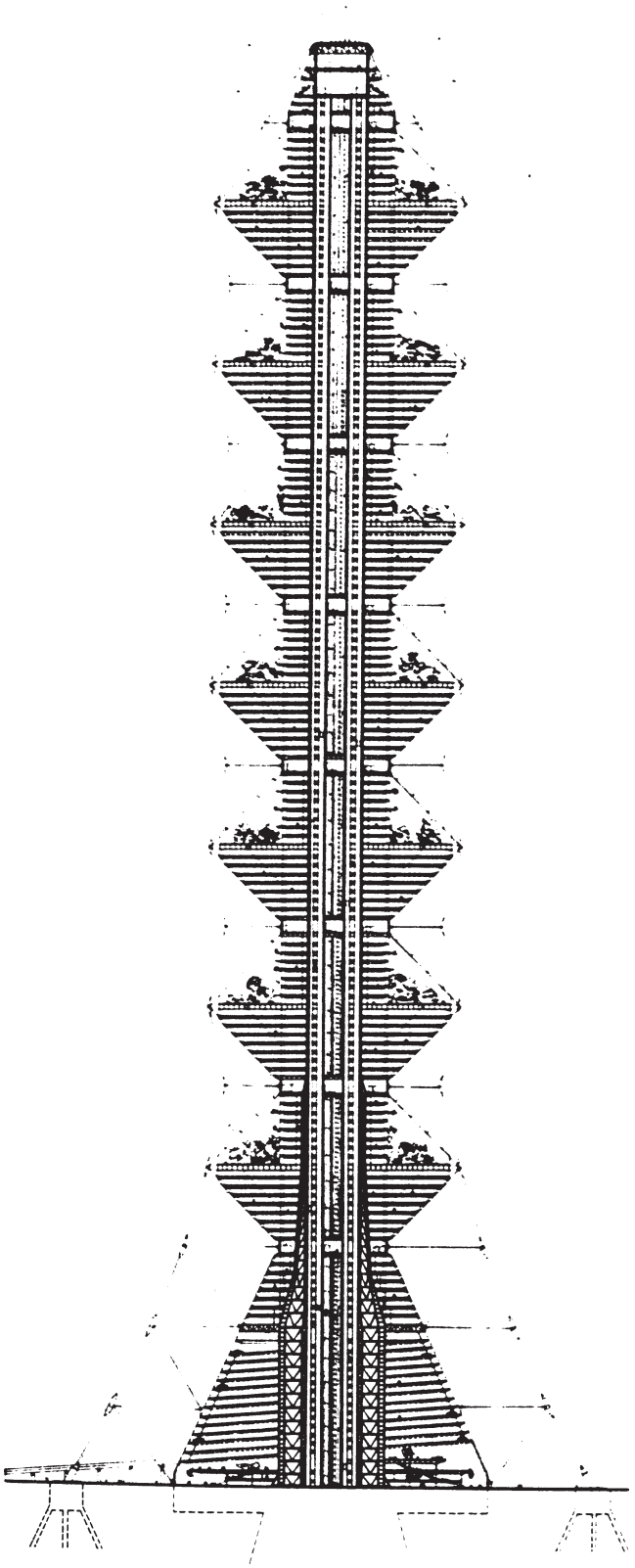
Exhibit pavilion.

Bart Prince, Architect.



Cross section of energy self-sufficient home.

Steve Badanes, designer and builder.
Guest lecturer, San Francisco Institute of Architecture.



Mixed-use urban tower with offices and apartments alternating with high-rise landscaped parks.

David Nixon, Architect.

EXTRO²

The 2nd Extropy Institute Conference on Transhumanist Thought

June 16-18 1995, Santa Monica, California at The Miramar Sheraton

PURPOSE: Extro² will be a rich, intellectually invigorating gathering designed to help push outward the boundaries of progress and possibility. It will be both a serious study and a spirited celebration of humanity's limitless potential and how it will be achieved. Besides presentations of accepted papers, the conference will feature lectures by leading thinkers, panel discussions, and the Extropy Awards banquet. The event will begin on Friday evening with a reception.

Keynote Speaker:

Prof. Marvin Minsky, of MIT
"The father of artificial intelligence"
author of *The Society of Mind*.

PAPER SUBMISSIONS: If you want to consider submitting a paper for the conference, contact Extropy Institute for guidelines.

LOCATION: Our second conference will be held at the elegant and superbly-located Miramar Sheraton in Santa Monica, California. The tower rooms offer an excellent view, though less expensive accommodation is available nearby. The Miramar Sheraton has recently been renovated, and will have a new cafeteria and large outdoor hot tub. Conference attendees will receive about 30% off regular room rates. The beach is a minute's walk away, as is the 3rd Street Promenade and its large number of restaurants and cafes.

Miramar Sheraton reservations: 310-576-7777
101 Wilshire Blvd., Santa Monica, CA 90401

REGISTRATION FEES:	Before Apr 1	After Apr 1	At the door
ExI Members:	**$135**	**$155**	**$165**
—Students/non-profit	$90	$110	$115
Non-Members:	**$160**	**$180**	**$190**
—Students/non-profit:	$95	$120	$125

- ***You may subtract $30 if you will not be attending the Sunday evening banquet and Extropy Awards presentation.***
- **Documentation for special student/non-profit rate is required; thank you.**

☐ Please send me further information on Extro² as it comes available.

☐ Please send me information on hotels in the area and accommodation provided by local Extropians.

☐ I want to reserve a copy of the conference Proceedings.

Mail to: Extro², Extropy Institute, 13428 Maxella Avenue, #273, Marina Del Rey, CA 90292

Lilliputian Uploads

Robin Hanson
hanson@hss.caltech.edu

From: Robin Hanson hanson@charon.arc.nasa.gov
To: nanotech@cs.rutgers.edu
Date: Tue, 5 May 1992 16:51-0700
Subject: Lilliputian Uploads (sci.nanotech submission)

Many people are repelled by the idea of uploading, in part because the usual descriptions of it are very alien — we become abstract computer-based software entities living in arbitrary virtual realities. An uploaded human brain running on a desktop computer might run many millions of times faster than us ordinary folks. At such speeds the time penalty for slowing down enough to experience an ordinary body would be far too great to allow many such indulgences. People's strong need for the familiar physical sensations and comforts would have to satisfied in a virtual reality that had little direct connection to ordinary physical reality.

But the future will still have a lot of physical work to be done, work which could greatly benefit the incredible space/time reasoning and control abilities our brains have developed over the ages. Perhaps a million slower minds would often be more economically useful than one super-fast one. I imagine people will want to make their new uploaded world as similar as possible to the old familiar world, just as we now try to keep close to nature and try to preserve familiar ways of dressing and organizing households. Though they could not overcome overwhelming economic pressure, such social tendencies can be remarkably strong.

Thus I am drawn to imagining lilliputian uploads — tiny bodies shaped like ours with a brain cavity filled with not much more computer power than it takes to keep up the faster body movements of their smaller bodies. This approach allows us to speed up thinking, devote a substantial fraction of our mass to advanced brain hardware, and yet continue our direct interaction with physical reality.

While various body sizes would be possible, I suspect standardization pressures would encourage one (or at most a few) standardized body sizes. Thus I see small cities landscaped with real but small plants, houses and churches build from wood, all looking recognizably like the world we live in. As now, wealthier citizens would be able to better afford country estates that look more like the old days, and the less wealthy may settle for more functional and temporarily-alien accommodations.

Of course many things would be strange compared to now, with backups, travel by "teleportation", and the wrenching economic, social, and legal changes resulting from the ability to make copies. But this would be all the more reason for people to cling to the familiar.

In fact, I have done a nano-calculation and estimate these uploads would stand within an order of magnitude of a 1/4 inch tall (the same size as in *Honey, I Shrunk the Kids*!), and run perhaps a few hundred times faster than us (with much more uncertainty in this figure). Thus billions of these uploads might live in one current office building.

Here is my calculation:

Assume we are just scaling down a 6 foot tall person using similar materials, so that the periods of typical body motions scale with the body size. Our 1500 cc brain cavity is scaled down also, and filled 1/2 with fast nano-mechanical RAM, and 1/2 with nano-mechanical CPUs. The specs of these devices are conservatively estimated by Drexler [upcoming *Nanosystems* book] to be: CPU: 10^9 instructions per second (= 1000 MIPS) fits in a cube 400 nm (nanometer) on a side, uses 90 nW (nanoWatt). Contains 10^6 "transistors" and 10^4 bit registers.

RAM: as fast as CPU registers takes 40 nm^3 per bit stored.

Our current brains use about 25

Watts to have our estimated 10^{15} synapses fire about 10 times per second each. Let us say that simulating a brain takes $c*10^{15}$ bits of memory, and $s*10^{15}$ instructions per second, where we may differ on estimates of the variables c and s. The smaller c and s get, the better our software will have become at compacting memory and speeding up the simulation.

Merkle ["Energy Limits to the Computational Power of the Human Brain", *Foresight Update* #6] estimates c < 1, s = .001 to 10. Moravec [*Mind Children*] estimates c = .1, s = .01. Schwartz [special AI issue of Daedalus] estimates c = 100, s = 1000. Results below will be parameterized in terms of c and s.

Let me also introduce a parameter x describing how fast we run the nanomechanical CPUs relative to their nominal speed. Slower speeds generate less heat. O.K., here are my estimates:

height:	l =	c^1/3 * 6.8 mm body
motion speedup:	b =	c^-1/3 * 266 mind
speedup wrt body:	m =	c^4/3 * x/s * 2.4 cpu
heat generation:	h =	c * x^2 * 56 Watts total
speedup wrt us:	t =	c * x/s * 640

For uploads that live in air and don't have to drag a cable around with them, 56 Watts seems a bit much — they would glow like Tinkerbell! If the mind is to at least be able to keep up with the body, we need some wins in s relative to c the allow us to lower x. That or accept an upload brain dominated by CPU. Note that x << 1 would require using reversible software (which avoids erasing registers), whose extra overhead would cost another constant penalty of ~ 10.

Note that if c = .4, one of our days would be a year for them, like living in the arctic circle is for us.

Continued from page 39

is the online Extropian virtual community. The Extropian cyber-community continues to expand, encompassing the main Extropians e-mail list (now in its 4th year), the ExI Essay list, five local e-mail lists for arranging meetings, parties, and other joint activities, a newsgroup, and now an Extropian presence on the World Wide Web (thanks primarily to Eric Watt Forste and Dave Krieger). Our FTP site makes available past postings to the Essay List, among other items. (See the back cover for information on most of these cyberfora.)

If this issue is your first real contact with extropian ideas, the short version of The Extropian Principles below will help clarify our shared values and goals. (The full text appeared in *Extropy* #11) The Principles is intended not as a detailed statement or final word on any topic, but as a codification of some of our shared values and attitudes.

THE FUTURE

1994's Extro[1] conference (with keynote speaker roboticist Hans Moravec) will be followed by the big-

Concluded on p.35

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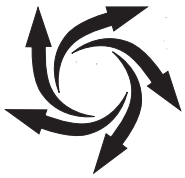

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Continued from p.32

ger and better Extro^2 from June 16-18 1995. MIT professor Marvin Minsky, author of *The Society of Mind* and others, and will speak at Extro^2. Prof. Minsky has been described as "The father of artificial intelligence". Last month he surprised many by having a highly extropic and transhumanist paper published in *Scientific American*. See elsewhere in this issue for on Extro^2.

We will be fostering the growth of more local discussion groups and international chapters of ExI, and we will continue to develop our network of communication, discussion, and action. We look forward to the continued development of the Extropians cyberculture. As finances allow, ExI will expand the range of tapes, books, and other items for sale; we will build cooperation with other organization for shared goals and make contact with more scientists, technologists, philosophers, and artists to strengthen our network.

As we grow larger we will offer seminars and classes, publish and publicize public policy papers on aspects of technology, start discussion groups in more areas, supplement the general conferences with special-purpose conferences and seminars. Other ways of disseminating extropic ideas include producing extropic teaching materials for schools (e.g., critical thinking, thinking about the wise use of technology), the production of truly extropic TV documentaries, science fiction shows, and big-screen movies portraying the positive possibilities of the future.

We hope you will join us as an active participant in the Extropian movement. (See p.2 for membership information.) Help shape the future!

EXTROPIAN PRINCIPLES v.2.5

(Full version in *Extropy* #11)

1. Boundless Expansion

Seeking more intelligence, wisdom, and effectiveness, an unlimited lifespan, and the removal of political, cultural, biological, and psychological limits to self-actualization and self-realization. Perpetually overcoming constraints on our progress and possibilities. Expanding into the universe and advancing without end.

2. Self-Transformation

Affirming continual moral, intellectual, and physical self-improvement, through reason and critical thinking, personal responsibility, and experimentation. Seeking biological and neurological augmentation.

3. Dynamic Optimism

Fueling dynamic action with positive expectations. Adopting a rational, action-based optimism, shunning both blind faith and stagnant pessimism.

4. Intelligent Technology

Applying science and technology creatively to transcend "natural" limits imposed by our biological heritage, culture, and environment.

5. Spontaneous Order

Supporting decentralized, voluntaristic social coordination processes. Fostering tolerance, diversity, long-term thinking, personal responsibility, and individual liberty.

B.E.S.T. D.O. I.T. S.O.

Prozac — and the Next Generation

Dr. Ray

"I don't want to talk, I just want a prescription for Prozac," was the first thing a new patient voiced as soon as I walked into the examining room. I looked at the chart handed to me by the nurse. Marjorie, a 42 year old graphic artist, married with one child, a twelve year old daughter. She continued, "I've read Dr. Kramer's *Listening to Prozac* and I know that Prozac is what I need."

She looked so tense, her upper and lower jaws almost grinding her teeth. Stern-faced, she was menacing. I sat down and tried to elicit a medical and psychological history. Her answers were brief and almost rude. She did not have any past medical or mental problems. Her job was stressful, a boss repeatedly pressured her to have projects ready by unreasonable deadlines, and she was having constant arguments with her husband. She was not in the least interested in discussing any cognitive or behavioral psychotherapeutic options as treatment. After a physical exam including a neurological check-up, and making sure that she did not have any suicidal or homicidal ideations, I started her on 10 mg of Prozac and prescribed 21 pills.

Three weeks later she was back in the office. I apprehensively walked in the room expecting the stern face. "Hello Doctor, how's your day going?" She said flashing a smile. I looked at the chart to make sure she was really Marjorie. "You seem so different" I blurted. She nodded, "I feel calmer than I have for years."

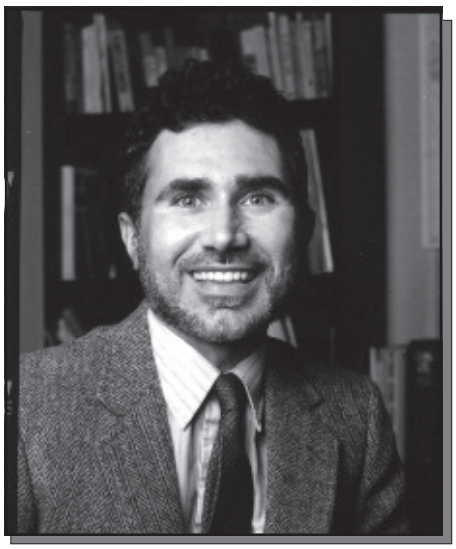
Millions of Americans are using mood-altering prescription medicines. What is so different about Prozac? Before we answer this question let's go over the basics about the brain and neurotransmitters.

We each have over 100 billion *neurons* (brain cells) that communicate with each other electrically and chemically. The junction where one neuron touches to communicate with another neuron is called a *synapse*. A synapse is a little space where one neuron releases a chemical which then crosses the space and attaches to a receptor on the other neuron. The chemicals the brain uses to communicate with are called *neurotransmitters*. At present at least 60 of them have been identified. Some of them are serotonin, norepinephrine, dopamine, endorphin, acetylcholine, phenylethylamine, etc.

Our moods are associated with the levels and balance of these neurotransmitters. Low levels of serotonin are implicated in depression, alcohol abuse, bulimia nervosa, obsessive-compulsive disorder, and more. Prozac and its cousins Zoloft and Paxil are called *selective serotonin reuptake inhibitors* (SSRI). (The word selective is used since they primarily raise serotonin levels as opposed to dopamine or norepinephrine.) They prevent serotonin in the synaptic cleft from being broken down, thus increasing the amount and time serotonin has to act on the receptor.

Before the SSRI came on the market other effective anti-depressants, such as imipramine, were available. They also elevated serotonin levels but at a cost. They influenced many other receptors in the brain that were not involved with mood. Stimulation of receptors such as cholinergic, histaminergic, and adrenergic resulted in many unpleasant side effects thus limiting the use of these medicines to those who were seriously depressed. The SSRI have opened a new chapter in psychopharmacology. Now even those who are mildly depressed may use these medicines for mood enhancement without paying the piper.

The SSRI are not totally free of side effects. In higher doses they can cause nausea, dry mouth, impotence, insomnia, and rash. A few years ago there was a media scare about higher rates of suicide



in those who had started taking Prozac. Careful studies disproved these claims[1]. It turns out Prozac does not lead to any more frequent cases of suicide than does placebo or other anti-depressants. However, we don't know the long-term effects of these medicines. There are receptors for serotonin not only in our brain, but on certain cells of our immune system such as white blood cells. As of yet we do not know if taking SSRI for prolonged periods will enhance, interfere or have little effect on our immune system.

Any form of therapy can have side effects. Sometimes we overlook the fact that a natural treatment, such as psychotherapy, can also have side effects if the therapist is not competent. On occasion, a patient may get even more depressed if many repressed traumatic emotions are exposed too quickly. There have been many cases of suicide in those undergoing psychotherapy. There have also been many cases of suicide in those who were depressed but did not seek therapy. The benefits of treatment versus the possibility of side effects must be carefully weighed. Each person is unique and requires a unique approach to treatment.

Many psychiatrists are using medicines and psychotherapy synergistically, reducing the time it takes to improve a patient's mood.

The discovery of these new medicines and their low side effect profile has grayed the *black or white* way of thinking about and treating depression. Many people are beginning to accept the possibility that mood-enhancing medicines can be used effectively not only in the severely depressed, but also in those who are mildly depressed. Mild personality trait weaknesses such as low self-esteem are being successfully treated. Not only does our personality influence our moods, but our moods can in turn influence our personality. Recently, some people are raising the possibility that even relatively content individuals can take these medicines to become even happier.

Let's discuss each SSRI presently available with a few words about new ones that may be introduced to the American market over the next few years. Since we don't know the long-term effects of these medicines, it's advisable to use the lowest effective dose and to slowly taper them and stop after a few weeks or months. They can always be restarted again if necessary.

Prozac (fluoxetine) was introduced in 1988. Since then millions of prescriptions have been filled, making the stock owners of Eli Lilly quite a jovial bunch. In March 1994 the FDA approved Prozac for the additional use in treating obsessive-compulsive disorder (OCD). Prozac is available as 10 and 20 mg capsules and liquid solution of 20 mg per teaspoon.

Zoloft (sertraline) was introduced in 1991 and is available as 50 and 100 mg tablets. In a recent small trial of 11 patients treated with Zoloft for social phobia, 7 improved.[2]

Paxil (paroxetine) was introduced in 1992 and comes in 20 and 30 mg tablets.

Luvox (fluvoxamine) is expected to receive FDA approval soon. It has been available in foreign countries for the past 11 years. It will likely be used for obsessive-compulsive disorder (OCD). Compulsive sexual exhibitionism has been successfully treated with Luvox. Some psychiatrists now believe that exhibitionism may be an OCD.[3]

Femoxitine is in the process of being approved but is not yet available.

In February of 1994 a new medicine became available called **Effexor (venlafaxine)**. It raises both serotonin and norepinephrine levels and is believed to work faster as an antidepressant. Tablets come in 25 mg and 50 mg.

The many faces of serotonin receptors

In the last few years, neuroscientists have discovered that there are many types of serotonin receptors. They have started numbering them 1A, 1B, 1C, 1D, 2A, 2B, 3, 4, etc. Serotonin acting on each receptor will have a different effect. Furthermore, neurons in different parts of the brain have different serotonin receptors. Using this information, neuropharmacologists have developed different types of drugs that are much more specific.

Buspar (buspirone) was approved by the FDA in 1986. It acts on serotonin receptor type 1A as an agonist. The word agonist as used in pharmacology means that the drug stimulates the receptor. Antagonists do the opposite: they block the receptor and in the case of serotonin receptors, an antagonist will not allow serotonin to act on that particular receptor. Buspar is used to relieve anxiety, and unlike diazepam (Valium) and other benzodiazepines, it has no sedative or euphoric effects and has no withdrawal symptoms.4

LSD (lysergic acid diethylamide) is of course not a new discovery, but I mention it here because researchers now suspect that it acts on serotonin type 2 receptors in its hallucinogenic effects. Interestingly, some newer anti-psychotics drugs such as risperidone and clozapine, used in schizophrenia, partly work by blocking type 2 receptors. They are antagonists. There is a possibility that they can be used to stop a bad acid trip. Over stimulation of type 2 receptors have been implicated as one of the causes of schizophrenia.

Ondasetron is marketed as an anti-nausea medicine and used to prevent vomiting in cancer patients who are receiving chemotherapy. It is a type 3 antagonist.

Over the next few years more specific serotonin receptor agonists and antagonists will be found and marketed. A recent survey showed that within the next six years 31 medications—16 for mood disorders, 15 for anxiety disorders — will be available to the public.5 This is likely to give doctors ever more refined tools to help patients suffering from depression, anxiety, and various other illnesses. Perhaps more research will be done in combining medicines with other forms of non-drug therapy to maximize synergism. Psychiatrists are additionally studying the possibility of using low doses of two or more drugs as a more effective approach. For instance a SSRI can be used to elevate serotonin while another anti-depressant can be used that elevates dopamine, norepinephrine, and others.

Back to Marjorie. During her second visit she reported having slight insomnia and mild nausea off and on. You recall she was on 10 mg of Prozac a day. I lowered her dose to 5 mg a day, in the liquid form. She returned a month later indicating that she was still getting benefits from the medicine with few if any side effects. Her relationship with her husband had improved. The stress at work was still there, but it was more tolerable. She continued on Prozac for another three months and then I gradually tapered her off the drug. I saw her a month after her last dose and she reported that the calmness she had experienced on Prozac had partly faded away but she had incorporated some new coping skills. During previous visits I had discussed with her stress reduction techniques including meditation, exercise, change of attitude, and improved nutrition. She preferred to wait and see and continue trying exercise, a better diet and other natural methods before restarting Prozac. "I feel comforted to know that a medicine is there for me in case I ever need it again."

1. Beasley et al; Fluoxetine and suicide. *Br Med J* 303:685-692, 1991.

2. *Psychiatric Times*, July 1994, p15.

3. Zohar et al: Compulsive exhibitionism successfully treated with fluroxamine. *J Clin Psych* 1994; 55:86-88.

4. Buspirone: Seven-year update. *J Clin Psych*, May 1994.

5. *Psychiatric Times*. July 1994, p44.

Also see The Psychiatric Clinics of North America: *Annual of Drug Therapy*, volume 1. 1994.

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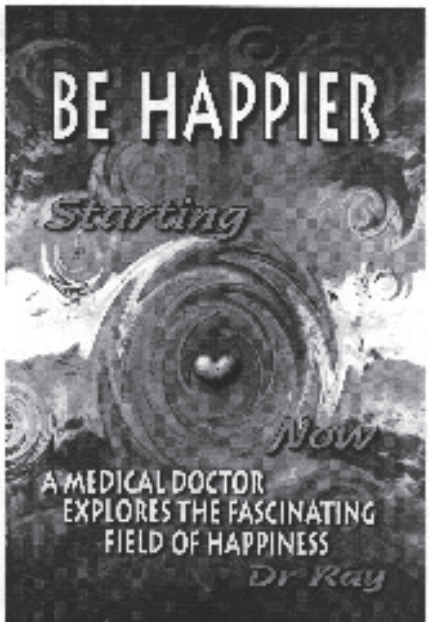
8. Nurturing Physical and Mental Health.
9. Learning and Creating.
10. Developing a Personal Truth.



The first few pages of the book provide a philosophical and scientific overview including a discussion of The Brain: an owner's guide. The appendix is comprised of the following four sections:

The mind-body two-way communication.

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" Ed Regis, **"Meet the Extropians", *Wired*, October 1994.**

The major article in the October '94 issue of *Wired* has brought a very much greater discernable response than previous coverage in *The Village Voice, GQ,* and other publications. Still coming in, the number of inquiries via e-mail has passed 400. The article did not so much seek to critically analyze what we, as Extropians, are up to, as to convey our basic attitudes. The reader is introduced to Extropian attitudes of technological far-sightedness, dynamic optimism, rationalism, and commitment to self-transformation. Rather than the deadly-serious tone of *The Village Voice*, Ed Regis in his *Wired* article conveyed not only our thinking and our zest for living and exploring. "Fun, indeed, would be the sixth Extropian Principle, if there were one."

Note also the Fall 1994 issue of *Free Inquiry*. "In Praise of Prometheus" is the highly extropic theme of the issue. In addition to many interesting items, including an interview with Francis Crick and a defense of Dr. Frankenstein, you will find ExI President Max More's "On Becoming Posthuman" and ExI Advisor Dr. Bart Kosko's "Heaven in a Chip" .

EXTROPY INSTITUTE

Extropy Institute (ExI) was incorporated in 1992 as an educational, tax-exempt organization. Like the Extropians e-mail list, ExI was an outgrowth of *Extropy* (founded 1988). We created ExI in order to provide a structure and network that would facilitate the spread and evolution of extropic ideas, values, and culture.

This organizational mission encompasses two aspects which together explain all our activities: (a) Within our existing Extropian culture refining and developing our ideas, working together to transform ourselves into "posthumans" and to evolve a radically new culture free of the irrationalities and limitations of the past. (b) To clearly and persuasively communicate our philosophy of life even to those who are not already attuned to the same ideas and attitudes, in order to influence the broader culture in more extropic directions.

In pursuit of these *transhumanist* goals Extropy Institute continually seeks new outlets for its members' energy, ability, and creativity. Complementing our primary publication, *Extropy: The Journal of Transhumanist Thought,* is our members' newsletter, *Exponent*, edited by frequent *Extropy* contributor Simon D. Levy. *Exponent* carries shorter articles, membership information such as forthcoming meetings, reports on progress of projects and new media attention, and reviews of relevant books, software, and other media.

We hold a variety of meetings, including special events like the *Extropy* 5th birthday party, monthly Idea Forum discussion meetings in the Los Angeles area, weekly lunch meetings in the N. California Bay Area, and impromptu celebrations and outings with extropic themes. As membership grows, local events across the country and abroad are taking place. Spring '94 saw an important new development: Extro[1] heralded the start of a series of annual conferences where ideas can be explored in depth, and bounced off persons of many different specialities and perspectives. (The main talks from each session can found in the Proceedings volume.)

As befits a transhumanist, high-tech subculture, supplementing printed publications and physical meetings

Continued on page 32

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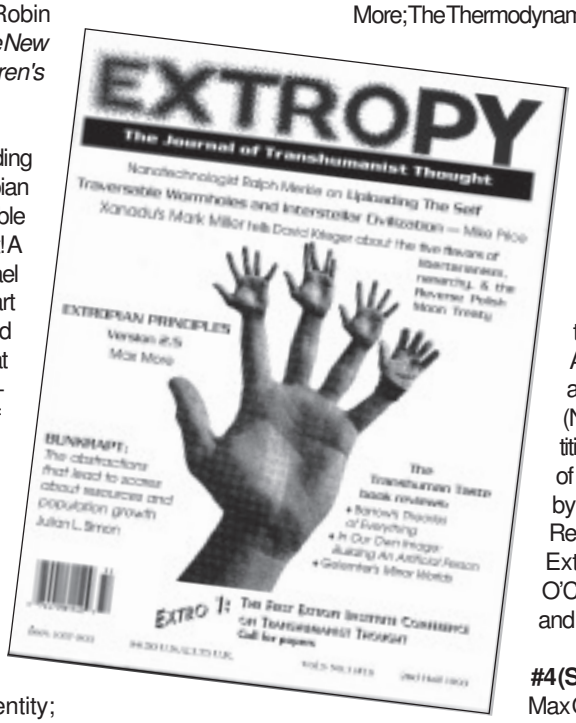

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5 Years Ago in *Extropy*

"This article is written in praise of Satan, Lucifer, the Devil, or whatever you want to call him. […] I am quite serious on a symbolic level in what I write but my statements praising the Devil and attacking Christianity, God, and Jesus are not to be taken as implying the real existence of any of these supposed beings.

'Lucifer' means 'light-bringer' and this should begin to clue us in to his symbolic importance. The story is that God threw Lucifer out of heaven because Lucifer had started to question God and was spreading dissension among the angels. We must remember that this story is told from the point of view of the Godists (if I may coin a term) and not from that of the Luciferians (I will use this term to distinguish us from the official Satanists with whom I have fundamental differences). The truth may just as easily be that Lucifer *resigned* from heaven.

God, being the well-documented sadist that he is, no doubt wanted to keep Lucifer around so that he could punish him and try to get him back under his (God's) power. Probably what really happened was that Lucifer came to hate God's kingdom, his sadism, his demand for slavish conformity and obedience, his psychotic rage at any display of independent thinking and behavior. Lucifer realized that he could never fully think for himself and certainly could not act on his independent thinking so long as he was under God's control. Therefore he left Heaven, that terrible spiritual-State ruled by the cosmic sadist Jehovah, and was accompanied by some of the angels who had enough courage to question God's authority and his value-perspective.

Lucifer is the embodiment of reason, of intelligence, of critical thought. He stands against the dogma of God and all other dogmas. He stands for the exploration of new ideas and new perspectives in the pursuit of truth."

— "In Praise of the Devil" by Max O'Connor (More), *Extropy* #4 (Summer 1989).

"High table afterward was the traditional walnuts and port, Cuban cigars and somewhat arch conversation, occasionally skewered by an interjection from Stephen [Hawking]. When we left, Stephen guided his wheelchair through the shadowy reaches of the college, indulging my curiosity about a time-honored undergraduate sport: climbing Cambridge. At night young men scramble among the upper reaches of the steeply steepled old buildings, scaling the most difficult points for the glory of it. There is even a booklet describing the triumphs and centuries-long history. Stephen took me to a passageway I had been through many times, between high buildings. It looked to be about ten feet across. I couldn't imagine leaping that abyss from the slate-dark roofs. "All that distance?" I asked. "Yes," he said. "Any miss?" "Yes." Injured?" "Yes." "Killed?" His eyes twinkled and he gave us a broad smile. "Yes." These Cambridge sorts had the right stuff all right."

— "Leaping the Abyss" by Dr. Gregory Benford, *Extropy* #5 (Winter 1990).

"Down with the laws of gravity!

By what right does it counter my will? I have not pledged my allegiance to the law of gravity; I have learned to live under a tyrant. Whatever gravity's benefits, I want the freedom to deny its iron hand. Yet gravity reigns despite my complaints. "No gravitation without representation!" I shout. "Down with the law of gravity!"

Down with *all* of natures law's!

Gravity, the electromagnetic force, the strong and weak nuclear forces — together they conspire to destroy human intelligence. Their evil leader? Entropy. Throw out the four forces! Down with entropy!

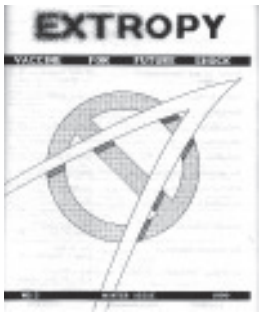
Down with *every* limitation!

I call for the highest of all freedoms. Come, let us cast off all chains! We will make our own heaven. We will become our own gods.

I call for perfect self-rule; I call for arch-anarchy!"

— "Arch-Anarchy" by "A". *Extropy* #5, Winter 1990.

"We already live in an anarchy. There is no "State". There are only individuals acting in a statist manner, often because they believe it to be right, to be necessary, and because they see no alternative. Extropians who wish to bring about a more rational social system, a system more capable of allowing diversity, of encouraging rational responsible behavior, and of minimizing conflict should not join political parties, or try to attack "the State". What is needed is a micro-politics, a politics of individual behavior.



We should seek to minimize our own contribution to statism, and to persuade others to do the same. We should withhold all support for statism whenever possible without seriously endangering ourselves. We should avoid paying tax-extortion (the life blood of statism) and should pay no heed to unjust laws whenever we can…"

— Max O'Connor (More), "Deep Anarchy: An Eliminativist View of 'The State'", *Extropy* #5, Winter 1990.

"The moment when first the conqueror spared his victim in order permanently to exploit him in productive work, was of incomparable historical importance. It gave birth to nation and state." Franz Oppenheimer, *The State*, Free Life Editions, 1975.

The Transhuman Taste

Reviews of Extropian Interest

The Physics of Immortality:

by Frank Tipler

Doubleday, New York, 1994
528 pages, ISBN 0-385-46798-2

Reviewed by Michael C. Price

Frank Tipler, Professor of Mathematical Physics at Tulane University, has made major contributions to the subject of general relativity and in particular on singularities. SF readers will perhaps be aware of his article on the possibility of time travel in the vicinity of a massive rotating cylinder, directly inspiring a Larry Niven story of the same name: "Rotating Cylinders and the Possibility of Global Causality Violation". Within quantum cosmology he is well known as a proponent of the many-worlds interpretation of quantum mechanics. To SETI enthusiasts and skeptics he is famous or infamous, depending on your viewpoint, and as having locked horns with Carl Sagan on the existence of extraterrestrial intelligent alien life. In 1985 he co-authored, with John Barrow, the monumental *The Anthropic Cosmological Principle* (reviewed in *Extropy* #9, Summer 1992). Now he has written a sequel, *The Physics of Immortality*, where he develops these ideas further.

In *The Physics of Immortality*, Tipler seeks nothing less than a unification of cosmology with theology. Questions like "Does God exist?", does "It love us?", and "Is there an afterlife?" are subjects to be tackled with the same rigor as the behavior of a star as it collapses into a black hole — in Tipler's opinion. The book is cogently written and includes voluminous technical appendices and notes, backing up his logic. In addition to the physics (most of which is quite wisely confined to appendices) there are extensive discussions of identity, the arrow of time, reductionism, free-will and comparisons of the eschatology of the major world religions, and other topics.

Tipler's thesis is that as the universe collapses towards the final Big Crunch the amount of information processing diverges asymptotically to infinity, even as at the same time as the universe is compressed down to zero volume within finite time. The final end point, which will exist only for an infinitesimal moment, he calls the Omega Point and achieves infinite complexity and information processing. In the Omega Point all the beings that have ever lived, you, me, Tipler and everyone else — or ever *could have* lived — are resurrected to live again in an infinitely advanced virtual reality. Subjective time stretches out forever for the denizens and controllers of the last moments.

I found it a technically interesting book, but I was repulsed by the application of religious language to scientific concepts. (I am an atheist, so others may not mind this so much or may mind it more). I find this use of language very dangerous and likely to cause much confusion. For all that, the discussion and comparisons of the major world religions is quite interesting and original, although the relevance of a lot of it, I have to confess, does escape me. Tipler's re-interpretation of Moses' encounter with the burning bush is worth reading (page 4). Even so, I feel that the theistic terms are misleading. It would have been better to avoid such language.

I have no doubt that many non-technical theists will take solace in this book as "proof" that science endorses notions of a personal God, Heaven, immortality of the "soul" and whatnot. Similarly many scientifically trained people will reject Tipler's arguments out of hand. With this book Tipler will, I'm sure, cement his image in scientific circles as a one great scientist turned crank, joining the likes of Penrose, Eddington, Hoyle and others.

Tipler's arguments deserve careful

examination before forming a judgment. To see why Tipler's pseudo-theology is incorrect, I shall review his book from three different perspectives. First, I shall examine what Tipler means by the Final Anthropic Principle, which he now calls the Omega Point boundary condition, and why he is, essentially, begging the issue by assuming that God exists rather than deriving this scientifically. Second, I shall examine short fallings in his predictions that result from a certain narrowness of vision or lack of imagination. Third I shall show that Tipler is being inconsistent, selective and simplistic in his application of logic.

The Anthropic Principle and Boundary Conditions

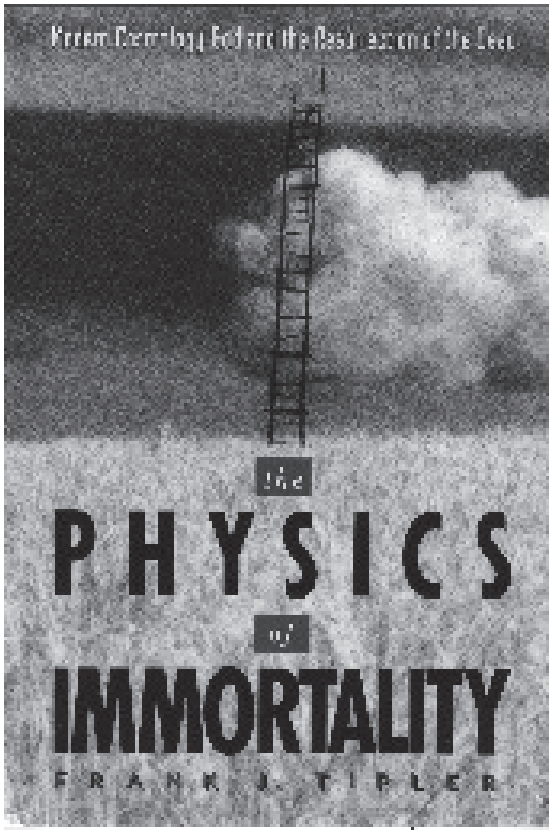
The Anthropic Principle comes in three varieties, Weak, Strong and Final.

The Weak Anthropic Principle states that we, as conscious observers, necessarily observe, in the surrounding Universe, those conditions necessary for the emergence of life. Had conditions been otherwise there would be no observers to note this. Consequently we must be careful about drawing conclusions about the more distant regions of the Universe where different, more inimical, conditions may apply. For instance, just because the Earth has a relatively large satellite (the Moon) does not mean we can infer that most planets have large moons, since the Moon's presence may be linked with the evolution of intelligent life via, say, tides or the stability of the Earth's orbit. Large moons may be very rare, but only such favored planets are capable of evolving complex land-living organisms, so we naturally find we have a large moon. At one level the Weak Anthropic Principle is no more than a tautology and most scientists have few problems with it.

The Strong Anthropic Principle moves a step further and proposes that only those universes that contained conscious observers, at some point in their history, exist. This is controversial, to put it mildly — I, for one, see no reason for believing it — although some people see it as meshing well with the wackier side of quantum theory. I find it odd that Tipler should find the Strong Anthropic Principle the least bit attractive, since one of the motivations of the many-worlds interpretation (which he believes in, see page 169— as I do) was to remove the observer from any role in physics. The Strong Anthropic Principle intertwines the observer with physics in an unacceptable, non-reductionist fashion.

The Final Anthropic Principle states that only those universes exist in which conscious life exists for ever. Tipler has recast the Final Anthropic Principle in the form of boundary conditions at the future end of time. To see quite what this means we will digress briefly onto the subject of boundary conditions in science.

Traditionally, in science, boundary conditions on a system are sought at an *earlier* time and the laws of physics used make predictions about the system at a *later* time. For example, I let go of an apple above the floor in a gravitational field (the boundary condition) and, a few seconds later, the apple hits the floor (the prediction). Logically, though, there is no reason why boundary conditions can not be imposed at later times and used to make retrodictions (deductions about the past). Detectives do this all the time, in reconstructing crimes from clues left at the scene, witnesses, etc. — although it is unlikely that they would describe it as such! Cosmologists do this when they make conjectures about the early state of the universe from the way the universe is (or appears) now. The present state of the universe, as revealed through a telescope, acts as a boundary condition. The early evolution of the universe emerges as a retrodiction.



The reason why scientists and engineers tend to search for or place boundary conditions in the past, rather than the future, is because of the Second Law of Thermodynamics. The Second Law of Thermodynamics, based on countless observations, states that the future is less predictable than the past is retrodictable. Thermodynamics defines the arrow of time. It's why we remember the past and not the future. (Tipler discusses this in more illuminating detail. There is a vast literature on the subject of the "arrow of time" which I can't do justice to here.)

To return to the Final Anthropic Principle, Tipler imposes the boundary condition that conscious life will exist for ever at the end of time, or at least in the distant future. He recasts this in terms of information processing diverging to infinity in the final moments of the Big Crunch. He speculates that infinite subjective time passes for the being(s) who can control the collapse process, extracting unlimited energy from collapse-induced temperature gradients. These being(s) at the End of Time he calls the Omega Point (or God). Unlike the Big Bang and Hubble expansion, which was and is reasonably smooth, as far as we can see, the collapse process is expected to become increasingly disordered or anisotropic. During the collapse process this disorder or shear is expected to grow as time progresses, generating large temperature differences which oscillate back and forth, growing without bound. Tipler's plan is for the Omega Point to extract work from the rising shear and temperature anisotropy. Tipler argues that, even though the operating temperature rises to infinity, the available work grows even faster, enabling intelligent information processing to last "forever" in subjective time.

Unfortunately there seems to be a high level logical flaw in his reasoning. The validity of Tipler's calculations de-

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pend on the existence of the Omega Point as an starting assumption, since Tipler starts by assuming that the Final Anthropic Principle is the correct boundary condition. All Tipler does is derive the existence of the Omega Point by *assuming* the existence the Omega Point as a final boundary condition. Tipler has derives what he has assumed. A completely circular argument which medieval theologians would have been proud of.

I am also very skeptical of the validity of any calculations projected indefinitely into realms where we know our knowledge of physics is incomplete. On the energy scales and distances approached by the Omega Point we expect quantum gravity to predominate. Science does not have a complete theory of quantum gravity, yet, so this exercise seems rather premature, to put it mildly.

Omega Point Predictions

In fairness to Tipler he does offer predictions of his Omega Point theory. He tries to show that the existence of the Omega Point at the Big Crunch — which requires that civilization expand throughout the entire universe before collapse starts — imposes constraints on the universe today.

Unfortunately all these predictions require that life can't exist indefinitely in *any* other fashion than he imagines in the Omega Point. This is where his lack of vision lets him down. He dismisses the possibility of infinite life in an open universe (as Freeman Dyson has suggested) because, for instance, protons must all decay, given long enough. This ignores the possibility that an advanced civilization may find a way of regenerating matter, for instance by controlling cosmological inflation in the laboratory or, more likely, by some means we can't presently imagine or understand. The task of harnessing inflation to generate new matter requires control of physical processes at grand-unified-theory level energies, so this must be inherently *more* probable (although still, perhaps, unlikely) than the degree of control the Omega Point requires of *all* energy levels, all the way up to infinity. Whether this is a reasonable assumption I'm not sure. Personally I would have thought that simple thermodynamic considerations suggest that a cold, open universe would be much more conducive to open-ended information processing than an infinity hot dense universe. It certainly seems rather premature, to say the least, to rule out the former in favor of the latter.

Tipler also states that life in an open universe must eventually start repeating itself (which he concludes from an examination of the complexity permitted by the Bekenstein Bound) and, therefore, could not grow without bound. This means that no entity can exist for ever, in the sense of always experiencing new and different stimuli, adding new memories. At some point any system in an open universe must start to repeat and overwrite its earlier selves. Unfortunately the Bekenstein Bound has only been proven to apply to flat space-times. There are good reasons for thinking that the Bekenstein Bound will be violated in a non-simply connected space-time manifold that quantum gravity probably implies, permitting indefinite growth in complexity. (Traversable wormholes, for instance, would permit infinite complexity — see "Traversable Wormholes..." in *Extropy* #11, Second Half 1993.)

I am also disturbed by Tipler's claim that the Omega Point would have access to sufficient information to resurrect all historical personages, animals and alien life (if any) from information or signals currently unrecognizable and/or lost into space. The first few times he mentions this claim Tipler adds that signal incoherence (when the signal strength is swamped out by the background noise level) may make this impossible. After awhile, though, he stops adding this all-important caveat. He argues that the indeterminism or randomness in the background static is not relevant to information loss because the many-worlds or Everett interpretation of quantum mechanics is deterministic (true) and so all the "lost" information is recoverable (false). The many-worlds interpretation of quantum mechanics does not permit such recovery of past information since as entropy increases/ information processing grows the worlds become increasingly divorced from each other via a quantum thermodynamic process called decoherence. Loosely speaking, the original information has been dispersed across a multitude of mutually inaccessible quantum worlds or parallel universes. No super- intelligence, no matter how advanced, without violating the Second Law of Thermodynamics, can access the totality of information necessary for total reconstruction since each intelligence is confined to their own Everett-world, which necessarily has incomplete information.

It must be admitted that it is possible to get around this information loss, with truly infinite computational resources, by simply resurrecting *all possible* entities, regardless of whether they really existed or not. Tipler does mention this possibility, which he dubs Universal Resurrection. This theme has been explored by other authors (see "Pigs in Cyberspace", *Extropy* #10, Winter/Spring 1993, by Hans Moravec) without all the theological trimmings that Tipler brings to the subject.

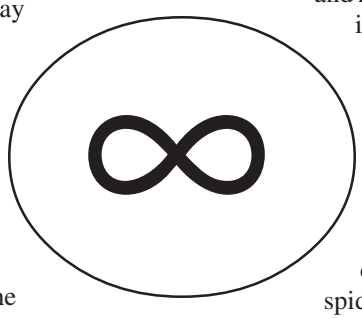
I would have thought that simple thermodynamic considerations suggest that a cold, open universe would be much more conducive to open-ended information processing than an infinity hot dense universe. It certainly seems rather premature, to say the least, to rule out the former in favor of the latter.

Internal Inconsistencies

The alert reader will notice that I have not disproved Tipler's central thesis — that in the future unbounded information processing will permit the resurrection of everyone who has, or might have, ever lived. Instead I criticize him for being too narrow in his outlook in dismissing other open-ended futures for immortals. The prospect of universal resurrection is far more likely than he realizes. If these were the only faults in his thesis then I would have to accept his notion of universal resurrection.

Tipler's earlier work on the impossibility of "nearby" extraterrestrial life was based on the principle, by analogy with Darwinian diversity and capitalism, that societies naturally become more diverse as they evolve. Now that it suits his purpose to conclude the opposite he quietly ignores this work.

Unfortunately his vision also has internal inconsistencies. In my opinion the motivation of the Omega Point is never satisfactorily explained. Tipler supposes that as the universe contracts then civilization will necessarily become more co-operative, altruistic and centralized. (Or else they will fail to control the collapse process, the possibility of which, remember, he excludes by assumption!) Therefore, he argues, the Omega Point "ends" up as a benign unified, singular, god-like super-intelligence, although he concedes that there may be semi-autonomous "subprograms" running.



I find this wholly unconvincing. The relevant parameter for describing the "size" of the Omega Point is, as Tipler argues everywhere else, complexity not volume. Tipler needs to think in terms of cyberspace, not physical space. There is sufficient "cyber"-space, within the Omega Point, by Tipler's calculations, for infinite diversity. Within the infinite cyberspace domain there is absolutely no reason to suppose that the Omega Point will converge on a common set of values. Indeed all the trends in society and evolution point to more diversity with time, not less. It is interesting to note that Tipler's earlier work on the impossibility of "nearby" extraterrestrial life was based on the principle, by analogy with Darwinian diversity and capitalism, that societies naturally become more diverse as they evolve. Now that it suits his purpose to conclude the opposite he quietly ignores this work.

If we buy Tipler's line about being resurrected into blissful heaven by angels we must also accept that other copies of ourselves will be reincarnated into painful versions of hell, tortured forever by sadistic virtual demons. Indeed, to resurrect *all* possible individuals the Omega Point would necessarily have to create an infinite number of virtual hells, all fully stocked with anguished inmates.

In a paragraph tucked away in an footnote (page 359), the argument is presented that super-beings in the future will fear retribution (or of not being resurrected if *they* die) if they abuse resurrectees. There are many assumptions implicit in this. Surely more powerful beings will have less to fear, being immortal? All societies have contained sadistic individuals and sometimes torture and sadism is condoned at higher group level. I see no reason for supposing that such arational impulses will ever cease. I certainly would not bet eternity on it — lose and end up in hell!

There is also no reason for supposing that future societies would share our concept of morality and feel obliged to bring us back to life. An argument from super-rationality could have been presented here, but Tipler does not do that, unfortunately. Instead Tipler argues that there is common morality which we all agree on which we can expect the Omega Point to share. As an example he cites the human right to life, or the prohibition against murder, as applied to the abortion debate (page 331) and argues that both the pro- and anti-camps are agreed on the right to human life, they just disagree about at which stage a fetus becomes human. This is pure sophistry. There are numerous societies in the past which condoned murder of humans. The Thugs of India spring to mind, or the Aztecs with their human sacrifices. Or consider the Roman attitude to the gladiatorial slaughter in their arenas for public amusement. No doubt Tipler would argue that they viewed the victims as in some way sub-human. No matter, I could equally imagine future super-beings deciding that we have no rights because we are not super-beings!

I am surprised that a free thinking pro-capitalistic, Hayek-school "Austrian" libertarian, as Tipler seems to be (pages 172 and 267), could entrust his life to super-entities in the infinitely distant future. We have as little right to understand the motivations of our technological descendants as an amoeba has of understanding Einstein's relativity. I prefer to entrust myself with myself, no matter how much I may develop and evolve over the ages. Surely that has to be a better bet than handing over your life to the caprices of the Omega Point descendants of, say, a race of alien intelligent spiders from a distant galaxy? (There is after all, in Tipler's scheme, no guarantee that we humans will be the race that evolves into the Omega Point.)

Conclusion

I can't help but feel that Tipler wants to live for ever without doing anything about it — the whole Omega Point theory is a just a rationalization for this Panglossian stance. To this end he has convinced himself that he will be resurrected by the Omega Point in heaven. I was reminded of my experiences reading Penrose's *The Emperor's New Mind*: bad logic and questionable science is being used to establish a preconceived position, rather than point the way forward in the spirit of inquiry. An interesting book, but the central message of the Omega Point is quite ridiculous. Buy this book only if you're interested in theology — the discussions of religion are interesting (although repetitive) even to an atheist — or cosmology — the physics is fascinating. But if you want to live forever, start your own life extension program or sign up for cryonics!

Morals by Agreement

by David Gauthier

Clarendon Press, Oxford University Press, 1986
367 pages; ISBN: 0-19-824992-6

Reviewed by Eric Watt Forste

Without a God, is everything permitted? Why not do anything you want? Why accept *any* limits on our behavior? After all, Extropians reject *unnecessary* limits on our actions. When we face the fact that our morals do impose restrictions on our actions, what is it about morals that necessitates these restrictions? What kind of theory can we comeup with to explain why these restrictions are necessary, or at least useful? In Paul M. Churchland's essay "Moral Facts and Moral Knowledge" [1], he discusses moral theories as having a structure in the brain similar to scientific theories (though clearly not based on the same *kind* of empirical evidence), and discusses paradigms and paradigm-shifts in the context of moral theories. The moral paradigm that human beings have lived under for almost all of history has been the *stern parent* paradigm; in the particular case of the Judeo-Christian tradition, Dad gives the orders.

But most Extropians have rejected this paradigm. Now that we've grown up and no longer take orders from Dad, is morality a necessary and reasonable limit, or an unnecessary one which we transhumans can dispense with? Philosophers who have attempted to provide a moral theory that does not reduce to divine commandment have found it frustrating. As Bertrand Russell put it: "I cannot see how to refute the arguments for the subjectivity of ethical values, but I find myself incapable of believing that all that is wrong with wanton cruelty is that I don't like it." [2]

There are two traditional sources in which people have sought to find a basis for rational constraint on individual behavior. David Hume and many others since his time sought to find it in our "fellow feeling" for one another, but this certainly doesn't address the puzzlement expressed by Russell above. Others, such as Kant and Rand, have sought to locate rational constraints in some objective good that exists independently of vagaries in people's individual preferences. Utilitarianism [3] attempts to reconcile these two approaches, but has a long history full of frustrations, and the problems of utilitarianism are very well documented by now. The new approach of moral philosophers to the search for rational constraints on individual behavior is contractarianism, borrowed from political philosophy. The good news of the contractarian is that we can find such constraints in the rational agreement to certain predispositions, such as a predisposition to keep one's promises, that will be reached among rational individuals in hypothetical negotiation. The contractarian's claim, which here is a claim about moral constraints and not political power, does not require an actual negotiation of an actual social contract, but only an explanation of how it is in our interest to adopt, for instance, a mutual predisposition to keep promises.

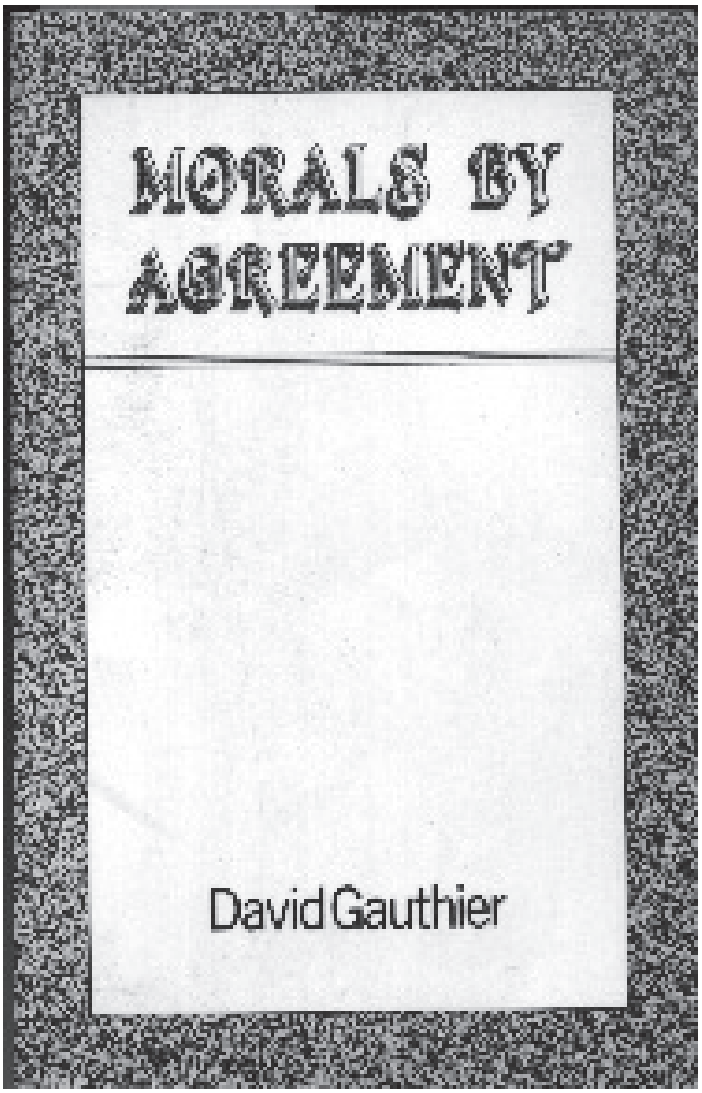
The quickest way to sum up David Gauthier's *Morals by Agreement* in terms that will make its appeal evident to Extropians is to say that it develops a theory which explains moral constraints as a spontaneous order arising from rational utility-maximizing behavior. Gauthier operates within the context developed most recently by John Rawls [4] and Robert Nozick [5]. Like Rawls, he develops a rigorous and systematic theory, but like Nozick, he rejects the drastic redistributionism demanded by Rawls. The theory of morals by agreement is an ambitious one that attempts to answer rigorously such questions as "What rational motivation can I have for not taking another's property, when I can get away with it? What rational motivation can I have for not going back on my word, when it seems advantageous for me to do so?"

Morals by Agreement is unusually pleasant going by the standards of this genre, but the reader should be warned. The going will be much easier if you familiarize yourself with the basic terms and ideas of economics and game theory before you start. Personally, I got a lot more out of Gauthier's book by pausing to read *The Compleat Strategyst* [6], a simple introduction to game theory, before trying to finish it. Axelrod's explanations of game theory [7] would probably do as well. On the other hand, Gauthier does explain these terms before he uses them, but he does so very tersely, as befits background material, so these prefatory remarks are among the most difficult parts of the book.

Gauthier himself doesn't seem to be any kind of fervent libertarian, and libertarians who eagerly delve into his work may find a few puzzling dissonances.

Gauthier starts by drawing a connection between the suboptimal outcome of the famous Prisoner's Dilemma of game theory, and the suboptimal outcome of a market afflicted by externalities. What does this mean? Game-theoretical analyses of interactions between people, with outcomes measured according to the utilities received by the people interacting, leads us to one conception of a "good" outcome. Market economics leads us to a different conception of a "good" outcome. The first is equilibrium: the outcome "which maximizes the expected utility of the person choosing it, given the strate-

gies chosen by other persons." [8] The second is optimality, usually called Pareto-optimality: the outcome in which no one can be made better off without making someone else worse off. Game-theorists look for equilibrium solutions. Economists tend to look for optimal ones. Now in many, many interesting interactions, there seems to be no difference between equilibrium and optimality. In fact, the basis of the satisfactory results derived from free markets is that market interaction exemplifies optimal equilibrium.



Our problems (and the problems Gauthier is interested in analyzing) begin when equilibrium and optimality lead to two separate outcomes. The two classic examples of this are, in game theory, the Prisoner's Dilemma, and in economics, the problem of externalities. Essentially, straightforward maximizers of utility will always choose the action which yields them the greatest expected utility, given their expectations about the actions of the people they are interacting with, under the assumption that those people in turn are also straightforward maximizers. The Prisoner's Dilemma and the problem of market externalities are situations in which interaction of straightforward maximizers leads to suboptimal outcomes. Recall that in a suboptimal outcome, there are actions which could be taken which would increase the utility of some or all of the participants without making any individual participant any worse off, but the "rational" constraints of straightforward maximization prevent people from taking those actions.

Gauthier's solution to this problem begins when he points out that we can make choices on multiple levels. At the level of each individual choice, it may make sense to be a straightforward maximizer. But we can also choose to adopt certain "dispositions to choose"; we can make choices at a higher level than the level of individual decisions. Although it is rational for us, in any given situation, to choose the course of straightforward maximization, might it not be possible that, at the higher level of choosing a particular disposition-to-choose, it is rational for us to voluntarily choose to constrain our behavior in a way that makes it possible for us to attain optimal outcomes? Optimal outcomes are, on average, of greater utility to us than equilibrium outcomes, since in any given optimal outcome we will never be any worse off than we are at equilibrium, and will sometimes be better off.

Gauthier calls this optimality-enabling disposition to choose "constrained maximization" and contrasts it with straightforward maximization throughout the work. He is careful to contrast his conception of constrained maximization with rational prisoner's-dilemma strategies such as Robert Axelrod's TIT-FOR-TAT [9], pointing out that constrained maximization, as a disposition to choose in certain ways, comes into play even when interacting with people in one-shot games, whereas a straightforward maximizer (and Axelrod never discusses any other kind) finds TIT-FOR-TAT rational only in iterated interactions. In this way, constrained maximization seems to find a compromise between simple TIT-FOR-TAT (which is no help in one-shots) and Douglas Hofstadter's "superrationality" [10] (which contradicts most people's intuitions about the one-shot prisoner's dilemma). For, unlike "supperrationality", the rationality of constrained maximization is not completely insensitive to the identity of the other player(s). It is rational for us to follow a policy of constrained maximization only when we are interacting with people whom we believe to be other constrained maximizers. Given that belief, and good grounds for it, it truly does not matter whether the interaction is iterated or one-shot: when the optimal outcome does not coincide with the equilibrium, it is still the preferable outcome, and constrained maximization is the only course which allows for the optimal outcome instead of the equilibrium.

This raises an immediate practical question for those of us interested in thinking about the problems that will arise among posthumans. The reliability of our current assessments of the morality of people we are dealing with depends on the difficulty of lying convincingly about one's intentions over a long period of face-to-face contact. There are subtle clues of insincerity that most of us are capable of detecting; we have instinctive "hunches" about who is and is not trustworthy, hunches that are accurate more often than not. Without this ability to detect the dispositions of others, our ability to choose the correct disposition and strategy in prisoner's-dilemma situations is impaired. What happens when we are posthumans dealing with other posthumans, each of us with complete control over every bit of information that trickles out from us? What happens when we (and the people

we deal with) have complete override control over the subtle cues of untrustworthiness? The results of Gauthier's theory indicate that we might find some advantage not only in not masking our intentions, but finding some way to *guarantee* that we are not masking. We might need a forward-thinking cryptologist to develop a cryptographic protocol for "expression of true intentions" to save us from having to settle for non-cooperative, equilibrium outcomes instead of reaping the benefits of cooperative, optimal ones.

So what does constrained maximization amount to? In large part, it seems to consist of such bedrock ethical principles as not lying, keeping ones promises, and in general, not cheating. Some libertarians such as Jan Narveson [11], have been excited by the political implications of Gauthier's development of a theory of property and fair distribution from his moral theory. Gauthier cannot find any philosophical ground in his own work for the leveling, equality-at-any-price redistribution that Rawls sought to justify in his *A Theory of Justice*. In fact, the theory of property he develops is more than superficially similar to Locke's theory as defended by Nozick in his notorious response to Rawls, *Anarchy, State, and Utopia*. While Nozick was quick to point out problems in Rawls' theory, he did not develop a coherent theory of his own. Narveson and other libertarians are excited by the possibilities of Gauthier's moral theory as providing a pretty good foundation for libertarian political theory.

Gauthier himself doesn't seem to be any kind of fervent libertarian, though, and libertarians who eagerly delve into his work may find a few puzzling dissonances. While most libertarians see the action of the market as a case of cooperation between buyer and seller, Gauthier is more interested in the contrast between cooperation (the theory of which he is trying to develop) and market competition. His emphasis on the contrast leads him to characterize the market as a "morally free zone" throughout the book. What is curious about this point of view is that, while indeed competition in a market without externalities should not be constrained by any concerns other than consumer demand, it is cooperation (even in Gauthier's technical sense) between buyer and seller that enables market transactions in all but the simplest case. The universality of credit or futures-delivery in wholesale markets exemplifies this.

In discussing the market, Gauthier seems to be so impressed with how the system functions despite the intense *competition* between seller and seller (and between buyer and buyer) that he overlooks the *cooperation* that is both routine and necessary for the market's existence. Fortunately, although his characterization of the market as a "morally free zone" is strong and reiterated, and used to good rhetorical effect throughout the work, Gauthier does not actually rely on it in developing the foundations of his theory of morals by agreement. He simply relies on the existence of market failures to provide room and relevance for his moral theory, and his failure to recognize that even a market free of externalities requires a moral theory does no harm to his foundational argument.

It's easy to come up with a plethora of questions about a theory as ambitious as this, and Gauthier, a good self-critical thinker, spends much of the book trying to formulate and answer as many of them as possible. He elaborates about what exactly his theory does and does not do. He deals with the question "Once I've adopted and displayed a predisposition to be a constrained maximizer, what it is that makes it rational for me to actually choose according to that "predisposition" when I find myself in the heat of the crunch?". Needless to say, a lot of this gets bogged down in technical details. In a "Note to the Reader" at the beginning of the book, Gauthier helpfully points out the more abstruse sections so we can skip them on the first reading, outlining the remaining two-thirds of the book which deal with the theory rather than with details of its elaboration. Overall, the book is clear, and if the theory raises more questions than it answers, that may be more a sign of the usefulness and fruitfulness of the theory than a sign of anything problematic about it.

Given the interest extropians have in self-determination and freedom from limits, eventually each of us must come face to face with each of the moral principles we've learned over the course of our lives, and make conscious choices in each case to adopt (or reject) that principle on the basis of our own autonomous decisions. The idea of morals by agreement gives us a background of thought that can help us try to apply the principles of rationality we use in our everyday lives to the profound ethical choices that serve, in some ways, as the anchors of our identity.

We might need a forward-thinking cryptologist to develop a cryptographic protocol for "expression of true intentions" to save us from having to settle for non-cooperative, equilibrium outcomes instead of reaping the benefits of cooperative, optimal ones.

ENDNOTES

[1] Paul M. Churchland, *A Neurocomputational Perspective*, Cambridge, Massachusetts: Bradford Books, MIT Press, 1989.

[2] "Notes on Philosophy, January 1960", *Philosophy*, April 1960, as quoted in *The Retreat to Commitment*, 2nd ed., p. xxv (Preface)

[3] Utilitarianism in its most familiar formulation is the idea that we should act so as to produce the greatest happiness in the greatest number of people. Among the more obvious problems of utilitarianism is the definition of happiness (in which the schism between the hedonist and non-hedonist varieties of utilitarianism finds its origin), the incommensurability of the happiness of different individuals (how do we choose between making two people somewhat happy or making one person extremely happy?), and the schism between rule-based and outcome-based utilitarianism. To put it mildly, this catalog of problems is not exhaustive.

[4] John Rawls, *A Theory of Justice*, Cambridge, Mass.: The Belknap Press of Harvard University Press, 1971.

[5] Robert Nozick, *Anarchy, State, and Utopia*, New York: Basic Books, 1974.

[6] J. D. Williams, *The Compleat Strategyst*, New York: McGraw-Hill, 1954.

[7] Robert Axelrod, *The Evolution of Cooperation*, New York: Basic Books, 1984.

[8] David Gauthier, *Morals by Agreement*, Oxford: Clarendon Press, 1986, p. 65

[9] Axelrod, op. cit.

[10] Douglas Hofstadter, "Dilemmas for Superrational Thinkers, Leading Up to a Luring Lottery," in *Metamagical Themas*, New York: Basic Books, 1985.

[11] Jan Narveson, *The Libertarian Idea*, Philadelphia: Temple University Press, 1988.

Consciousness: Spontaneous Order and Selectional Systems

Bright Air, Briliant Fire
On the Matter of Mind

by Gerald M. Edelman

BasicBooks, New York, 1992.
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Reviewed by Reilly Jones

This is a book about the coming neuroscientific revolution in which we will achieve a scientific understanding of what human nature *really* is, and *not* what philosophers of the past have reasoned it to be. Nobel laureate Gerald Edelman, of Scripps Research Institute, has produced a summary of his theory of consciousness intended for the non-scientific reader. The full theory is laid out in rigorous detail in a trilogy consisting of: *Neural Darwinism: The Theory of Neuronal Group Selection* (1987), *Topobiology: An Introduction to Molecular Embryology* (1988), and *The Remembered Present: A Biological Theory of Consciousness* (1989). He has added his own thoughts about the philosophical and social implications of this new view of humanity as well as submitting useful critiques of some of cognitive science's conventional wisdom. Since these books were published, there has been mounting evidence substantially confirming his basic theories, as well as an array of books expanding on many of the facets of consciousness with strong parallels to his ideas.

The subject of the governing principles of human nature is the most important subject possible to us. How do we know our world? What is the purpose of rationality, imagination, emotions, intuition, spirituality, dreaming? How do these all work together? What is the secular basis of morality? What creates the sense of self? How do we categorize our perceptions? How do we remember? How do we learn? How do we decide to act, and then act? We've had philosophers tell us that we are political animals, sick animals, rational animals, feeling animals, social animals, power-seeking animals and lately, that we are machines. Erroneous theories of human nature lead inexorably to failed political systems. The most recent failures were those systems based on Locke's rational animal, which produced the modern limited democracies committed to protect science in order to gain the benefits of technology, back when people still believed in purpose and progress. These systems have given way to Rousseau's feeling animal, which produced today's failed social welfare states committed to individual self-expression without moral responsibility, when people openly question the existence of purpose or progress.

Any new political system replacing the current failed systems must deal with human nature as revealed by the neuroscientific revolution. Edelman is in agreement with Ayn Rand's assertion that, "It is with a new approach to epistemology that the rebirth of philosophy has to begin." A biological epistemology is the prescription for more successful, meaning adaptive, philosophical and political worldviews. People are difficult. A person's conscious life is boundedly rational, much of life takes place in diffused focus, emotional states where rules of logic and deduction are not entirely accessible.[1] We cannot always escape superstitious beliefs, we do not always act in accordance with our purposes nor say what we are thinking even when we try to.[2] This revolution's most dramatic effects lie in our ability to biologically and mechanically enhance our consciousness, both individually and species-wide. The political ramifications of such changes are immense.

Edelman is strongest when explaining his scientific theory of consciousness and outlining some of the major implications this theory has for the methodology of brain science and the philosophy of mind. He is particularly strong when relying on his long research experience in somatic selectionism and adaptationism within immunology. He is weakest when he relies on work done primarily by others in the areas of language, the meaning of truth, emotional complexity and the teleology of consciousness. The book's organization is difficult to follow, you have to read it in entirety to find all the relevant points. I believe this is due to the scope and complexity of the topic of consciousness, there is no good beginning or end to the topic, you have to view it as a whole. He makes cogent arguments against mainstream positions in cognitive science: the mind is not a computer, humans are not "intelligent machines," the brain is not a "finite state machine," no connectionist neural nets work like the brain, psychofunctionalism can never be coherent without a thorough understanding of the biological selectionism and morphology of the brain, no language acquisition device exists, no specified semantics exist, no formal grammar can be specified, no objectivism (classical categories or unequivocal descriptions of reality) fits with how we actually categorize experience, no "mentalese" exists to causally determine behavior.

Edelman begins with the brain as a self-organizing and selectional system. I believe the marriage of self-organizational and selectional systems within thermodynamically open environments is the primary direction biological and social sciences are going to take for this scientific revolution (see review of Kauffman's *Origins of Order* in *Extropy* #13).[3] It is hoped that the fruit of this marriage will be universal laws of living forms and functions for any open-ended environment. Edelman calls it "completing Darwin's program," the study of morphologic evolution. New scientific disciplines are speciating in this vibrant research environment: recognition science (adaptation to novelty), selectional systems (mapping of biological and conceptual fitness space), applied molecular evolution (mapping of polymer shape and function space), noetics (artificial sapience and inorganic neuromorphology), complexity sciences (self-constructing far-from-equilibrium dynamical systems), artificial life (synthetic biology), distributed metabolic systems (immunological, genomic, sociotechnological), and more.

Any new political system replacing the current failed systems must deal with human nature as revealed by the neuroscientific revolution.

Edelman starts his biological theory of consciousness with a physics and evolution assumption. No laws of physics are violated, there are no ghosts and no consciousness existed prior to its evolutionary appearance as a phenotypic property. I would add that no spook physics or spook biology are needed: no holographic mind, no consciousness collapses the wave-function, no Many-Worlds ontology, no computational microtubules in the cellular cytoskeleton, etc. He proceeds with a discussion of how consciousness evolved, how neurons work, what topobiology is, and what selectional systems are (he terms them "recognition science"). He presents his Theory of Neuronal Group Selection, explaining homeostatic values, neuronal maps and memory. Then, the old distinctions of reptile brain, paleo-mammalian brain and neocortex are recast by Edelman into Primary Consciousness (the older brains) and Higher-Order Consciousness (the newer brain). Each of these are made up of a primary neuronal repertoire (self-organization processes in embryonic development or "nature") and a secondary neuronal repertoire (experiential development or "nurture"). Distributed processing of self-generated and non-self-generated signals occurs throughout this four-way anatomical matrix: primary, higher-order, nature and nurture.[4]

Consciousness evolved in stages: first, systems of the interior to take care of the body; second, systems to categorize world events and to permit sophisticated motor behavior; and third, systems to handle time and space, succession in motion and memory.[5] This last stage has led to a more complex selectional system than simple natural selection operating at the previous stages. Elliott Sober notes, "The mind is more than a device for generating the behaviors that biological selection has favored. It is the basis of a selection process of its own, defined by its own measures of fitness and heritability."[6] Sober agrees with Edelman on the contingent nature of which selectional system will govern in any given instance. As Edelman puts it: "Given the diversity of the repertoires of the brain, it is extremely unlikely that any two selective events, even apparently identical ones, would have identical consequences. These observations argue that, for systems that categorize in the manner that brains do, there is macroscopic indeterminacy." An important new holistic view of the evolution of genetic intelligence is being formulated, outlining the intimate connection between self and non-self, how organism's perception of the environment leads to changes in the environment through selectional systems, and how increased perceptual accuracy hastens the pace of evolution.[7]

This revolution's most dramatic effects lie in our ability to biologically and mechanically enhance our consciousness, both individually and species-wide. The political ramifications of such changes are immense.

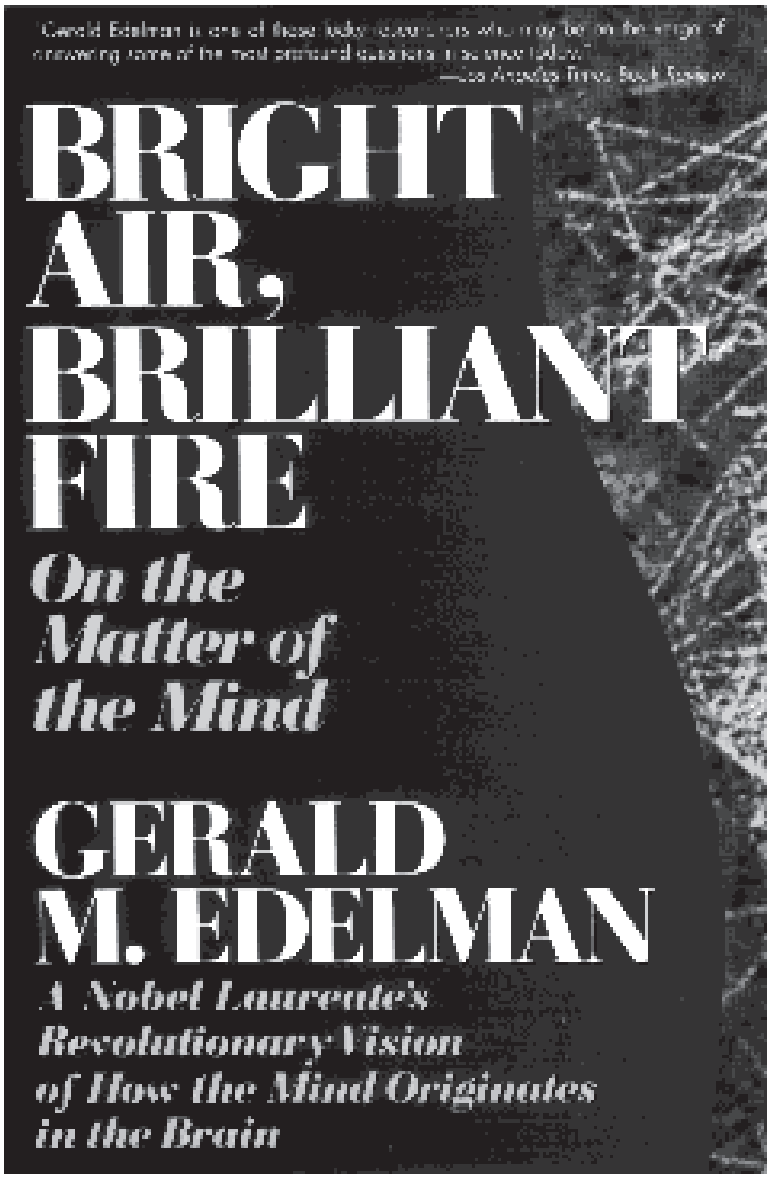
Topobiology is the study of the mechanical events occurring at particular places and temporal sequences during cellular development. Cells divide, migrate, adhere, differentiate and die. Edelman explains how these processes lead to individual uniqueness, even in genetically identical twins. "...Genes specifying the shapes of proteins are not enough; individual cells, moving and dying in unpredictable ways, are the real driving forces. The principles governing these changes are epigenetic – meaning that key events occur only if certain previous events have taken place." Unfortunately, researcher Rae Nishi reports that, "Very little is known about the mechanisms of neuronal cell death or of the mechanisms of cell rescue by trophic factors."8

Edelman uses the term "recognition sciences" to mean the study of selectional systems with a particular definition of 'recognition.' "By 'recognition,' I mean the continual adaptive matching or fitting of elements in one physical domain to novelty occurring in elements of another, more or less independent physical domain, a matching that occurs without prior instruction." Natural selection (science of evolution) has given rise to two somatic selectional systems: the science of immunity and brain science. Somatic, in this sense, means occurring within the life of an individual. This sense of recognition and selection are representative of Stuart Kauffman's synthetic biological models of "knower-and-known" (or subject-object relation) and "map-and-interpretation" (or approximation and evaluation of truth). Both Edelman and Kauffman emphasize that recognition systems can only survive with a sufficient degree of stability, poised at the boundary of chaos.

This stability is crucial to our search for truth. Edelman points to science as being "studies of stable relations among things," mathematics as being studies "of stable relations among stable mental objects," and logic as being studies "of stable relations between sentences that are applicable to things and to mental objects." Robert Nozick characterizes this search: "Enhancement of inclusive fitness yields selection for approximate truth rather than strict truth. Knowing this, we can sharpen our goal and its procedures."9 There are

mathematical and computer models available now, dealing with how the continuous flow of external reality becomes mapped or compressed internally, simultaneously with interpretation or evaluation of such chunks of information.10 Our visual recognition system is unlimited in capacity and the selection of visual information occurs "early" in the course of processing (prior to recognition).11 The brain attempts to maximize perceptual accuracy by reducing the uncertainty in a variable input, thus gaining information about the precursor to the continuous stimulus distribution, while processing all perception through recategorical memory influenced by dynamically changing values.12 The importance of simultaneous map-and-interpretation is due to the critical problem in sensorimotor integration: the selection of single targets for movement from the continuous stimulus distribution.13 Friedrich Nietzsche showed great foresight when he wrote in *The Will to Power*: "We can comprehend only a world that we ourselves have made. It cannot be doubted that all sense perceptions are permeated with value judgments... The organic process constantly presupposes interpretations."

A very brief summary of the Theory of Neuronal Group Selection (TNGS) in Edelman's words:



"(1) Developmental Selection: This entire process is a selectional one, involving populations of neurons engaged in topobiological competition . A population of variant groups of neurons in a given brain region, comprising neural networks arising by processes of somatic selection, is known as a primary repertoire. The genetic code does not provide a specific wiring diagram for this repertoire. Rather, it imposes a set of constraints on the selectional process.
(2) Experiential Selection: Selective strengthening or weakening of populations of synapses as a result of behavior leads to the formation of various circuits, a secondary repertoire of neuronal groups.
(3) Reentrant Mapping: The linking of maps occurs in time through parallel selection and the correlation of the maps' neuronal groups, which independently and disjunctively receive inputs. This process provides a basis for perceptual categorization. This is perhaps the most important of all the proposals of the theory, for it underlies how the brain areas that emerge in evolution coordinate with each other to yield new functions. To carry out such functions, primary and secondary repertoires must form maps. These maps are connected by massively parallel and reciprocal connections. A fundamental premise of the TNGS is that the selective coordination of the complex patterns of interconnection between neuronal groups by reentry is the basis of behavior."

The coordination of brain areas, or modularity, is one of the most promising paths to future enhancements of consciousness.14 Reductionist research on shifting synaptic strengths is showing positive results in confirming much of the selection and map formation theories. Some difficulty arises from the fact that diffusible substances (or "microhormones") such as nitric oxide and at least three possible others, trigger groups of neurons probabilistically.15 The individual synapse cannot be the computer bit of the brain, rather, local groups of neurons behave like buffered attractors. Major difficulty arises when researchers try to follow the dynamic field receptivity of groups of neurons. Pettit and Schwark report: "...It is difficult to detect reorganization in subcortical maps, which are three-dimensional and can exhibit large somatotopic shifts over relatively small distances. ...It appears that mechanisms underlying receptive field reorganization exist at multiple levels of sensory systems. In normal brain function, such mechanisms might help to adapt to a continuously changing sensory environment."16 A serious theoretical model for why neuronal groups have evolved involves both linear and non-linear synaptic conductance. It is called the normalization model, and shows why group behavior allows for more fit responses to continuously variable stimulus distributions.17

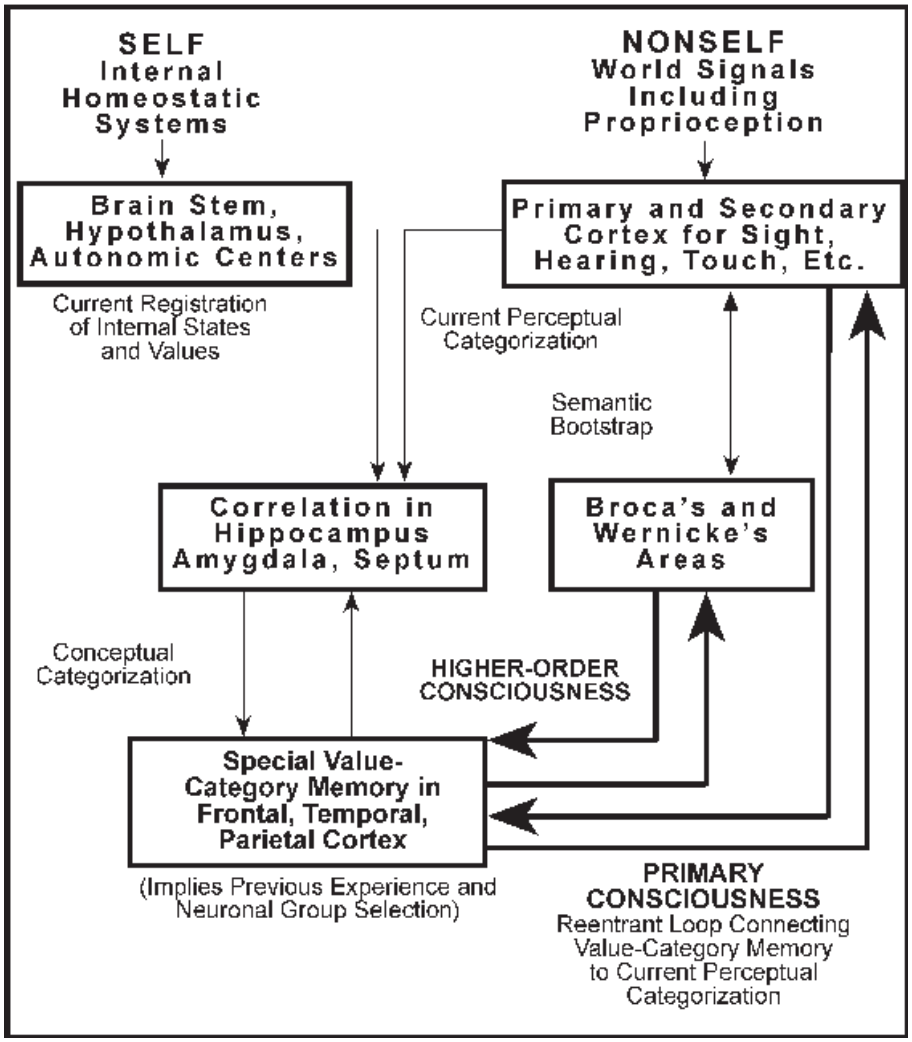
There is an on-going "units of selection" controversy in biology over group vs. individual selection that is similar to the controversy in social sciences over methodological holism vs. individualism. After absorbing Kauffman's ideas on biological attractors, I can't help but think that Edelman should call it, Theory of Neuronal Attractors. Research is revealing that neurons behave strongly like attractors.[18] The environment is open-ended, each individual unit is subject to a unique set of constraints at each instant. Thus, all selection is localized at the individual unit instant by instant, perhaps around attractors acting on varying spatio-temporal scales. I think it is misleading to speak of group selection in open systems.

The driving forces of an animal's behavior are evolutionarily selected value patterns that helps their brain and body

maintain conditions fulfilling the purposes of survival and reproduction. These systems are homeostats, and include regulation of heartbeat, breathing, sexual responses, feeding responses, endocrine functions and autonomic responses. Homeostasis is the buffered capacity of a system to return after being disturbed. Ralph Waldo Emerson, in his essay *Experience*, addresses this capacity for constancy: "If I have described life as a flux of moods, I must now add that there is that in us which changes not and which ranks all sensations and states of mind." These homeostatic values are the base of morality, built-in values adhering around purpose. Miguel de Unamuno, in *The Tragic Sense of Life*, expressed this secular morality as, "Our desire is to make ourselves eternal, to persist, and whatever conspires to this end we call good, and evil is whatever tends to lessen or annihilate our consciousness."

The concept of cognitive maps has a long history. The psychologist Edward Tolman viewed organisms as intrinsically goal directed, and as forming "cognitive maps" of their environments, in his 1932 book *Purposive Behavior in Animals and Men*. The philosopher Gilbert Ryle argued that the individual must "map" various mental concepts and determine their position in relation to other concepts, in his 1949 book *The Concept of Mind*. Elliott Sober draws attention to the analogy between biological models and maps in general; and argues that even though we don't understand why probability works (without circularity), it is useful to use probability to make *significant generalizations*, or maps. I would note that the interpretation of probability (the map), is dependent on what your purpose is, or utility value. This freedom to interpret probability based on utility (an adaptive mechanism), is seen in various interpretations of quantum mechanics, Darwinism (population thinking), classification of species, even political polling. Mark Twain was right, there are "lies, damn lies, and statistics."

Edelman's theory covers not just perceptual mapping, but other mapping processes and their inter-relationships along reentry circuits with each other. Global mapping is a dynamic structure containing multiple reentrant motor and sensory maps interacting with nonmapped neuronal regions. The body and brain work together to produce the system property of consciousness, the brain requires the body in order to think. There is also a mapping of types of maps, operating free from immediate sensory input, capable of activating or reconstructing portions of past



global and perceptual mappings.

The mechanisms of maps, homeostatic values and selection are central to the system property of memory. Memory is critically related both to perceptual categorization and to learning. The mechanisms of memory transfer, from short-term to long-term, are receiving a great deal of scientific research effort, confirming parts of the TNGS.[19] Edelman writes: "To have memory, one must be able to repeat a performance, to assert, to relate matters and categories to one's own position in time and space. To do this, one must have a self, and a conscious self at that." David Gelernter emphasizes that "*Thinking* is primarily, overwhelmingly *remembering*."

The primary consciousness of lower animals is phenomenal experience arising "from the correlation by a conceptual memory of a set of ongoing perceptual categorizations." It is a "remembered present." Higher-order consciousness in humanity is the achievement of temporal extension through the ability to distinguish conceptual-symbolic models of the processes of primary consciousness from ongoing experience. "The remembered present is placed within a framework of past and future. Once a self is developed through social and linguistic interactions on a base of primary consciousness, a world is developed that *requires* naming and intending." Concept formation in the TNGS is linked to subjectivity, intentionality and volition.

Edelman attempts to move the science of consciousness as close to natural science and as far away from social science as possible. He does this through his "qualia assumption." "Qualia, individual to each of us, are recategorizations by higher-order consciousness of value-laden perceptual relations in each sensory modality or their conceptual combinations with each other. Given the fact that qualia are experienced directly only by single individuals, our methodological difficulty becomes obvious. As a basis for a theory of consciousness, it is sensible to *assume* that, just as in ourselves, qualia exist in other conscious human beings, whether they are considered as scientific observers or as subjects. It is our ability to report and correlate while individually experiencing qualia that opens up the possibility of a scientific investigation of consciousness."

Thus, there is to be a marriage: between the natural science portion of the underlying physiology, that is to be studied through Francis Crick's program of reductionism; and the social science portion of reports of mental states, that is to be studied through statistics.[20] The difficulty we have of accurately reporting the complexity of our states and feelings means this research program is going to take considerable time because of the need for large sample sizes.

A crucial concept to understanding human nature is what Gelernter calls the "spectrum of focus" of consciousness. This is the idea that we live our lives along a sliding scale of thoughtful attention, from high-focus analytical reasoning, through medium-focus emotional states down to low-focus associative creativity. Edelman notes that the upper end of the range produces a thinker who "is so immersed in a specific attentive state related to the project of thought that he or she is truly 'abstracted'– unaware of time, space, self, and perceptual experience." At the low end of the range are dreaming and mystical experiences. This spectrum of focus has evolved largely because, as Edelman says: "The brain and the nervous systems cannot be considered in isolation from states of the world and social interactions. But such states, both environmental and social, are indeterminate and open-ended."

Gelernter refers to his plunge-squish method from *Mirror Worlds* (see review in *Extropy* #11), to characterize reasoning; "High-focus thought is capable of penetrating a whole stack of memories at once." This could be termed a mapping of maps, abstract rationality typifies this state. From Kauffman, "...Similar states typically flow to the same attractor and hence are classified as the same." An excellent source for understanding high-focus categorization covers memory, induction, pattern completion, and causal reasoning.[21] Estes gives formal accounts how instances within a category vary in their typicality and categorization accuracy; how categories that are defined by different rules are learned with different degrees of efficiency; how concepts are combined; and how categorization is influenced by variables such as category size, presentation order, frequency, and featural similarity.

Gelernter proposes affect-linking as a mechanism for continuity in medium-focus thought, "The role of emotion in thought, then, is exactly to glue low-focus thought-streams together." Kauffman describes a mechanism of fluctuations in the distributed neuronic architecture that could stand for shifting emotional states, "...Minor alterations in network structure and logic can cause nearby states which formerly flowed to the same attractor to flow to two different attractors." The emotional affect-linking has been characterized as "binding" or "chunking" allowing cognitive maps in the to-be-remembered environment to be processed simultaneously.[22]

Arthur Reber has discovered "experience, thought, and action can be influenced by past events that we cannot consciously remember (implicit memory) and current events that we cannot consciously perceive (implicit perception)."[23] Implicit learning occurs because interpretations of cognitive maps that are not necessarily content-specific, may generalize the map to pick up patterns in the environment that the subject was unconscious of. These are low-focus processes. Gelernter calls emotion: "a 'content-transcending' abstraction. The *vocabulary of the abstraction* is completely separate from the *vocabulary of the thing being abstracted*." A function of dreaming is to consolidate the affect-linking of emotions through single episodic memories. This linking could be what Kauffman describes as "...States along trajectories flowing to the same attractor converge on one another." Rather than the mapping of maps of high-focus thought, this is more like cruising over maps picking up bits and pieces of memory. This low-focus area seems to be a likely candidate for what John Searle calls the Background. "A crucial step in understanding the Background is to see that one can be committed to the truth of a proposition without having any intentional state whatever with that proposition as content."[24]

I will close by letting Edelman express his philosophical thoughts arising from his theory of consciousness. "By taking the position of biologically based epistemology, we are in some sense realists and also sophisticated materialists. Given how meaning is defined in this book, we must accept a position of *qualified* realism. Our description of the world is qualified by the way in which our concepts arise. According to biologically based epistemology and qualified realism, knowledge *must* remain fragmentary and corrigible. We have suggested a favored set [of philosophical positions]: **qualified realism, sophisticated materialism, selectionism, and Darwinism**. Selfhood is of critical philosophical importance. Please remember, however, that no scientific theory of an individual self can be given (our qualia assumption)."

The coordination of brain areas, or modularity, is one of the most promising paths to future enhancements of consciousness.

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Productioninformation

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