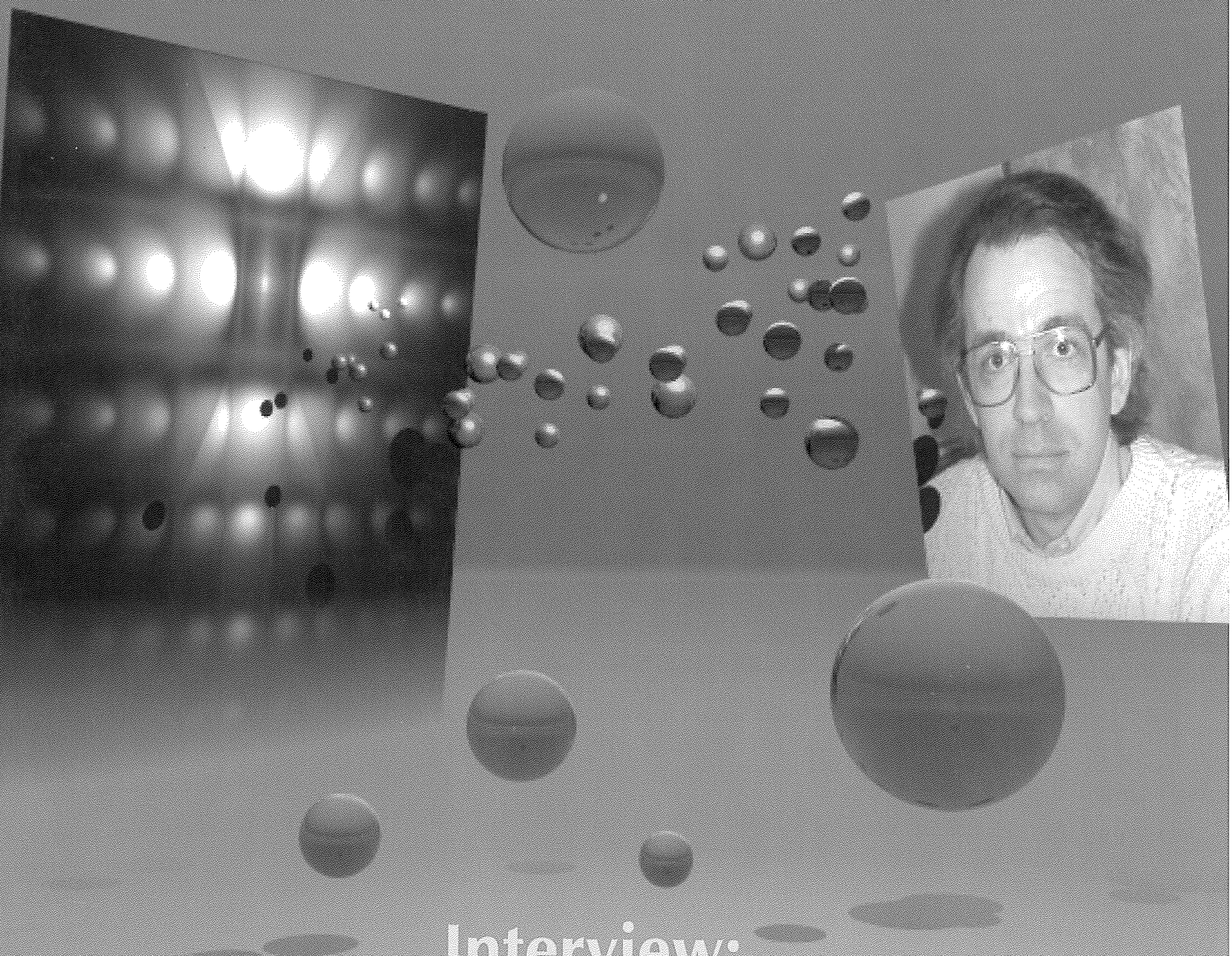
CRYONICS

2nd Qtr. 1998 A PUBLICATION OF THE ALCOR LIFE EXTENSION FOUNDATION Volume 19:2



Interview: K. Eric Drexler, PhD

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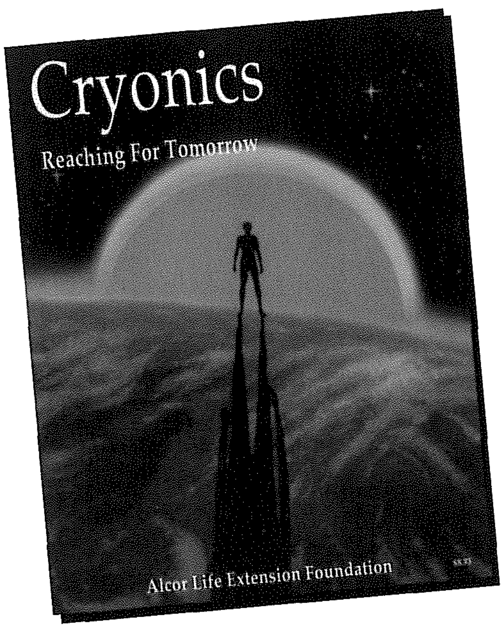
"What *is* cryonics?"

Cryonics is the ultra-low-temperature preservation (biostasis) of terminal patients. The goal of biostasis and the technology of cryonics is the transport of today's terminal patients to a time in the future when cell and tissue repair technology will be available, and restoration to full function and health will be possible.

As human knowledge and medical technology continue to expand in scope, people considered beyond hope of restoration (by today's medical standards) will be restored to health. (This historical trend is very clear.) The coming control over living systems should allow fabrication of new organisms and sub-cell-sized devices. These molecular repair devices should be able to eliminate virtually all of today's diseases, including aging, and should allow for repair and revival of patients waiting in cryonic suspension. The challenge for cryonicists today is to devise techniques that will ensure the patients' survival.



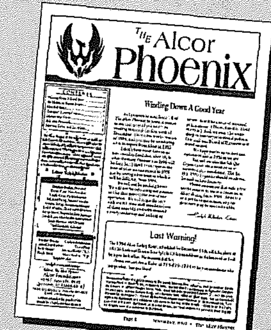
"How do I find out more?"

The best source of detailed introductory information about cryonics is *Cryonics: Reaching For Tomorrow.* Over 100 pages long, *Reaching For Tomorrow* presents a sweeping examination of the social, practical, and scientific arguments that support the continuing refinement of today's imperfect cryonic suspension techniques, in pursuit of a perfected "suspended animation" technology.

This new edition features an updated and lengthened chapter on revival, as well as the appendices "The Cryobiological Case for Cryonics" and "Suspension Pricing and the Cost of Patient Care." Order your copy for $7.95, or receive it FREE when you subscribe to *Cryonics* magazine for the first time. (See the Order Form on page 48 of this issue.)

For those considering Alcor Membership. . .

If you're intrigued enough with cryonics and Alcor that you're considering Membership, you might want to check out *The Alcor Phoenix*, Alcor's Membership newsletter. *The Phoenix* is a Membership benefit, so it's free to Members and Applicants, but anyone can receive it for $20/year ($25/year if you live overseas). It's released 8 times each year, on the "off months" of the quarterly *Cryonics* (February, March, May, June, August, September, November, and December). *The Phoenix* is shorter than *Cryonics*, but appears twice as often and is mailed First Class. Being a Membership newsletter, *The Phoenix* focuses on Membership issues such as financing cryonics, staff and management matters, developments in Patient Care and Emergency Response, etc. These issues will impact you directly if you decide to become a Member, and may help you make a more informed decision in the meantime.

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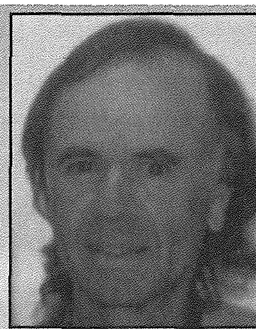
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ISSUE TO PRESS: March 31, 1998

UP FRONT

BY BRIAN SHOCK, EDITOR

Did you open this issue to read the Eric Drexler interview? Great! I'm glad we have something that piques your interest, and I'm very grateful to Eric for donating some of his valuable time. (And please note a special thanks to Tanya Jones of the Foresight Institute, who arranged this entire deal.)

But don't just stop at the interview — this magazine is packed with thought-provoking material. For example, CryoCare president Charles Platt has graciously consented to begin a regular column ("Reality Check," page 6), frequent CryoNet poster Joe Strout has contributed a fine introductory article on uploading (page 26), and Alcor member Mike Laprade sent a piece on how he reconciles cryonics with his personal faith (page 37).

And as usual, if something you read here inspires a strong opinion — positive *or* negative — please write and tell me about it!

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Editor: Brian Shock

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Submissions may be sent via e-mail (brian@alcor.org) in ASCII, Word, WordPerfect, or PageMaker format. Mailed submissions should include a PC diskette with the file in any previously mentioned format (although printed text alone will be considered). All submitted media become property of the Alcor Foundation unless accompanied by a self-addressed stamped envelope. The Alcor Foundation asumes no responsibility for unsolicited manuscripts, photgraphs, or artwork. Send all correspondence and submissions to:

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ABOUT THE COVER: CGI art by Tim Hubley; portrait photo by Tanya Jones

LETTERS TO THE EDITOR

Dear All,

Via this letter we would like to inform you, that recently we have founded a Transhuman Society in the Netherlands. For those of you who are not familiar with this term, here's a brief description:

"Transhumanism is a commitment to overcoming human limits in all their forms including extending life-span, augmenting intelligence, perpetually increasing knowledge, achieving complete control over our personalities and identities and gaining the ability to leave the planet. Transhumanists seek to achieve these goals through reason, science and technology."
(Natasha Vita More)

One of our main goals is to establish a first aid cryonics network in the Netherlands. Apart from this, we'll also be promoting the ideas of transhumanism in general, and cryonics in particular, to create more public awareness, and to hopefully attract some new members for our group. When we'll have gathered enough enthusiastic people we could think of funding some training and affordable equipment, and finally become a full-fledged local Alcor chapter. One of our first actions will be to send an information pack to all the Dutch hospitals, for three reasons:

1. To make them aware there are people with a cryonic suspension wish
2. To find possible members in the medical scene
3. To do a poll regarding their willingness to actually help, should an emergency occur

Besides becoming an active local Alcor group with some rescue capabilities, we would like to contribute to a network or organization for all European cryonicists. Some features could be: providing comprehensive (possibly multi-lingual) information for Europeans interested in cryonics, primarily via a webpage with, among other things, advertising space for all cryonics companies and related groups (such as morticians that perform suspension procedures) and contact addresses (or links) of all local European cryonics groups. Apart from this, the European Cryonics Society (temporary name for this project) could function as a mutual aid organization for various local cryonics groups and individuals. The exchange of experiences, collective training sessions or equipment purchase, more/better media coverage and research into EU law are just some of the possibilities of a European network. Anyone interested in such an undertaking is free to contact us (see below).

We believe that by educating people regarding foreseeable future technologies and their impact on everyday life, they will start to see cryonics as a realistic possibility. After all, we have the strongest argument possible: you have nothing to lose, and possibly everything to gain!

We invite everybody to mail us your thoughts, ideas or criticism, especially regarding the European cryonics network. You can visit the Transcedo website at: http://www.dse.nl/~transced, E-mail: transced@dse.nl, Phone: 0031 26 3893096 (Berrie Staring's private phone number).

Best regards,

TRANSCEDO

Dear *Cryonics*:

I found the article by Hugh Hixon on "Cooldown, Strain Energy, and Cracking" in volume 18:2 of *Cryonics* very stimulating. In it Mr. Hixon states that cracking of the brain during cooldown to temperatures below the glassy point of the perfusate is inevitable. Since liquid nitrogen (LN2) temperature is well below this point for the perfusates currently being used, anyone cooled to the LN2 temperature cannot expect to be re-animated without extensive tissue repair. His statement implies that if the temperature were kept just above the glassy point then reversible re-animation would be possible. I find that possibility very attractive because I would no longer need a (religious?) faith in the hypothetical capabilities of future nanotechnology. (Is nanotechnology the god of cryonicists?)

Clearly, it is important to determine the actual rate of tissue degeneration at the chosen temperature. If Mr. Hixon's statement is correct that it is sufficiently slow that it will not compromise successful re-animation, then storage at this temperature provides several advantages to present procedures.

Cost: Storage of the cryo-patients at a warmer temperature means less LN2 is needed because the rate of LN2 boiloff is proportional to the temperature gradient. I expect that this cost advantage must be weighed against the simplicity of storing the patient in an LN2 container that needs no servicing other than occasional topping off with LN2. However, it seems possible that the patients could be kept in a dry dewar and that only the warmed gases from a separate LN2 container would be admitted to the patients' container to hold the temperature constant. If the container enclosing the patients were connected by a thermal conductor (like an aluminum bar) to the inside of the dewar containing LN2, then when the patient container warmed slightly, more heat would be conducted to the LN2 which would boil off faster and provide more cooling to patients. Such a feedback system could probably be designed so that it too would only need to have the LN2 topped off occasionally. Hence the equipment and procedures now used to care for the patients would need little modification. The costs for the modifications might be made up in the lowered costs for LN2.

A more important advantage of keeping the patients slightly above the glassy point is that such a situation would open up new avenues of re-animation research. Today a major requirement for reversible re-animation is that the perfusates and the tissues not crack at LN2 temperatures. Apparently all the useful perfusates fail this test. If the cooldown temperature stayed above the glassy temperature, then cracking is avoided and research on procedures to provide re-animation could begin immediately.

For example, hamsters (which have long been used in hibernation research) might be a useful test subject. They already have a physio-chemical makeup that allows the body to re-animate itself from temperatures well below the basal temperature. Various combinations of perfusates and warm-up procedures could be tried and those that allowed the closest approach to the glassy temperature chosen for further study. Because the research could be conducted on animals that ordinarily re-animate, those procedures and perfusates that are detrimental to re-animation could quickly be identified and eliminated from further study. Concurrent studies of the rate of tissue degeneration as a function of temperature and perfusate composition could be conducted to give a reliable determination of how long the patient could be held while awaiting re-animation and a cure. The fact that the test animals routinely demonstrate reversible re-animation would provide great encouragement to the cryonics community in that it would give us reason to believe that we too could someday be re-animated. It would be wonderful to move from faith in nanotechnology to scientifically repeatable re-animation.

Sincerely yours,
William J. Borucki

Hugh Hixon replies:

Given reversible suspended animation, storage above the threshold temperature for cracking is a necessity, but there are a lot of problems between there and where we are presently. Some details need to be corrected in Mr. Borucki's letter.

In terms of repair requirements, cracking is really a very small fraction of the total; less than, and probably very much less than 1%. Most of the repair effort will go into the reconstruction of nerve tracts and synaptic connections

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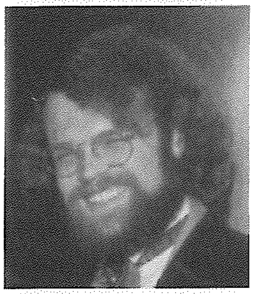


Future Strangeness

by Brian Shock

A week or two ago I was discussing history with one of Alcor's octogenarian members, when this fine old gentleman startled me with the assertion that "Nazi Germany lost World War II because key members of the Third Reich were homosexuals."

Of course I took the only polite course open to me: I tried to change the subject. My acquaintance refused to allow any diversion, however. Perhaps annoyed by my lack of agreement with an hypothesis considered fairly reasonable in his day, he proceeded to explain how Ronald Reagan was a suspiciously *liberal* president, how African-Americans had ruined major cities, and how giving women the vote had led to the downfall of democracy in the U.S.

Did he really believe these notions? Perhaps not, though I could've sworn that his voice rang with at least one coarse note of certainty.

If this man is so calcified in his beliefs now, I wondered smugly, *how does he think he will tolerate waking up in a strange post-suspension future?*

My sense of superiority didn't last long. If I could project someone else X years into the future, I couldn't help repeating the process for myself.

Assuming I live to eighty, what's to stop me from chiseling my own outmoded beliefs in stone as well? Values change, mores change, politics change — will I adapt to future strangeness any better than someone born eighty years ago?

All of us have some tendency to deny the possibility that time may leave us permanently stranded along the wayside. All of us, at one moment or another, have condemned the previous generation's mind set as "wrong headed" and the next generation's attitudes as "irresponsible." Inevitably, someone will someday consider our current opinions hopelessly out of date. How well will we survive this relative obsolescence?

Let's perform a quick mental exercise about present and future value systems:

I accept the rights to life, liberty, and the pursuit of happiness. Like Robert Heinlein, though, I believe such freedoms also include the freedom to die, the freedom to starve, and the freedom to feel disappointment. I do not believe in *sustentative* rights, such as the "right" to free healthcare, the "right" to receive food you haven't earned, the "right" to have a job simply because you're breathing.

Of course I can imagine *acting* as though I believed in sustentative rights. If I were hungry and penniless, I would probably beg for a hand-out. Still, I would *know* that I was living off the kindness of strangers. I doubt if I could convince myself that society owed me sustenance for no other reason than the fact of my existence.

Now, let's jump ahead one pretend century or so.

I awaken from cryonic suspension to find that U.S. society's nascent belief in sustentative rights has grown to encompass all aspects of life. Not only does every citizen have the right to healthcare, food, and work, but he also takes for granted his right to housing, clothing, and entertainment! A young person could spend his entire life playing in government-sponsored virtual reality (this *is* the future, after all; television is as dead as the dinosaurs), without a moment's thought about how he will earn a living or better himself. As far as I can discern, ninety percent of the population sits around on its lazy collective butt and happily vegetates.

"What's the point in all this?" I might ask myself. "Why do we need fifty billion worthless drooling idiots taking up space on this planet?"

This question would have no meaning because the circumstances of my youth no longer exist. Throughout the 21st century, advances in computers, communications, manufacturing, and power systems (all probably relating closely to some form of nanotechnology) created a social system with more wealth than any other in history. Technology gradually made food, clothing, shelter, and even entertainment so cheap that governments could dole out these items as easily as they used to mail out tax forms. The vast majority of people did indeed choose to spend their lives in nothing more ambitious than consumption and reproduction, though a significant — if ridiculed — handful continued to strive, learn, and expand the possibilities of humanity.

And who could blame slackers for taking advantage of the bounty? No law of physics compells humans to labor for their daily bread. Are digging ditches and shuffling papers fundamentally more important than napping and playing games?

Instead of asking, "What's the point in all this," I should have asked, "Can I open my mind to new situations? Now that I no longer have to waste eight hours of every day in earning my food and shelter, can I reach for all of the amazing possibilities this time and place offers?"

I doubt that this sketchy future bears any resemblance to what will come to pass. Even so, social conditions *will* change drastically over the next century. If you find yourself deploring every superficial novelty in fashion, music, and film today, how will you deal with the unimaginably fundamental differences in values, mores, and politics that may confront you after your suspension? Will you revile the strangeness and turn inward, or will you treat it as a challenge and explore the new opportunities?

None of us can know for certain how we will react to the future, but we may be able to improve our ability to cope. Stretch your mind: try some mental exercises similar to the one in this editorial. Explore your basic values, beliefs, and preferences, then imagine how society could develop in ways contrary to them. How would you handle a civilization that confined suspension revivees to a low-tech reservation? How would you feel if most of the "people" in your environment didn't appear even remotely human by today's standards? What if all individuals of your social standing were prohibited from reproduction? What if society recognized five different sexes, or only one, or none?

By all means, do *not* drown yourself in future strangeness — treat it as an unknown sea, and build your mental and emotional muscles until you can swim it with greater confidence.

Letters to the Editor,
Continued from page 3

that have been damaged by degradative biochemistry but can still be inferred. The real problem with cracking is that the vascular system of the brain leaks at the cracks, making any system of repair that depends on simple fluid transport undeliverable.

The suggestions concerning temperature regulation at some higher temperature fail to account for the complexities of serious cryogenic dewars.

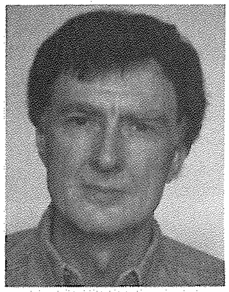
In operation, the vacuum of a cryogenic dewar is improved by cryogenic pumping, as the gas molecules remaining in the less-than-perfect vacuum (factory spec — 4 microns of pressure) condense out on the cold surfaces and become unavailable for heat transfer. They are also captured by the zeolites (getters) in contact with the cold surfaces. Thus, a cryogenic dewar does not exhibit the same heat conductance at all temperatures, and the higher the temperature, the lower its efficiency.

Maintaining a low temperature with cold gas evolved from liquid is grossly inefficient. A large part of the refrigerative heat value of a liquefied gas comes from the energy absorbed in the gas-liquid phase transition. To capture that heat value, the liquefied gas should be in an insulated container inside the dewar with the patient. In one of the designs I have come up with, we would stretch a Bigfoot about two feet taller, with the LN2 in the bottom, and the patients in cold gas above, with temperature regulation and circulation machinery in the patient volume. Servicing with LN2 would be a complication, since a lot of cold gas is evolved at that time, but that seems readily soluble. This design also has the virtue of cryogenic pumping of the patient dewar, even though most of its volume is not at the liquid gas temperature.

The system described by Mr. Borucki using a thermal conductor between the patient dewar and the refrigerant reservoir is a passive, equilibrium, system, and the temperature would vary with the outside temperature. A feedback system needs an amplification stage somewhere. The system I described in the above paragraph contains both passive and feedback elements to hold the temperature steady.

Storage at T_g *is complicated by the problems that the body, or even the brain, is inhomogeneous, and that the degree of cryoprotective perfusion may vary from patient to patient, or organ to organ, or even between brain regions. This means that a patient may have a mixture of* T_g*s, and you are forced to make a choice. (I hope it wouldn't be this bad, but it's a consideration that would have to be answered experimentally.)*

Regarding animal experiments, 50 years of cryobiology have demonstrated that if reversible suspended animation is possible at all, it's certainly not very easy. Before we try with whole animals, even tough critters like hamsters, we need to know a lot more about mechanisms of damage at every level from the molecular to individual organs. In many respects we are still stone ignorant, and yes, it would be nice to need less faith.



Column #1: Of Angst and Activism

by Charles Platt

When Brian Shock invited me to write a new series of columns for this magazine, I decided that I could make best use of the opportunity by focusing on some of the hard realities of cryonics that people often prefer to avoid. Along the way, I'll do my best to suggest some possible solutions.

Although I'm an ex-member of Alcor, currently signed up with CryoCare, I'll endeavor to generalize my commentary so that it applies to all cryonics organizations.

-- Charles Platt

Six years ago I was a bright-eyed cryo-activist, full of fresh ideas to leverage cryonics into the mainstream of public awareness. In January, 1991, I wrote my first article for *Cryonics* magazine, itemizing some suggestions.

Looking back at that article, I find it naive and laughably wrongheaded. My outlook hasn't changed because of any specific events in the field of cryonics; I simply went through a lengthy maturation process, similar to changes that I have seen in other cryonicists.

The sequence tends to run something like this:

1. Enlightenment.

By chance, someone — call him John Frost — discovers cryonics. Unlike most people who encounter the concept, he doesn't just view it as an interesting thought experiment, he *applies it to himself.* John makes that extra leap because his personality embodies eight key traits:

a) He is an idealist, dissatisfied with unpalatable aspects of reality (such as, for instance, aging and mortality).

b) He is extremely stubborn and doesn't like being told what to do.

c) He believes that in some vague sense he is important as an individual — yet his potential has been insufficiently recognized or fulfilled. He imagines that somehow, in the future, he can find greater fulfillment.

d) Although he may lack a formal science background, he has a generally optimistic feeling about science derived from reading science-fiction novels and popular-science magazines.

e) He is a shy, asocial person, with few friends. He isn't scared of feeling alienated if he wakes up in the future; he already feels alienated today.

f) He abhors religion, which leaves him with nothing to buffer the threat of mortality.

g) He is an imaginative person who questions assumptions that others take for granted.

Of course, not all cryonicists fit this profile; but many do, and to them cryonics seems so damned obvious, they can't understand why everyone doesn't want to do it. (The answer, of course, is that most people have personality profiles that are very different from the sketch that I have suggested above.)

2. Procrastination.

John recognizes that he's mortal; indeed, he believes he has faced this fact with unusual honestly. Still, he shares one trait with his fellow human beings: he doesn't expect to die *today.* Consequently, he doesn't sign up for cryonics today. His vague decision to sign up at some time in the future is quite sufficient to revitalize his worldview and give him a new feeling of possibilities.

Three factors encourage him to procrastinate, even while he advises other people that *they* should sign up:

a) The signup process is no fun at all. The documents are densely packed with legal technicalities, grim warnings, and difficult questions. The signup process is morbid and disturbing.

b) Cryonics costs money. Like most cryonics converts, John is not wealthy.

c) The process of obtaining life insurance is also unpleasant, since it re-minds John that to gain a chance of living again in the future, first he must die. For real.

3. Fulfillment.

After months or years, finally John signs up. He emerges from the process feeling pleased with himself, having taken a significant step toward transcending the human condition. He has defied the assumptions shared by 99.9995 percent of his fellow citizens. He has done something that only 1 American in 200,000 has been willing or able to do. He wears his med-alert bracelet with justifiable pride.

4. Readjustment.

John's life changes in unexpected ways. In particular, long-term romantic relationships become complicated. If his wife or girlfriend has no interest in cryonics, he'll be saddened by the idea of waking up alone in the future — while she may be angry about his "self-indulgent" and "wasteful" misuse of their money. This may precipitate arguments and a possible rift. On the other hand, if she is willing to sign up, he wonders what will happen if one of them dies relatively young and is frozen, leaving the other to fall in love again with some new partner, creating the potential for a problematic *menage-a-trois* in the far future.

Financial planning, career, child-rearing, family relationships, health — all of these aspects of John's life are also changed or complicated by cryonics.

Overall, however, he's still glad that he signed; and many (perhaps most) cryonicists remain in this state for the rest of their lives.

5. Reassessment.

If John makes the mistake of reading too many cryonics publications or talking to some serious cryonicists, he may be forced to reassess some of his optimism. There's a daunting list of problems and potential disasters:

Freezing damage can be so severe and complex, the worst cases may be irreparable even by nanotechnology.

Cryonics organizations are underfunded amateur enterprises weakened by squabbling.

Standby team members sometimes make potentially fatal errors, and equipment sometimes malfunctions.

Hospitals, doctors, and state officials may refuse to cooperate.

Relatives may interfere.

If John dies in an accident, almost certainly his body will be claimed by a coroner and his brain will be turned to mush by a long period of warm ischemia before being dissected in an autopsy.

John may react to these (and other) nightmare scenarios in one of three ways:

a) He may become disillusioned and quit his membership. This is unlikely because, as noted above, he is extremely stubborn. And the *concept* of cryonics still grabs him.

b) He may indulge in denial, preferring not to think about the downside of cryonics — or telling himself that it won't apply to him. John still hopes that nanotechnology will fix everything, and he uses life-extension supplements in the hope that he'll live long enough for cryonics technology to mature. He signs a statement of religious belief renouncing autopsy, and carries it in his wallet even though such statements are routinely ignored by many coroners. He makes small donations to his cryonics organization to improve their standby capability or enable more research. None of these measures makes a big difference to his situation, but they help him to feel better.

c) He may decide that the problems in cryonics are so severe, he has to take action personally. This, of course, is the last thing John wants. Cryonics was supposed to simplify and enhance his life, not complicate it and degrade it with time-consuming shitwork. Still, he has a powerful motivation: he wants to cheat death.

6. Activism.

John gets involved, on the local level or in his national cryonics organization. He witnesses a cryopreservation and is gripped by powerful emotions: excitement at the audacity of denying death, dismay at the pain and misery of the dying process, and unease at being reminded so graphically of his own mortality. The hands-on practice of Cryonics is far more emotionally demanding, complex, and disturbing than he ever imagined.

7. Angst.

As John's involvement deepens, he experiences severe emotional conflicts. He's shocked by bitter animosity among some cryonicists — yet feels accepted by the cryonics community as a whole, which gives him a greater sense of belonging and reassurance than he has found elsewhere. John still feels good about the grand ambition of cryonics, but he's daunted by some of the realities — especially the task of maintaining and improving procedures using underpaid employees or volunteers who lack proper qualifications.

As years pass and age encroaches, John's feelings become more intense. The need to encourage growth and finance research becomes urgent, in order to improve his own chances of being frozen with minimal damage. Other activists share his goal — but unfortunately they have different ideas about how to achieve it. Now John understands why there is so much conflict: the stakes, here, are life and death, yet there's no way to know, for sure, whose ideas are right and whose are wrong. The fundamental questions in cryonics cannot be settled conclusively, because there's no way to test the process. Thus, the arguments never end.

* * *

Six years ago, I had no inkling of what I was getting into as a cryonics activist. The situation seemed ridiculously simple: If we presented cryonics to the general public in the right way, using standard techniques of news management, we could achieve growth, raise money, and spend it on improvements that would benefit everyone.

Yet of course it isn't that simple. What, precisely, is "the right way" to present cryonics? If we describe it as a life-saving procedure, we're not being totally honest, because we have no proof that current techniques will save anyone's life. Cryonics is a very speculative procedure founded on unverifiable hypotheses. In other words it requires some faith — in people of the future, who (we hope) may be willing and able to repair inconceivably complex damage that we inflict today by imperfect techniques of freezing. Unlike most faiths, this is not absolute; it's faith in a *probability*. This is unappealing to most people. Thus, cryonics is a hard sell.

So — should we emphasize the positive aspects and downplay the uncertainties? This, I believe, is fraudulent. Also it can be self-destructive, because some people will uncover the harder facts about cryonics sooner or later, at which point they will feel deceived. Any cryonics organization survives only so long as it engenders trust. If it deceives its members, even in small details, it creates feelings of betrayal with potentially disastrous consequences.

Let's suppose, though, just for the sake of argument, there *are* easy, ethical ways to promote cryonics, and we *can* achieve rapid growth. Still this is not a net gain, because each new member is a potential liability. Everyone (currently) is mortal, with a future need to be cryopreserved; and the process of cryopreservation is arduous, entails financial and physical risks, drains the energy of volunteers, and taps resources. I believe that no cryonics organization today could do more than, say, eight high-quality cryopreservations per year without running into significant problems, such as volunteer burnout.

Also, one team can only tackle one case at a time. Calculating the probability of two members dying simultaneously is a nontrivial problem, complicated by the escalating risk of mortality as age increases. Without a doubt, though, the chance of two members dying on the same day increases more than linearly with membership growth — and no cryonics organization is equipped to deal with this.

Lastly, even if an organization somehow manages the challenges of growth and derives an enhanced cashflow, the availability of money creates its own problems. The use or misuse of funds can be such an emotional issue, it can (and has) split organizations and turned friends into enemies.

I wouldn't say that I feel paralyzed or daunted by these factors, but I am far more cautious about promoting cryonics than I used to be, and I weigh my own involvement very carefully, always mindful that instead of doing voluntary work I could be furthering my career or simply having a good time. Of course, it may be in my own interests to contribute to cryonics, if my contribution helps in some small way to improve procedures that would be used in my own cryopreservation — but on the other hand, I may die in such a way that I can't benefit from the improvements. If I'm unlucky, I may keel over with a heart attack when there's no one around and suffer hours of warm ischemia. If I'm *really* unlucky, I may mash my brains in a car crash.

Overall, I believe there's a 50-50 chance that I may die "badly," resulting in significant brain damage from ischemia or physical trauma, thus negating an optimal cryopreservation. Since I have no way of knowing whether this will happen, I can't plan accordingly, which adds to the overall angst factor in cryonics activism.

Still, despite my grim perceptions, I do see some hope. Just as a nation prospers if its work force becomes more productive, cryonics would benefit immensely if, instead of acquiring more members, we were able to persuade *existing* members to become more actively involved. This would result in almost a total net gain, and personally I believe it should be a high priority for any cryonics organization.

Unfortunately, many people seem to feel that by writing two annual checks (for membership dues and an insurance premium) they have paid off the Grim Reaper and acquired an automatic lock on immortality. These true believers vastly overestimate the maturity of cryonics and their chances of survival. If they would take a more honest look, they would find a horrendous list of uncertainties, hazards, and problems to be fixed.

This, of course, is a great incentive to remain in a state of blissful ignorance, especially since (as I've outlined above) activism is not necessarily a recipe for happiness. But blissful ignorance isn't worth much if it perpetuates a wholly unsatisfactory status-quo in which research is underfunded or nonexistent, local help is unavailable when a member goes down, and the cryopreservation team is inadequately trained, or forced to work with equipment that is less than state-of-the-art.

The problems that I've mentioned are significant, but they need not be overwhelming, and if we if ignore them they certainly won't go away. Therefore, I encourage members of any cryonics organization to become more actively involved, at least to some extent, especially at the local level. Alcor, I know, is ready and willing to facilitate this. All you have to do is call.

You may end up complicating your life somewhat, but at the same time you may increase your chance of saving it. This may not sound like a very enticing sales pitch, but it's more useful, and definitely more realistic, than the one I had in mind six years ago.

Alcor FlashCool Project:

Synopsis of Objectives, Proposed applications, and Progress Summary

by Linda Chamberlain

Overview

In what follows, you will see the conceptualization of a promising development effort, the evaluation of its feasibility, and adjustments to the project's scope and priorities as initial study tasks yielded results. This type of approach is necessary in each step forward that we take, and the purpose of this article is more to illustrate that principle than to report a new advance in technology.

Below, you will find a brief statement of objectives, along with a condensed version of the survey of knowledge used to define an approach. Then, a two-fold approach is described, feasibility findings are outlined, and a summary of progress and status is given. The objectives and the survey of knowledge are, in any case, valid and valuable. When obstacles were encountered, they were recognized quickly, and wasted effort was avoided. In light of the limitations encountered, we were able to properly adjust priorities and go ahead with an appropriate level of effort.

The level of detail in this article is far less than in the full proposal and interim reports published within Alcor up to this point. Even the first versions of the initial proposal were 30+ pages in length, and as early study results were obtained, the documentation expanded rapidly. Any Members of Alcor who have related professional qualifications and who would like to join the following effort are invited to contact me for copies of some or all of this material.

Objectives Synopsis

In CryoTransport, the primary objective is to reduce the cellular-level biological damage that results from inadequate blood flow (ischemia). Ischemic damage takes many forms. These include crippling the critical activities of enzymes, rendering the molecular pumps inactive, weakening and damaging cell membranes, clotting of blood, producing injurious pH shifts, depletion of biochemical intermediates, and oxidative and free radical damage, to name just a few (Marion, Safar et al, 1996; Wass and Lanier, 1996; Kataoka et al, 1996; Kuluz et al, 1992). We seek to reduce this damage by any pharmacologic or other treatment approach possible, for cryonics patients. In the current effort, our goal is development of equipment for accelerating the cooling of the brain.

Reduced Metabolism; A Promising Avenue

Although ischemic damage is the result of many synergistic interactions (Marion, Safar et al, 1996), metabolism drives many of the mechanisms resulting in ischemic insult to the cells (Guyton and Hall,1996). Van't Hoff's law (Davenport, 1992) states that there is a direct and linear relationship between body temperature and oxygen consumption. Cellular metabolism is reduced by approximately one half for each 10 °C the temperature is reduced, and in some cases, an even smaller temperature drop can be effective (Davenport, 1992; Natale and

Linda Chamberlain is one of Alcor's founders (along with current Alcor president Fred Chamberlain). She has participated on numerous cryonics suspensions, including that of her mother, Arlene Fried, in 1990. Aside from serving as Alcor's first president during the 1970's, Linda acted as head of Alcor's Patient Care Fund Investment Advisory over four years (until the advent of the Patient Care Trust Fund), and now serves as an Alcor Director and Alcor CryoTransport Manager.

D'Alecy, 1989; Weinrauch, Safar et al, 1992; Moyer et al, 1992; Kuluz et al, 1992; Tisherman, Safar et al, 1990; Tisherman, Safar et al, 1991; Watanabe et al, 1996; Rosomoff, Safar et al, 1996; Marion, Safar et al, 1996;Nakashima and Todd, 1996, Yager and Asselin, 1996, Mora et al, 1996;Coimbra et al, 1996; Markarian et al, 1996; Kataoka et al, 1996; Wass and Lanier, 1996; Hoffman and Thomas, 1996; Gunn et al, 1997; Zhang et al, 1997). In the brain, a benefit of 75% reduction in metabolism for each 10 °C decrease has been reported (AHA and NRC, 1974).

The single most urgent task of the CryoTransport Team is to reduce the patient's brain temperature as far and as quickly as possible (without freezing). External cooling is only effective, however, to about 5 cm. below the surface (Collins, 1976) and is not, therefore, an efficient means of lowering the temperature of a mass the size of a human brain. Thus, other methods are needed to maximize the benefits of external cooling. For use by personnel at or below the EMT level, two additional measures are typically employed. These include cardiopulmonary support until the blood can be replaced with an organ-transplant type of blood substitute, and the intravenous administration of medications. The infusion of cold fluids into the circulatory system is, as opposed to external cooling, a means of "internal" cooling. Our project seeks to apply this latter approach to reduced metabolism.

Research Findings Regarding Brain Cooling by Perfusion

More efficient methods have long been sought by researchers in the fields of cardiac and cerebral surgery. Three decades ago researchers were having success with brain cooling techniques. In the 1960's, Wolfson and co-workers (Wolfson et al, 1965) had dogs survive 30 minutes of anoxia after circulatory arrest by perfusing the brain with 0 °C saline. Survival of 30 out of 30 baboons without evidence of neurologic damage after total body ischemia of 90 minutes resulted from carotid perfusion of 0 °C THAM-buffered Ringer's solution (Bacalzo and Wolfson, 1971) . The ischemic period could be pushed to 120 minutes with 100% survival (however, some degree of spinal cord damage was found on autopsy). In other work, tolerance to ischemia of 30 minutes duration was exhibited even if perfusion was delayed up to 3 minutes after arrest. (Bacalzo and Wolfson, 1969).

Work in this area is still being pursued and the results are important for CryoTransport protocols. A team of Japanese physicians (Ohta, 1992) report similar success in 10 dogs by perfusing the brain with cold Ringer's solution via the vertebral arteries. The brain temperatures fell to 28 °C within 4.4 +/- 1.5 minutes and were maintained at 27 °C +/- 1.0 degrees for 60 minutes. All animals survived in good condition until sacrificed at 10 weeks. Histological examination of the brain revealed no evidence of ischemic injury. Five control dogs were infused in the same manner but with Ringer's solution at 38 °C. None of the controls recovered from anesthesia. Ohta et al concluded that "*selective cooling of the brain under profound hemodilution has a protective effect on cerebral ischemia.*"

Outside the U.S., selective brain cooling (cooling the brain only, and not the whole body) seems to be a fairly common procedure for use in aortic arch surgery. This may correlate with countries where heart-lung bypass machines are not as commonly in use (such as Russia or India).

In an article (Marion, Safar et al, 1996) in Critical Care Medicine, 75 references on resuscitative hypothermia were reviewed. According to this body of work, the protective effects of hypothermia are not due solely to the reduction in cerebral oxygen demand as previously believed. Rather, there appears to be a synergism of many beneficial mechanisms. Further, even mild hypothermia may extend the therapeutic window for other interventions. The authors concluded that "*the earliest possible induction of mild hypothermia after cardiac arrest seems desirable. Head-neck surface cooling alone is too slow. Among many clinically feasible rapid cooling methods, carotid cold flush and peritoneal cooling look promising.*"

Proposed Applications

Building upon the previous work described above, and using a systems approach, Alcor proposed to design a field-portable apparatus. This system would combine the development and incorporation (if successful) of a new procedure (FlashCool) with compact washout equipment already under development (Washout Suitcase). "Flashcool" would involve the immediate injection of cold fluids into the brain, by injection into the carotid arteries (Figure 1). "Washout Suitcase" is the name for a small and very portable perfusion system, which could be set up for use very rapidly and applied to blood washout and recirculatory cooling, via cannulation of the femoral arteries and veins.

The proposal defined a multi-phase study and development project to permit the implementation of FlashCool as a standard part of Alcor's Standby and Transport capability. Rapid infusion to the carotid arteries depended on a number of areas of feasibility and workability. These included rapid surgical access, infusion route integrity, clinical efficacy, and practicality of field application. Prior to detailed design, basic feasibility questions would have to be resolved. Later, field application strategies would have to be developed and refined, and solutions to all remaining difficulties would have to be found.

The Washout Suitcase (by itself, exclusive of the FlashCool cooling procedure) would *not* dramatically change the procedures used for the whole-body washout phase of transport procedures. Being more compact, however, it would give the transport team two major advantages. First, it would be easier to relocate and set up in the field. Second, it would be more likely to gain the acceptance of hospital staff, leading to greater cooperation. It was thought that such a system could help obtain permission for a full body washout to proceed in the hospital room, immediately after a FlashCool brain infusion, thereby eliminating the time required to transport the patient to a mortuary (which can vary, but is often prolonged, resulting in devastating delays to washout, especially if traffic is heavy).

Conversely, the FlashCool brain infusion procedure would be valuable even if used without the Washout Suitcase. In combination, the two would compound the effectiveness of field cooling. (In an earlier proposal, The Washout Suitcase was planned as a separate project. The two were combined when it became evident that the feasibility of FlashCool might lead to a dead end.)

A feasible multi-purpose system would substantially improve the biological protection afforded to CryoTransport patients, reduce transport times, lighten the burden of equipment needed in the field, and reduce the cost of transport operations. If we were able to develop a field-useable means of cooling the brain 10 degrees within a few minutes after pronouncement, we would have a transport capability far exceeding the efficacy of any methods Alcor has used to date. The decision was made to pursue development of both these projects in parallel as a single system.

Before committing substantial energies to hardware design, we wanted a high degree of confidence that we would not encounter fundamental obstacles related to surgical feasibility. Therefore, at the outset, this was the focus. Basic component tests were performed, to provide design data, but no detailed mechanization comparisons were made, other than as necessary to relate the components tested to the systems described in the initial proposal.

Review and commentary were obtained from a number of consultants and from the published literature. This advice and more detailed information quickly led to the conclusion that surgical route problems might be more difficult and costly to overcome than originally anticipated (for EMT or paramedic-level transport technicians who did not engage in these surgical procedures frequently).

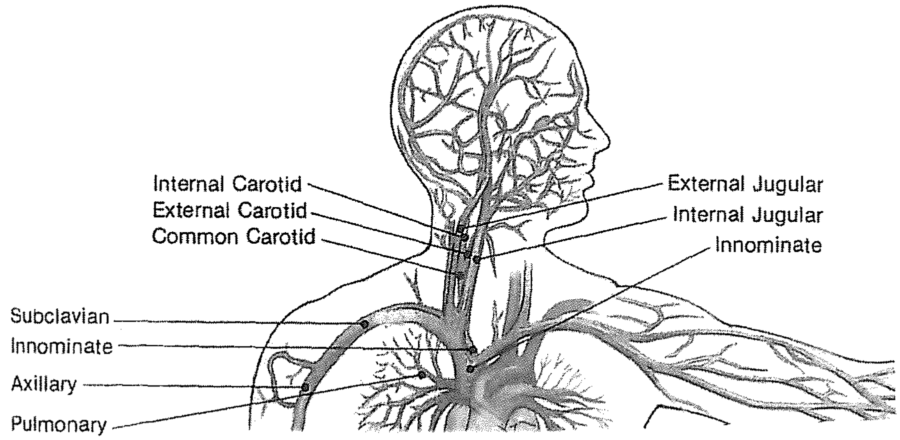


Figure 1: FlashCool would involve the immediate injection of ice-cold fluid into the brain, by injection into the carotid arteries.

As an example, we found a commercial enterprise already heavily engaged in the development of a system for rapid brain cooling, via the carotid injection route. More to the point, we learned that even though their project had been in progress for over a year, they *still* had not defined a strategy for vascular repair of the vessels involved (carotid arteries).

For cryonics purposes, the large vessels in the neck are essential to cryoprotection of the brain at a later time, following initial blood washout. Clearly, it would not be acceptable to irreversibly damage them at the outset, in order to cool the brain somewhat more quickly. If we had skilled vascular surgeons available both in the field and at Alcor Central, such an approach might be workable. The likelihood of having such a team available in the field any time soon, however, is very low.

The advice of other consultants and information in the literature, similarly, indicated that extensive development work would be needed to make FlashCool a reasonable gamble. While previous thinking at Alcor had raised hopes that this approach could lead to a straightforward way of improving patient viability, this did not turn out to be the case. Negotiations with 21st Century Medicine to license the use of their proprietary CryoVent System [liquid ventilation of the lungs with an ice-cold fluorocarbon to produce rapid cooling of blood, which would circulate through the brain and cool it in turn (Darwin, 1996)] also decreased the motivation to immediately pursue the carotid infusion approach to cooling the brain. Development of improved training and more efficient packaging of equipment for standby/transport teams is, therefore, currently Alcor's major emphasis in the area of cryotransport readiness.

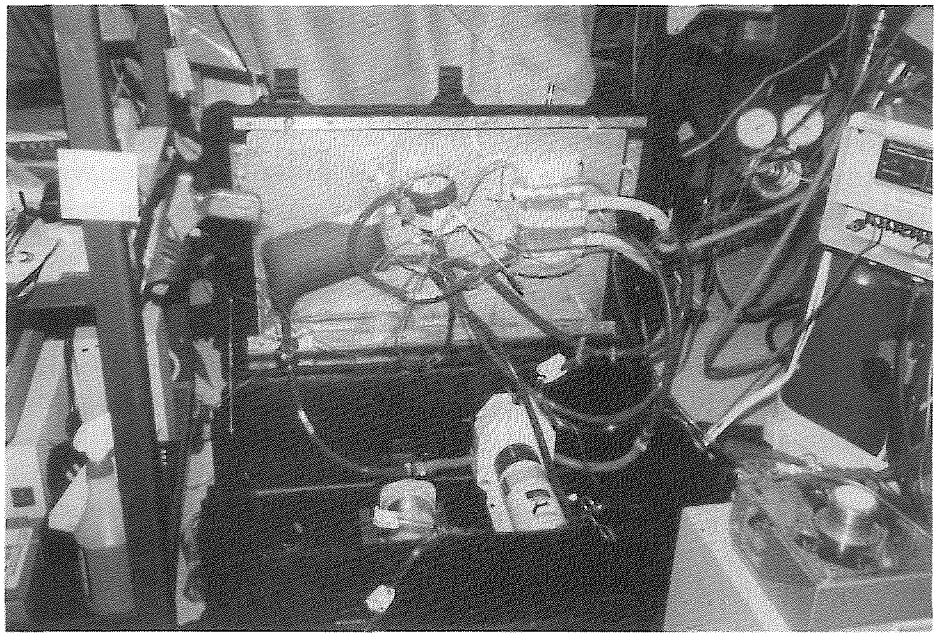


Figure 3: Washout Suitcase during Detail Design Phase, ready for functional testing on a canine model.

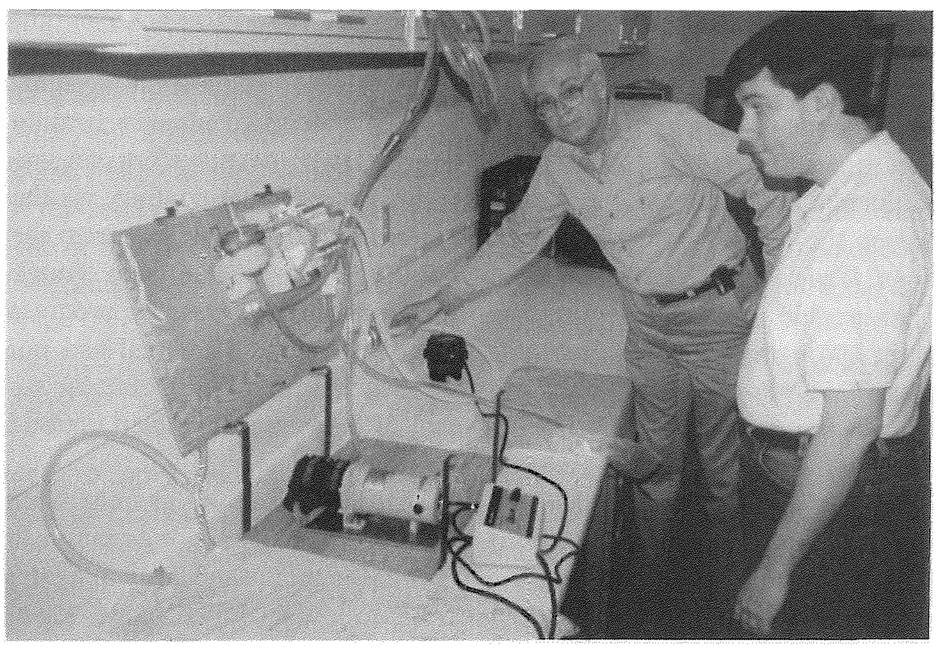


Figure 2: Hugh Hixon and Stephen Van Sickle work on the breadboard for the Washout Suitcase.

Project Summary

The steps in the development of a Washout Suitcase (many of which were overlapping, and some of which are still in progress) included:

1. Conceptual Design Phase. Work during the first 6-8 weeks was to address basic questions relating to what would be needed in the field and conceptualization of how those needs might be met.

2. Preliminary Design Phase. This was planned to include breadboard fabrication and demonstration of feasibility and setup of equipment for all functional aspects of operation (Figure 2), tests to demonstrate efficacy, and definitive functional testing to narrow the focus to a single, preferred mechanization.

3. Detail Design Phase. This effort includes packaging and final component design (still in progress as of the writing of this report), parts lists, drawings, and detailed procedures for assembly (Figure 3).

4. Test and Evaluation Phase. A test of the performance of the Washout Suitcase was made at the laboratories of 21st Century Medicine (Figure 4) by using the apparatus during a cerebral resuscitation experiment on a 120 pound (shepherd type) canine. The Washout Suitcase was used for the heart bypass procedure. Many changes to the tubing configuration were made to improve its safety and usefulness, and a different (larger) pump was substituted. The new, compact oxygenator with heat exchanger performed well, and the thermocouple data logger was used. The result was a thorough evaluation of our new washout equipment in a clinical setting with full feedback on problems which needed fixing. With these changes, we should be able to consider the Washout Suitcase "ready to go," replacing the older, more difficult to move and assemble setup which was first devised by Jerry Leaf nearly a decade ago.

Prior to the Washout Suitcase, Alcor's field washout equipment was far from easy to transport and not user friendly at the destination. It consisted of a large, heavy pump head from a hospital pump array (positive displacement, roller pump) circuit with a modest-sized venous return bladder, oxygenator / heat exchanger, embolus filter, and other standard perfusion tubing and fittings. This equipment was (in the past) transported around the country in several rugged shipping containers, and the sterile tubing required skilled personnel to assemble components and sterile parts after arrival. Further, the final system (once assembled) could not be easily relocated. Once ready to use, any change of the site for the procedure had a serious impact both on readiness and (potentially) on the sterility of the apparatus.

The new Washout Suitcase, a miniaturized assembly, including all of the above named components and sterile tubing, is preassembled and contained in a single piece of hard case luggage (Figure 3). A newer and far more compact oxygenator / heat exchanger is part of this system. In all, this represents a great improvement over past capabilities in portability and convenience during a procedure where time is critical (Figure 5).

Figure 4: Washout Suitcase being tested during canine cerebral resuscitation experiment at 21st Century Medicine on February 20, 1998.

Figure 5: Compact remote equipment ready for deployment during emergency cryotransport operations.

While we did not (at this point) pursue the development of the FlashCool carotid infusion brain cooling concept, we have developed a base of knowledge generally applicable to the goals of improved field washout equipment. Even more productively, we have developed the Washout Suitcase, a miniaturization of existing systems.

A lot of "hi tech" challenges in hardware development lie immediately ahead, in an era where vitrification of whole humans may become possible, and in which the use of very advanced pharmacology and instrumentation will be necessary in the field. Only if we approach each opportunity to do things better in a highly organized way, can we hope to develop highly reliable systems and procedures with which to try to save lives.

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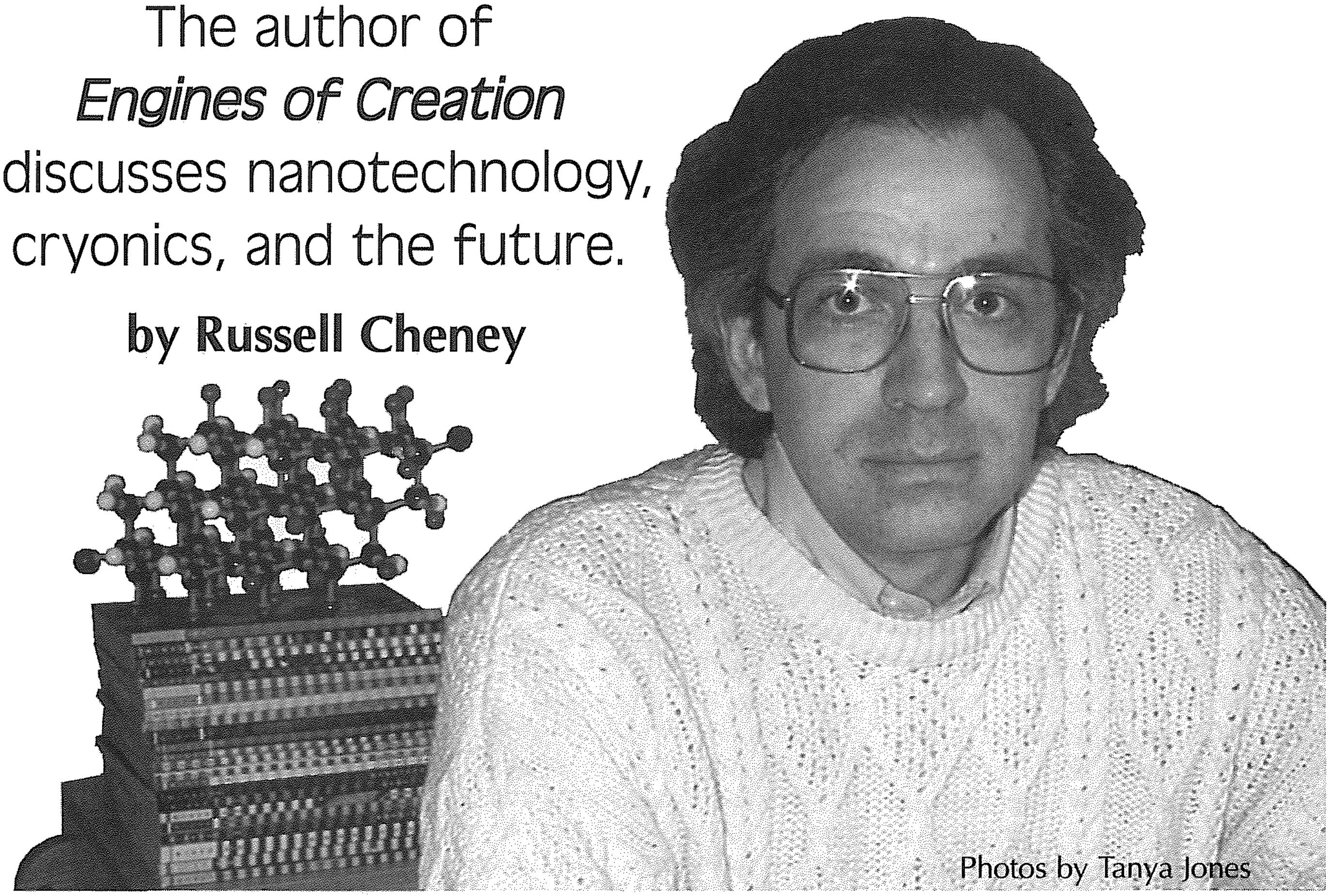
Cryonics Interview: Eric Drexler

The author of *Engines of Creation* discusses nanotechnology, cryonics, and the future.

by Russell Cheney



Photos by Tanya Jones

Part I of II

Russell Cheney (RC): What caused you to originally sign up as a full-fledged cryonicist? When was that, and to what extent are your original reasons still valid today?

Eric Drexler (ED): Well if "full fledged" means having suspension arrangements in place...

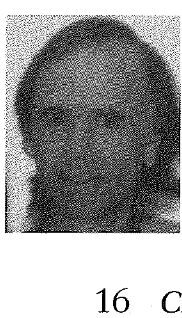
RC: Sure.

ED: Late 1996. And I think that my original reasons are still substantially the same.

RC: The original reasons: what would you say the prime movers were for you in terms of deciding to go ahead and get signed up?

ED: It seems to me that the major determining factors in the behavior of almost everyone almost all the time is certainly some combination of internal motivations and a large dose of peer pressure and sense of what the expectations are from one's community. And being a basically spineless go-along-with-the-herd kind of creature, I just gave in to peer pressure; all my friends are signed up for cryonics, so how can I refuse?

RC: (Laughing) I see; "spineless?"



Russell Cheney is a retired Northrop Aviation computer analyst and active marathon runner. He is also an Alcor suspension member, a certified Alcor CryoTransport Technician and frequent contributor to *Cryonics* Magazine.

— this somehow doesn't sound like the Eric Drexler I know. Were there other secondary factors also involved?

ED: (Laughing) Well, in a slightly more serious vein: I'll give a little history here. I had first become interested in the idea of cryonics from having read, I guess, too much science fiction as a lad. And when I went off to MIT I did a little bit of reading in cryobiology and got as far as thinking, "Ah, perhaps one can play games with the phase diagram of ice going to high enough pressures that you are actually freezing at higher temperatures, and I got as far as finding out that the higher pressures themselves were sources of toxicity and damage to organisms. And somewhere in there I concluded that probably the goal of having a conventionally reversible freezing process for adult mammals was a very tricky objective, that it wasn't at all obvious that it would be possible. It certainly was not something that was possible then, or something that seemed to be within reach. And sure enough it's twenty years later and we still don't have one.

So that was when I decided that the goal didn't make sense. Not too long after that, meaning probably a couple of years or something like that, I had been following a line of thought that led me to understand that we could develop a new technology based on molecular machines able to build more molecular machines: the notion of molecular manufacturing or molecular nanotechnology. And very shortly after that, this was within a few months of getting the basic concepts straight in early 1977, I concluded that those cryonics people were right after all. And at that point I went

Biography

Dr. K. Eric Drexler is a researcher concerned with emerging technologies and their consequences for the future. This interest led him to initiate studies in "molecular nanotechnology," an anticipated field based on the manipulation and construction of precise molecular-scale objects. Among his various ideas, Dr. Drexler has outlined the possibilities of diamond-based structural materials, computers more than a thousand times smaller than those currently available, and medical devices capable of repairing individual cells.

He received his Bachelor's degree from M.I.T. in Interdisciplinary Science, a Master's from M.I.T. in Engineering (while a National Science Foundation Graduate Fellow), and a Ph.D. from M.I.T. in Molecular Nanotechnology. Formerly a Research Affiliate of the M.I.T. Space Systems Laboratory and the M.I.T. Artificial Intelligence Laboratory, he is currently a Research Fellow of the Institute for Molecular Manufacturing. He has served on the Board of Directors of the National Space Society and is a member of the American Vacuum Society, the Protein Society, and the American Chemical Society.

To help in coping with the opportunities and dangers presented by molecular nanotechnology, he founded the M.I.T. Nanotechnology Study Group, and now serves as Chairman of the Foresight Institute, a non-profit educational organization created to help prepare for advanced technologies. In spring 1988 he taught (while a Visiting Scholar at Stanford University) the first formal course on nanotechnology and exploratory engineering. He chaired the first and second Foresight Conferences on Nanotechnology (1989, 1991) and co-chaired the third (1993).

Through 1995, Eric Drexler's publications list included over thirty articles (published in periodicals ranging from the *Smithsonian* to the *CoEvolution Quarterly*) as well as three books: *Engines of Creation* (1986), *Unbounding the Future* (1991, with Chris Peterson and Gayle Pergamit), and *Nanosystems: Molecular Machinery, Manufacturing, and Computation* (1992). Among his awards are the annual Association of American Publishers award for best computer science book (*Nanosystems*), and the 1993 Kilby Young Innovator Award, named for Jack Kilby, inventor of the integrated circuit.

Acknowledgements:
The material for this biography was obtained from the Foresight Institute and is used with their kind permission: http://www.foresight.org/FI/Drexler.html (Biography of K. Eric Drexler) and http://www.imm.org/DrexlerCV.html (Curriculum Vitae: K. Eric Drexler).

and read Ettinger's original book [2] and found out that not only were they right, they even knew why, in that he spoke of a future technology perhaps somehow being able to work at the molecular level to effect repairs.

So I concluded, "Yes, this works, this is tremendously important. This is perhaps the most effective way of saving lives available to modern medicine." This was shortly before the publication of my first scientific paper on the subject, in the Proceedings of the National Academy of Sciences, which, by the way, fairly clearly if obliquely, states the consequences for cryonics [3].

RC: And this is about what year?

ED: That came out in late 1981. The intervening years are another story, having something to do with my concerns about the misapplication of the technology and my thoughts on how to deal with that. But, in the fall of '81, shortly before that came out, I invested a substantial block of time in talking to people with backgrounds and national reputations in brain science and medicine at MIT and Harvard Medical School, I guess at Harvard's biology department, and collecting statements that they found uncontroversial, some of which appear in *Engines of Creation*, that were intended to be conceptual building blocks. And yes, this cryonics thing ought to work in light of what we can now see about the future of molecular technology.

And what I found was that they agreed and agreed and agreed and agreed to all sorts of points as long as these points were abstract and had no obvious medical consequences, and as soon as I got to the point, which I took some time in doing, the amplitude of the head nodding went down. One professor at Harvard Medical said that he had found some objection, some crucial scientific objection, with the implication to

Eric with co-author and wife, Chris Peterson. (Notice the cryonics medical alert necktags on both!)

what I had to say, but he had forgotten what it was. And this in a very short time span; this was not a matter of asking him years later, this was days or weeks.

So I think in *Engines of Creation* I referred to that as, "the puppy ate my homework" excuse for not being able to present some result in answer to a question.

That was kind of discouraging. And I recall sending out a letter to some of these people I'd been talking to, saying I was going to continue working on this problem, but it was going to have to be a bit more round about. And what I did was, I wrote *Engines of Creation* in such a way that it makes a strong case, what I think is a strong case, for the feasibility of this medical technology with its curious split between present-day procedures and future capabilities. But I also did it in a way that made it possible for people to read the book and forget about that by the time they got to the end, if it bothered them too much.

So then the next unpleasant surprise was that the concepts of molecular nanotechnology, themselves, though nowadays more and more people are saying, "Oh yes, that's obvious, of course, of course, of course," had a lot of people confused. There's a long intellectual history there, but the short story is that for the first ten years or so after the paper that I published, the bulk of the response was disparaging.

RC: That was through the '80s?

ED: That was through the '80s and early '90s. And only recently has that turned around to the point where we have a conference series that's continuing to grow and the keynote speaker was a Nobel laureate [4] and people are saying, "Yes, yes, this is obvious, and it's happening and we're doing start-up companies, and all this nanotechnology stuff is great, and let's proceed."

But in the intervening time I concluded that the way to advance an understanding of the future for a variety of purposes — including not being killed in some techno-political disaster, and also for saving lives through the wide-spread acceptance of suspension technology — I concluded that those goals were best served by focusing on the technological foundations. This meant trying to abstract them a little bit more from consequences than I had previously done in *Engines of Creation.* There I talk quite a bit about long-term consequences of molecular nanotechnology in machine intelligence, space development, and medicine with its implications for present-day medicine with the curious fact that low temperatures slow everything down so much. Subsequent books talked about applications as a whole less and less, a narrower range in the case of *Unbounding the Future.* In *Nanosystems* I stick pretty close to the foundational questions of what can we do with molecules, going as far as abstract issues of computation and strength of materials, and barely touching on anything much beyond these foundational theses.

And now the ideas are sold, and for years I'd been telling people the reason I wasn't signed up for cryonic suspension was that I wanted to be able to tell members of the press that I was not signed up for cryonic suspension, and being a rather honest person that meant that I had to not be signed up for cryonic suspension. I went public actually before I signed up. I was being interviewed for the notorious *Scientific American* article on all this, the one where they missed the turn the scientific community had made and ran into a wall, by being inappropriately negative a little bit too late in the game [5].

But I told the interviewer that, oh yes, I was planning on signing up soon. And I did.

RC: So your original sign up was actually public?

ED: I announced a serious intention in public before I actually implemented it, yes.

RC: I would have been *so* uncomfortable to have been intellectually convinced that it was the right way to go, but to have held off for ten years.

ED: Well, it's actually closer to twenty, but... Questions of personal values and inclinations really are enormous in this kind of area, and most people who sign up for cryonics today, and certainly I think all of them who signed up before there was a really clear understanding of how the other end of the technology could be made to work, are people with an enormous drive for personal survival. And that strikes me as a perfectly reasonable thing. But, you know, when I feel around inside myself and look at my behavior, I find that personal survival seems like a good idea, but I don't have an enormous drive for it. And that's just a matter of values and psychological makeup, I guess. It's not as great a sacrifice as it might seem.

RC: I think most people perhaps do not have the ability to judge themselves so objectively.

"It seems to me that there's an enormous difference between a world in which you can take a molecule and, on a fairly straightforward and routine basis, put it where you want it, and a world in which you can't."

ED: In trying to understand what our present knowledge says about future capabilities in areas that make a big difference to people, trying to understand what you know and what you don't know, and what your biases are and what your biases aren't, is really important if you're going to avoid being misled by wishes or by ignorance, so it encourages introspection.

RC: How much, and in what ways, has the definition and scope of molecular nanotechnology changed in your own mind since the publication of *Engines of Creation* in 1986?

ED: My sense of the definition and scope of molecular nanotechnology remained fairly steady and that's largely because, since before 1986, I'd already been thinking about this field for about nine years, and a lot of my understandings had moved back and forth and then got reasonably settled. And many of the fuzzy boundaries are between enabling technologies, present-day technologies leading toward molecular manufacturing and later capabilities, and once focused on the later capabilities, you could point to the boundaries and say, "It's fuzzy here." Reasonable people could disagree on whether a particular intermediate device should be called an assembler, and likewise reasonable people later on could disagree on whether some advanced system was an assembler or just a special-purpose tool cranking out a particular product.

But most of the substance of what the technology is about, at least the part that we understand today, seems to be rooted reasonably directly in basic physical considerations. You know, atoms are a certain size and therefore minimal-sized parts are going to be in a certain size-range. The strength of materials is limited, roughly speaking, by the strength of carbon-carbon bonds that hold diamond and graphite together. And exactly what the limits are of what can be done in many areas is very unclear, but the shape of the core technology has been a fairly stable picture over that time period.

I guess we might have a much better understanding of how to build small compact computers, which was pursued in part because I thought it would be nice to have a design for a reasonably powerful computer that was in fact smaller than a human cell, and one that worked at ordinary temperatures or reduced temperatures. And also I think there's now more of an appreciation of the extent to which a lot can be done by using general-purpose machines to make arrays, and special-purpose machines that then work in a very repetitive and reliable fashion to produce a lot of product efficiently. That gets off into what from the point of view of a consumer of the technology, or a consumer of, experiencer of, the world that enables, is certainly lost in the technological background; people don't worry too much about the details of semiconductor fabrication technology though they care quite a bit about the performance of their computer.

RC: What is your perspective on the evolution of the relationship of molecular nanotechnology and cryonics?

ED: Most of the dynamics of the evolution have been sort of political dynamics. In my presentation of the long-term goals and prospects for nanotechnology, I took those ideas and welded them reasonably solidly to a range of advances, including cryonic suspension working. Largely because I wanted people who think seriously about this technology to think seriously about the long-term future and to realize that it isn't going to be "business as usual." Things are going to be *very* different, and in particular if they buy into cryonics, that even if developments were slower than it seems they're going to be, they would have a personal stake in the outcome, then maybe they should think about that more seriously than people historically have.

So, that was an early objective, and then as I was saying, I felt that the advance of this whole bundle of ideas was best furthered by decoupling and down-playing some of the more extreme and wild-sounding — superficially extreme, super-

"Right now we're in a world in which it's not routine to do that..."

ficially wild-sounding — ideas. And then more recently with our sense that the core ideas have succeeded, that they have a solid place in the world, and that the scoffers are now just a confused minority off in the fringe.

RC: When you refer to "core" ideas, you are referring to ...?

ED: Broadly speaking, the notion that a realistic long-term objective or expected outcome of research and development in miniaturization, scanning-probe microscopy, and most strongly chemistry and molecular engineering, is a technology based on molecular-machine systems, able to build better molecular-machine systems. That this will have a range of consequences, including being able to put the equivalent of a next-generation high-performance workstation into a cubic micron; able to put more computational power into a desk-top package than exists in the entire world today put together; being able to manufacture a wide range of products inexpensively by means of molecular machine systems; having a very large array of instrumentation that can study biological systems and materials better, and can manipulate them better. Now a lot of those consequences are not really, at this point, widely perceived or accepted, but they're part of a bundle of ideas such that people who buy into part of it tend to find their attention drawn to the rest of it, and they find that this is coherent. If part A makes sense then part B makes sense, and part A obviously makes sense so I guess we have to buy into part B.

We're now far enough into the selling of part A, which is essentially that we're going to get a molecular machine technology base, that the parts B can be regarded as kind of over the hump.

RC: What kind of technology will be required to revive people being frozen today, and how will we know when we've got it?

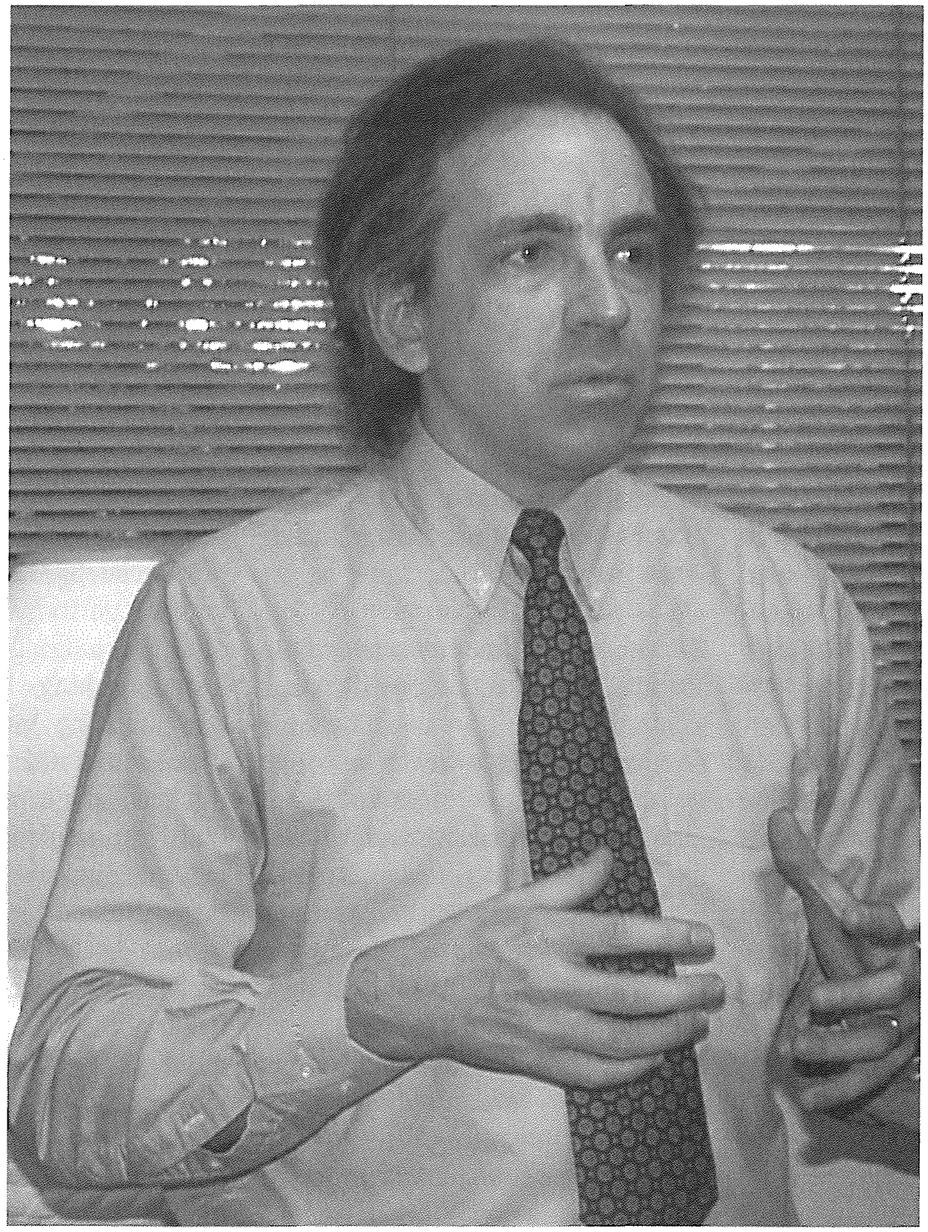
ED: Let me outline my sense of the shape of future technology. It seems to me that there's an enormous difference between a world in which you can take a molecule and, on a fairly straightforward and routine basis, put it where you want it, and a world in which you can't. Right now we're in a world in which it's not routine to do that, in a general flexible way. And it's obvious that we're going to be able to do that; there're a lot of ways to proceed. There are various people actively doing lab work intended to contribute to the goal.

When you're able to do that, you're on the other side of a technology mountain; you're not all the way to all possible objectives immediately, but you're past a major barrier. You have a tremendously powerful tool for building better tools.

Some of the tools that you can build are better computers. Today, computer-aided design is increasingly common, including what I was calling in *Engines of Creation*, "automated engineering," with increasing amounts of some kind of machine intelligence doing design work, at some level. It's a rapidly growing field; people are using a lot of techniques and evolutionary computation, which are reasonably limited today because of the limited power of our computers. If you want to achieve results by means kind of like those of biological evolution, you can do so by trying a whole lot of things, judging the outcomes, doing more things like the successful ones, iterating, but doing all this in a simulated world.

What the limitation has been is that this simulation requires just a tremendous amount of computer power. So we can see our way clear now to getting there. Here's a comparison: once upon a time, at the dawn of the era of mechanical computation, or at least serious commercial mechanical computation, people had hand-cranked adding-machines, and they could do something like an operation per second. With present-day machines, you can quite commonly do a billion operations per second. That has taken us from a world in which a graphical-user interface was inconceivable (how many turns of the crank do you need per pixel on the screen? Not a practical goal!), to one in which they are routine.

The advance from hand-cranked to present-day is one factor of a billion. It looks as though we now can see how to get another factor of a billion. So anything that we can do in rudimentary form with today's computers, like make them solve difficult problems and do creative smart things, we're probably going to be able to do very well indeed once we have the ability to put a trillion computers into a cubic centimeter.



Part of the answer lies in your ability to make computers of molecular scale, and another part lies in your having got the manufacturing process debugged so that you can make macroscopic quantities of them. There's nothing intrinsically enormously complicated about that; it's going to be a lot of work but it doesn't involve any fundamental breakthroughs either, certainly not in chemistry or physics, and likewise none in computer-aided design or the ability to design and manage complex systems. These are systems that are comparable in complexity to existing computers and existing factories, just a lot more identical units. Existing computers and factories are not trivial engineering enterprises, but the point is we do them; they're within the scope of human abilities, when we're organized as a productive society.

So it looks as though, barring some catastrophe, we're going to get there. And "there" is molecular technology, the ability to manipulate the building blocks, and an enormously powerful technology for recognizing patterns and doing design, and therefore building novel things that meet some criteria of usefulness. When we're on the other side of that transition, those technologies can be applied to medicine, which at that point looks like a problem of molecular manipulation plus pattern recognition and deciding what to do about it.

When we're on the other side of that technology transition, you're going to find that if someone wants to have a fresh heart that is exactly biocompatible with them, but has a really nice useful structure of tissue and so on, then that is the kind of thing that people will be able to make, and there won't be a lot of nonsense about immunosuppression and the macabre practices of modern medicine in the transplantation field, which, by the way, make cryonics look very reasonable indeed. I have not heard of cryonicists taking two people, living people with beating hearts, cutting open their chests, ripping the heart out of one, putting it in the other, and then burying the first; I mean that is really obviously a ghoulish and unacceptable kind of practice.

But keeping things in perspective, I would say that every cryonics practice that I know of is a very modest and conservative procedure by the standards of modern medicine.

To address the second part of your question, how will we know when we have the technology? Basically medicine will be able to bring about desired physical outcomes in patients largely without qualification, meaning the only limitation being, "Do you really know what it is that you want?" If you want to get Benjamin Franklin revived today, the problem is that you don't know what Benjamin Franklin is. There is no Benjamin Franklin to revive. That's not the kind of outcome anybody can produce.

But with a medical technology that capable, I think it's reasonably obvious that someone who's gone through, really, by those standards, the trivial kinds of damage or disruption associated with freezing and storage, would be considered to be practically in the prime of health; just needs a little bit of fix-up work.

"...how will we know when we have the technology? Basically medicine will be able to bring about desired physical outcomes in patients largely without qualification, meaning the only limitation being, 'Do you really know what it is that you want?'"

RC: That is so wonderfully optimistic; that is a really positive perspective.

ED: I'd just like to make a little comparison here. I think it's useful to regard neural tissue as being kind of like a printed page; a physical structure with information-bearing patterns in it. We should simultaneously view the future medical capabilities — the combination of human beings and enormous computational power applied to pattern analysis, pattern solving, pattern matching and problem solving — as being kind of like having an army of art conservators backed up by the brain and the computational power of the National Security Agency.

Now let's say that you're a wicked anti-cryonicist and you're trying to make it look as though you've saved somebody's life but you've actually destroyed them. In the analogy here, imagine that you have this printed page and you say, "Ah, we're going to thwart all those art conservators and the NSA, we're going to be terrible, terrible people, we're going to rip up the page, crumple it, and put it in a box." Well, I don't think that's a very effective way of keeping somebody from saying, "Oh, here are the pieces, yes, they go together like this. Here's a little bit of our super art-conservator glue and we'll proceed to put all the paper fibers back where they ought to be. And isn't that nice?"

What's damaging from that point of view is something that's more of a homogenizing process. If you burn the paper and blow away the ash, then I think you've succeeded in your nefarious goals. But I just fail to see how the present freezing procedures, when done reasonably promptly, are very destructive in any way that's important from the point of view of future medicine. They're like tearing and crumpling, not like burning and blowing away the ash. I think it's also important to note that what many people regard as freezing damage is actually thawing damage.

RC: So the damage does not exist today in currently suspended patients.

ED: Indeed. What thawing does is it lets things that have been, in many cases torn up a bit, come apart. The equivalent of tearing and crumpling is pulling things apart and compressing them. Thawing unpins those structures that were previously nicely held in place, and allows things to move around, to diffuse, to do entropic information-destroying damage. But that's thawing damage, not freezing damage. The freezing sets the stage for thawing damage, but then you have to thaw to actually cause the damage.

And I think that it is a reasonably sure bet that the initial stages, at least, of techniques for reanimation will be done at something like liquid nitrogen temperatures. There's no reason why not; many types of molecular machinery work better at liquid nitrogen temperatures. Not the biological styles, but the kinds that Ralph Merkle and I have been designing, in many cases, do [6]. And if you make sure that your patient is well stabilized by something other than the ice, before you thaw, then you completely avoid thawing damage.

I would note that basically anyone who became involved in cryonics before the emergence of some reasonably clear picture of a molecular-machine-based medical future, did so in the presence of a conceptual framework for the problem that looks very different from the one that I think is appropriate for today. There's a lot of shifting of gears that's necessary to look at this different landscape of problems and opportunities to respond appropriately; I think that's an on-going task.

RC: Did your optimism toward the potential success of cryonics over the years of the publications (1986 through 1992) decrease? Would I be putting words in your mouth by saying, "Absolutely not!"

ED: The words fit very nicely. On the one hand, my understanding of both neurobiology and the future of molecular technological capabilities has evolved steadily over the last twenty years toward seeing that things that we care about in the fine structure of the brain really are structural; they're not the sorts of things that will be obliterated by some ice crystals growing and pushing things around. On the other hand, by a better understanding of the abilities of molecular-machine systems and of computational systems, and a better understanding of the fact that there is a good match there, we can see that we're going to have overwhelmingly more resources than are necessary for the problem. It's not going to be some marginal, difficult, heroic effort, it's going to be the sort of thing that could be done as a science-fair project, if you wait long enough. It won't happen that way, but developing the technology could be done as a science-fair project if you just let the underlying technologies ripen for enough years beyond where things would actually happen in the real world.

RC: It sounds to me like you're saying your optimism has not only persisted over this period of time, but has actually *increased.*

ED: Yes, I agree. The additional information and understanding of things has just all been consistent and made a more solid and detailed picture; not as detailed as one would like, but enough to be confident.

RC: Since the publication of *Engines of Creation* and *Unbounding the Future*, what have been the new major developments and ideas in applying molecular nanotechnology to cryonics? Is it clear that any of these developments and / or ideas have affected the expected time to realization?"

ED: There has been some additional fleshing out of scenarios for how systems or devices could gather information and effect the needed repairs. There seem to be multiple ways to proceed.

But I really don't see that as having any substantial effect on expected time to realization, because my sense is that medical goals in general, and certainly long-term medical goals in particular, are not going to have a really huge effect on the rate of the development of this kind of molecular machine technology.

RC: Why is that?

ED: Let me try restating that somewhat. At present much of the research in complex molecules, systems of molecules, sensing, and certain kinds of manipulation, is driven by an interest in biology and medicine and by learning how biological systems do these things. But because of the structure of the research community there is almost no relationship between, in particular, the details of long-term objectives, and what's done in the laboratory today. The incentive structure is all wrong for it, and they don't have the necessary conversations with each other to let these become real living concerns in the research community. Furthermore, the longer-term developments look very non-biological. I think we'll find that molecular machine systems on the other side of this technology mountain that we're climbing will look about as much like present-day biological molecular-machine systems as passenger aircraft look like birds.

And there are quite a number of similarities. In both cases there are transparent things in the front with some sort of an optical sensing process going through them, there are some sort of foot-like structures on the bottom, there are wings and a tail, and both of them burn something with roughly the composition of a hydrocarbon, at least if it's a bird that's stored up some fat, and their aerodynamic principles are kind of similar. But no feathers, no muscle, size-scale, no flapping, etcetera.

But I think that's about the right scale of difference.

End of Part I

Look for Part II in
Cryonics Magazine,
3rd Quarter 1998

NOTES:

[1] Special appreciation is given in recognizing the following individuals for their inspiration and invaluable assistance: Hugh Hixon, Mary Margaret Glennie, and Steve Bridge for their thoughts on the right questions to ask; Bradley Cheney for his continued and successful determination to resolve all hardware / software problems; Chris Peterson and Tanya Jones for their splendid arrangements at the Foresight Institute; and Brian Shock who wields one of the world's most efficacious and inspirational cat-o-nine-tails.

[2] Robert C.W. Ettinger, *The Prospect of Immortality*, Doubleday & Company, Garden City, New York, 1964.

[3] K. Eric Dexler, "Molecular Engineering: An Approach to the Development of General Capabilities for Molecular Manipulation," *Proceedings of the National Academy of Science* USA, 78:9, 9/81, pp 5275-5278.

[4] The Foresight Institute Conference Series:

Technical Conferences on Molecular Nanotechnology:

- First: 1989
- Second: 1991
- Third: 1993
- Fourth: 1995
- Fifth: 1997 (Keynote speaker: Chemistry Nobel Laureate Richard Smalley)
- Sixth: 1998 (scheduled for November; details available at the Foresight's Web site)

First Foresight General Conference on Molecular Nanotechnology: 1992

Senior Associates Gathering (Foresight, Institute for Molecular Manufacturing, and CCIT): 10/18-20/96

Conference Publications:

First Foresight Technical Conference on Molecular Nanotechnology (1989):
Nanotechnology: Research and Perspectives,ed BC Crandall and James Lewis, ix + 381 pages, MIT Press, Cambridge, MA, London, England, 1992.

First General Conference on Nanotechnology (1992):
Prospects in Nanotechnology: Toward Molecular Manufacturing, ed Markus Krummenacker and James Lewis, xviii + 297 pages, John Wiles & Son, Inc., NY, 1995.

The Foresight Institute: Mission and fundamental goal is to guide emerging technology to improve the human condition. Foresight focuses its efforts upon molecular nanotechnology, the coming ability to build materials and products with atomic precision, and upon systems that will enhance knowledge exchange and critical discussion, thus improving public and private policy decisions. Write to: Box 61058, Palo Alto, CA, 94306; Telephone: 650 / 917-1122; Web site: http://www.foresight.org.

[5] The original article containing interview material: Gary Stix, "Waiting for Breakthroughs," Scientific American, 274:4, 4/96, pp 94-99. Also, most of the original article is available at www.sciam.com/exhibit/040000trends.html.

Related letters to the editor by Eric Drexler, Carl Feynman (son of Nobelist Richard P. Feynman), Ed Reitman and Haw: "Mega-Discord Over Nanotech," Scientific American, 8/96, p 8. Also available at www.sciam.com/0896issue/0896letters.html.

A Scientific American retraction?: Related in-depth article which appears to contradict many of the 4/96 article's conclusions: "A Turn of the Gear": www.sciam.com/exhibit/042897gear/042897nano.html. Also see www.sciam.com/exhibit/052796exhibit.html.

A considered analysis of the original interview article: Ralph Merkle: www.foresight.org/SciAmDebate/SciAmResponse.html.

[6] Ralph Merkle: For molecular nanotechnology designs and related ideas, see Web site: http://www.merkle.com.

Available at this Web site:
"It's a Small, Small, Small World" (1997) *MIT's Technology Review*
"A Brief Introduction to the Core Concepts of Molecular Nanotechnology"

[7] Marvin Minsky: Donner Professor of Science, Massachusetts Institute of Technology; of Artificial Intelligence (AI) renown (one of the undisputed fathers of AI), and author of *Society of the Mind*, *Perceptions: Introduction to Computational Geometry*, *Robotics*, *Semantic Information Processing*, *Computation: Finite and Infinite Machines*, and *The Turing Option*; The Internet Home Page: http://www.ai.mit.edu/people/minsky/minsky. *The Society of the Mind* provides an abstract model of how the human mind may really work: as an aggregation of interacting pieces (agents) that evolved to perform highly specific tasks; published 1988.

[8] James Watson, *The Molecular Biology of the Gene*, co-authors: Jeffrey W Roberts, Nancy H Hopkins; editors: Joan A Steitz, Alan M Weiner.

[9] Gregory M Fahy: Recent organ vitrification research: "Advances in Anti-Aging Medicine, Volume I," Ronald M Klutz, ed, Mary Ann Liebert, Inc, Larchmont, NY, 1996, 249-55.

Additional vitrification background: Gregory M Fahy: "Vitrification: A New Approach to Organ Cryopreservation," *Progress in Clinical and Biological Research*, 1986, 224:305-35; Gregory M Fahy, DR MacFarlane, CA Angell, HT Meryman: "Vitrification as an Approach to Cryopreservation," *Cryobiology*, 1984 Aug, 21(4):407-26.

[10] Extropian Conference III (EXTRO-3), San Jose, California, August 9-10, 1997, "The Future of the Body and Brain / Future Infrastructures": K. Eric Drexler, Keynote Speaker, "How to be Cautious and Conservative." Extropianism: The philosophy that seeks to increase extropy. Extropy: A measure of intelligence, information, energy, vitality, experience, diversity, opportunity and growth.

[11] Dr. James Bedford, a psychology professor from Glendale, California, was originally suspended January 12, 1967, has experienced over thirty years of uninterrupted cryonic suspension. Dr. Bedford was transferred to Alcor's care in 1982, and since then has remained resident with Alcor. For historical details, see *Cryonics Magazine* July 1991, Volume 12(7), pages 15-22, and August 1991, Volume 12(8), pages 17-24.

[12] Danny Hillis: A technology scholar, engineer, Disney employee, and, "One of the nation's leading thinkers on technology," per ABC News and Starwave. Advisory Board of ALife Conference, UCLA, June 1998. "The best way to design a thinking machine is to evolve one . . . It's now possible to copy the basic rules of evolution inside a computer."

MIND UPLOADING:

An Alternative Path to Immortality

by Joseph Strout

When Robert Ettinger's landmark book *The Prospect of Immortality* was published in 1964 [6], it was clear how a patient at death's door might be suspended; but it was quite unclear, at that time, how such a patient could possibly be revived. It was logical to believe that science would someday be up to the task, but without even a sketch of a solution in hand, few were able to believe it with conviction. The situation changed in 1986, when K.Eric Drexler's *Engines of Creation* [3] hit the shelves. A new technology — nanotechnology — had been sketched out, which could plausibly be the solution to reviving a cryonics patient. And with the more technical book *Nanosystems* in 1992 [4], the sketch was filled in with bolder strokes and considerably more detail. Since then, most cryonicists have come to assume that nanotechnology will be the means by which cryonics patients will eventually be revived; indeed, it is likely that many would never have made cryonics arrangements if not for the hope of nanotechnology.

While nanotechnology is indeed a hopeful prospect for curing cryonics patients, it is not the certain bet it is sometimes portrayed to be. While molecular machines of some form are inevitable, repair of widely damaged cells by microscopic agents acting locally may prove to be an extremely difficult problem— perhaps even insurmountable. Even if this pessimism ultimately proves unfounded, it nonetheless causes doubt in the minds of some, perhaps preventing them from believing that cryonics is really worthwhile.

Fortunately, nanotechnology is not the only possible path out of the dewar. Over the last several years, a growing number of scientists have been considering methods by which a person's brain might be copied into a functionally equivalent artificial device. This process, which goes by various names but has most widely been called "mind uploading," would provide a means not only to revive cryonics patients, but also cure aging and disease, and enable humanity to quickly adapt to any environment — all without the need for any qualitative technological breakthroughs.

Mind uploading is a new and very strange concept to most people, much like cryonics itself. In this article, I'll present the most plausible technical approach to the problem, and illustrate that only incremental improvements in existing technologies are required. A possible timetable for these developments will be presented as well. Finally, since uploading raises old but very important philosophical issues, I'll review past and current philosophy on the topic of personal identity, and attempt to show that an uploaded person really *is* the same person as the biological patient.

The Technology of Uploading

A number of methods of uploading have been proposed. The most comforting proposals are gradual, destroying the original brain as the new

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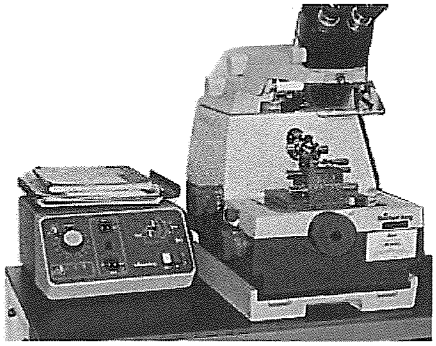


Cryo-ultramicrotome

one is created, with the patient kept conscious throughout the procedure [9]. The most convenient (but philosophically disturbing, to some) proposals do not damage the original brain at all, but scan it noninvasively. Unfortunately, neitherof these types of proposals appear to be possible. Keeping a brain conscious while replacing its parts is a valid philosophical thought-experiment, but in practice, the difficulties involved with disassembling vasculature and neural connections while nonetheless maintaining normal activity — or indeed, while simply trying to keep the brain from falling apart — may be insurmountable. And the linear resolution of any noninvasive scanning technique is a function of the energy put into the system, and the distance of the optics from the subject; the energy needed to resolve neural structures 10 cm deep would cook the brain quite thoroughly.

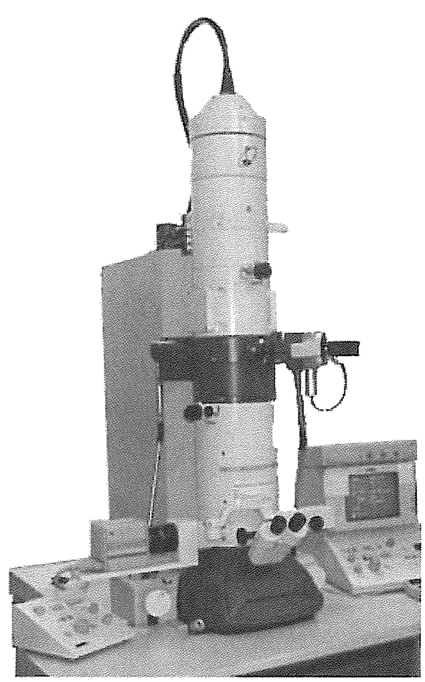
The most plausible means of uploading lies halfway between these two proposals. In this method, the frozen brain is sectioned, cut into microscopically thin slices, and each slice imaged individually. The data are then recombined in the computer, and used to configure a brain emulator. This method, referred to as the cryoultramicrotome technique, requires no qualitative breakthroughs in technology; it uses only techniques which are already in use on a smaller scale (e.g., [12]).

First, brain tissue must be rendered immobile and rigid for sectioning. Perfusion with cryoprotectants and freezing is standard practice in neuroanatomy; indeed, it is the only way such fine sections can be made. As a fortunate coincidence, this first step of the procedure is identical to cryopreservation; in this sense, cryonics patients are partly uploaded already.

Next, the brain must be cut into blocks of manageable size. This turns out to be the most challenging step, as the cuts must be made with minimal loss of tissue at the section interfaces. For this step, microtechnology will be important; extremely sharp, active blades can part the ice cleanly and gently force the sections apart, without losing many microns of tissue in between. Alternatively, recent developments in excimer lasers [5] may lead to a new, cleaner way to section tissue. When the large sections have been made, they will be transferred to an automated cryoultramicrotome, which makes the fine slices. These slices are so thin (probably in the range of 0.1 to 10 microns, depending on the imaging technique used), that they are currently manipulated with a single eyelash. Tiny machines will again be needed, this time to handle the tissue. The field of microscopic sensors and effectors is known as microelectromechanical systems (MEMS) [11], and it will be a critical technology in uploading, as well as basic neuroscience research.

Once the thin slices have been cut, they will be imaged. Here we need an imaging technology with resolution on the order of 10 nanometers or better in at least two dimensions, and preferably with comparable resolution in the third dimension. Transmission electron microscopy seems the most promising at this stage; it easily meets the resolution requirements in the plane of the slice, and current developments are improving resolution in depth as well [2]. However, proximal probe technologies (such as atomic force microscopy) are still in their infancy, and show the potential to improve dramatically in the coming years [13]. It is possible that technology from this newer imaging family will ultimately prove superior for the job at hand.

In either case, the tissue is imaged in high detail, resulting in an enormous data set picturing every synapse,vesicle, mitochondrion, and cell membrane in the brain. This image data must be analyzed and reduced to symbolic form: mainly lists of neurons, synapses, and their properties. A large body of evidence supports the notion that long-term memory and other mental traits are stored in the form of gross physical changes in the brain, i.e. in the pat-



Transmission Electron Microscope

tern of synapses (e.g., [1]). Thus it will probably be sufficient to record only this gross level of detail. If it proves necessary to also record chemical states, gene activation states, and so on, then the problem becomes more difficult, but not different in kind; more complex imaging techniques (such as electron microscope spectroscopy) would be used in this case. The end result is the same: a symbolic representation of that information in the brain which differentiates it from any other human brain.

This data is then used to configure a brain emulator, that is, an artificial device built specifically for the purpose of emulating a human brain. An emulator is a device that is functionally equivalent to another device — in this case, the brain; though artificial, it would be far more similar to the brain than to any computer existing today. The emulator will embody everything that is known about human brains general; it will need only the pattern of a specific brain — that of the patient — to be complete. Note that this implies significant improvements in our understanding of neuroscience at the lowest level, though complete understanding of higher-order phenomena may not be necessary. The brain emulator is connected to (and probably contained in) an artificial body, built to mimic a biological body as closely as possible. Once configured, the new brain is activated, and the patient wakes up, ready to go about the business of living.

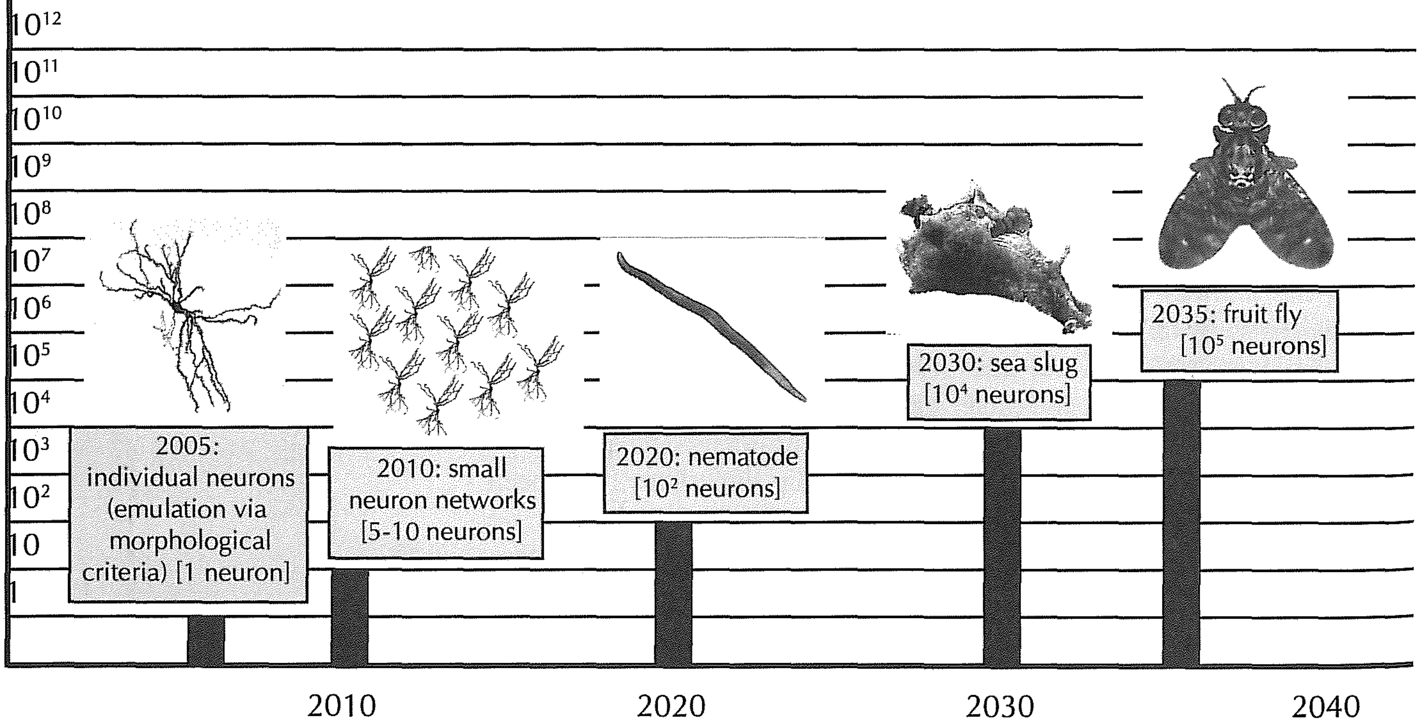
Two points about this scenario are worth noting. First, and most important, large-scale nanotechnology is not necessary. Nanotech would be helpful at several points, but if it turns out that the necessary atomic precision is not attainable on large biological structures, all is not lost. Uploading can proceed with only microtechnology. Second, all the required technologies exist today, though often in crude form. The needed improvements are largely ones of scale and automation. The size of the job is staggering by today's standards; but improvements rely mainly on computing power and microtechnology, both of which have been accelerating for years and show no sign of slowing down.

As a result, uploading may be developed fairly soon, in the grand scale of things. Table 1 presents a plausible time line for the development of mind uploading. We are very close to the first step (single-neuron uploads) already, and placing it at 2005 is quite conservative. Similarly, the other steps have been given more time than they will probably require. It seems very reasonable to suppose that human-scale uploading will be developed sometime in the twenty-first century.

Personal Identity

While the technological case for mind uploading is easy to see, many people find the philosophical issue more obtuse. The issue, in short, is this: is the upload really the same

TABLE 1: POSSIBLE TIME LINE FOR MIND UPLOADING

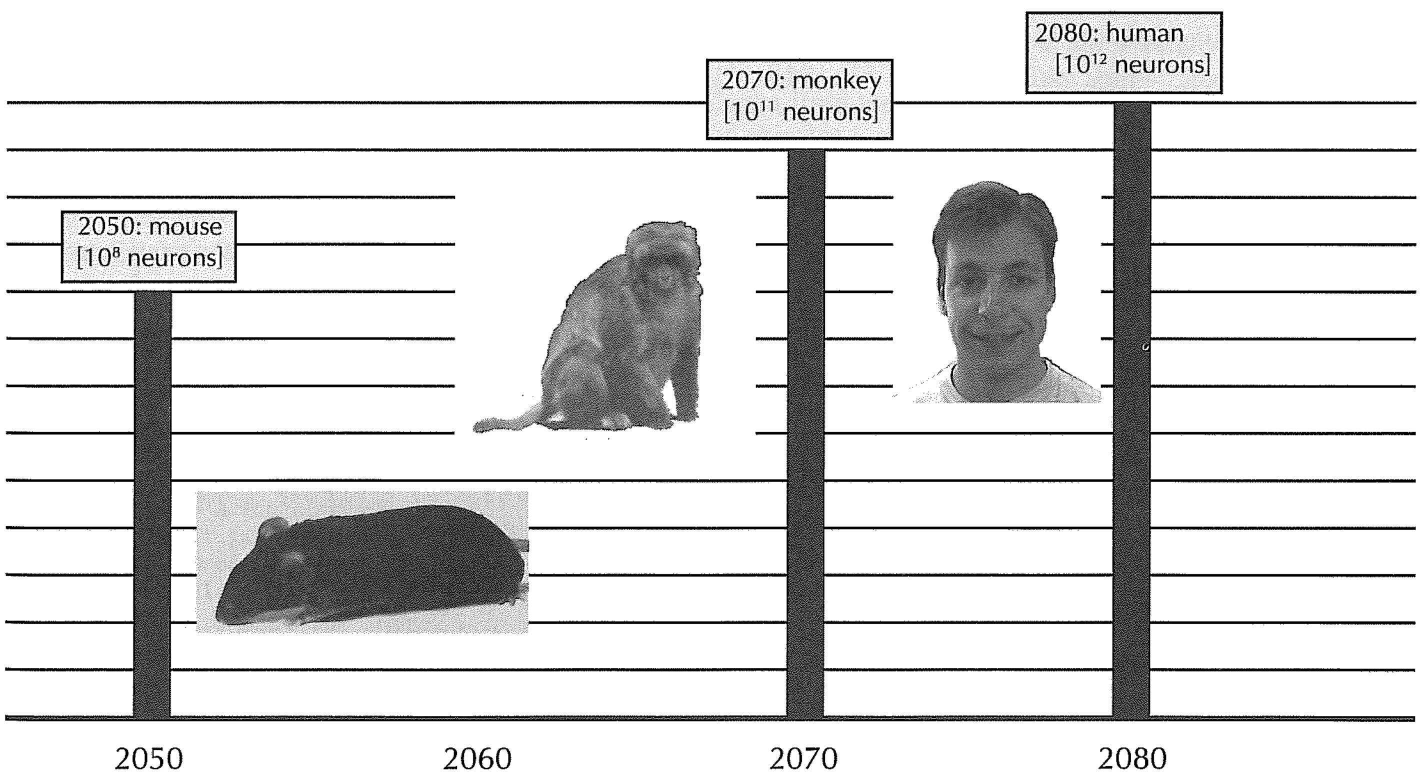


person as the original patient, or is it instead a new person, who happens to act, think, and feel just like the original?

The chief difficulty here is that, as individuals and as a society, we have absolutely no experience with this situation. With a few rare exceptions — such as split-brain patients— personal identity has never been more than an academic issue; we can get along just fine identifying persons with their bodies, and so we do just that, both legally and socially. As a result, we have not developed an intuition for personal identity sophisticated enough to cope with the issues raised by mind uploading.

Upon reflection, most people quickly realize that it's not really the body which is important to identity. You are pretty much the same person after an amputation, or even an accident which renders you quadriplegic. Identical twins have very similar bodies, yet are different people; we can even imagine perfect twins, identical down to their very fingerprints, yet still different people, with different hopes, fears, skills, and limitations. This leads us to consider that what really defines a person is his mind: memories of all kinds, and personality traits, a view similar to that first espoused by Locke in the 1600s [8]. We can even imagine being disembodied altogether, yet still being essentially the same person; indeed, this is quite similar to the notion of a "soul" which has pervaded our culture for thousands of years. A mental theory of personal identity can be stated more rigorously as follows: person A and person B are the same person to the extent that they have the same mental traits — memories, skills, personality, and so on.

A careful reading of the last statement may reveal a curious wording: we have the same person, not "if," but "to the extent that" they have the same mental structure. Such a minor difference in wording has powerful consequences. When we try to think logically, we are accustomed to using only Boolean logic, under which a proposition is either true or false. Applied to personal identity, that means a person either is or is not the same person; there can be no in between. Yet when we speak more casually, we use grades of personal identity all the time, for example, "She's not quite the same person she was before the accident." Philosophers of personal identity for centuries have become entangled in logical binds by restricting themselves to Boolean logic (e.g., [10]). Recently, however, an extension of Boolean logic has been formalized which allows one to deal with degrees. This fuzzy logic, as it is called, is the appropriate tool to apply to situations which are not black and white, but include shades of gray [7]. Personal identity is such a situation; mental traits change over time due to experience, and so two entities maybe more or less the same person, depending on the degree of difference. You are mostly the same



person you were yesterday, but you are only somewhat the same person as your five-year-old self. When a standard mental-traits theory of personal identity is extended through fuzzy logic, all logical binds disappear. The theory is self-consistent, and also consistent with our everyday experience.

With this theory in hand, we are prepared to examine situations where our intuition fails us. To resume the point of this article, consider mind uploading. The artificial brain created from the patient's biological one is functionally equivalent to the original. Therefore, it will have all the same mental traits as the original patient, and since mental traits are the basis of personal identity, it really will be the same person as the patient, just as much as you are the same person in the morning as the person who went to sleep. The patient has survived the procedure, and need not mourn the loss of her previous, biological brain.

But once a person is uploaded, it would be easy to make copies of her brain pattern. What are we to think about these copies? Since each one has the same mental structure as the original patient, each and every one really is the same person as the original. And by the same token, they are all the same person as each other. But as they have separate experiences, they will gradually become less the same person, and become mostly different people.This strikes many of us as very strange, which is not surprising — in all of history, it has never been possible to duplicate a person. But it soon *will* be possible, and while it seems odd, it is not a logical problem.

Conclusion

Mind uploading is philosophically sound; by the simplest and most logical theory of personal identity available, uploading preserves personal identity and constitutes survival. It also appears to be technologically feasible, in that the instruments and techniques needed are only obvious extensions of ones already in use today.

Nanotechnology may provide the means to repair and resuscitate a frozen, biological brain. But if it does not, or if it turns out to take much longer to develop, then uploading provides an alternative. Both approaches should be investigated and considered by cryonicists, for several reasons. First, it may aid in recruiting; listeners skeptical of one approach may be more receptive to the other. The argument of uploading is especially powerful on the issue of neurosuspension, since no headless cloning or nerve-joining are required. Second, we should prepare ourselves for the possibility that we may wake up in an artificial body, rather than a biological one. Thoughtful consideration now may ease your adjustment period in the future.

Finally, mind uploading will be one of those society-changing technologies, like fire, agriculture, and nanotechnology. Considering the magnitude of its effects, its development is just around the corner. If we begin collectively thinking about it and discussing it now, perhaps we will be ready when it arrives.

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Tape Transcript:

"Freeze-Wait-Reanimate"

transcribed by Brian Shock

While browsing a Wisconsin library's archives, Alcor member Steve Van Sickle (whose regular column appears later in this issue) discovered an audio tape entitled "Freeze-Wait-Reanimate." Part of a Pacifica Tape Library educational series, this 1973 program featured interviews with various Cryonics Society of New York members. We know little about the origins of the program except that its producer was Jan McNeedo, with technical assistance by David Rapkin and music by James Ursay. (My apologies for any misspelled names.)

Aside from my interest in cryonics history, I found this program fascinating because it presented both a sharp contrast and disquieting similarity between cryonicists of 1973 and 1997. The transcription has been edited for clarity and divided into two parts. I have tried to preserve a sense of the unnecessarily artsy 1970's sound effects and audio-montage cutting. -- *ed.*

Part Two

Male Interviewer: What is in this large case down here?

Cummings: This is a dry ice box.

Male Interviewer: Is there anybody in there?

Cummings: Yes, there's a woman in there. Dry ice is the second stage, after perfusion, after wet ice.

Male Interviewer: How old is the woman in this case?

Cummings: How old? Sixty.

Female Interviewer: And what did she die of?

Cummings: A conglomeration of diseases. We don't really know. . . exactly. I'm afraid I can't mention her name because we don't have permission from her family.

Male Interviewer: Dry ice.

Cummings: You should hear the sound of dry ice as it hits aluminum. The stretchers are aluminum. My father and the other man were put on stretchers. You can see that in the photograph there. When I was at this stage, the film shows him going from this stage in the dry ice box into the capsule. Before they could put him on the stretcher, they first had to cool the stretcher. Otherwise it would be like putting your hand on a frying pan. [They] had to bring the stretcher to dry-ice temperature, and it was done simply by placing blocks of dry ice on the stretcher. That makes the weirdest sound imaginable.

(Noise of more foil being unwrapped.)

That actually was her skin tone at death — she was quite ill.

Male Interviewer: She appeared to have been greatly ill at death?

Cummings: Yes, she was.

Female Interviewer: Was this woman frozen immediately after death?

Cummings: There was delay. Some of the initial stages were done where she died. We did not start perfusion until, I think, ten hours after clinical death.

Again it's all relative. It's all comparative. No one can say how long is too long, because what is irreparable damage today will not be irreparable damage ten years from now or twenty years from now, a thousand years from now.

Male Interviewer: How cold is it, or should it be, in this case?

Cummings: -79 degrees Centigrade. The temperature of dry ice.

Male Interviewer: And how long will she remain in this before she goes into liquid nitrogen?

Cummings: There's no point really in remaining in this stage after your body has reached this temperature. When she first went in this box (I helped in the final perfusion stages here and in the ice stages) I believe her temperature was -54 degreees. It took four days [to reach that temperature] just from the presence of dry ice. Dry ice at that point was eaten up at quite a fast rate because her body was warmer. Of course it stays a lot longer in this insulated dry-ice box. But it took about four days for her to get down to -79 degrees Centigrade. Actually, once you're at that temperature, there's no point to keep you there. You could conceivably go directly into a capsule, but. . . we're waiting for a final decision from the family.

Male Interviewer: Why not store at this temperature then? Why go into a capsule at all?

Cumming: Well, at this temperature some biological action does take place. It is slow, but it does take place.

Male Interviewer: You mentioned earlier someone in New Jersey...?

Cummings: The man, originally had his. . . we were the organization who froze his wife, got him the capsule, had the capsule built for him. He was originally with us, but he decided to try it on his own, actually maintain the thing on his own. Naturally, you know, people are free to do that if they so desire. Seems a little insane, but to each his own. If you want to put one in your living room and have it as a centerpiece, okay. But he has a hole in the ground in New Jersey, presumably. I say presumably because no one is allowed to see inside. But presumably he has a capsule similar to this with his wife in it. He could have just a hole filled up with concrete. We do not know.

We had his capsule made for him. We don't make them, of course. We hire the, actually the largest manufacturer of cryogenic equipment in the, in the whole country to make these things for us. And this man specified that there would only be room for one in that particular capsule because he didn't want anyone in there with his wife, even though they're back to back and, you know, she's dead.

No one was in there with his wife. The way the capsule is set up now there's no room for him in there. (Laughs) So, he doesn't know that — he probably thinks he can squeeze in, but, I don't know.

[*Nick DeBlasio, a New Jersey police officer, had his wife Ann frozen. Bob Nelson from Cryonics Society of California convinced DeBlasio that he, DeBlasio, could maintain his wife just as easily as CSNY. Ann and her capsule were kept in a New Jersey cemetery, in an underground vault. (1) Unfortunately, the fill valve on the dewar had been welded improperly, and so a great deal of heat was lost through this point. Ice formed around the valve, and had to be chipped away for each fill (usually by hitting it with a ball peen hammer). Eventually this abuse destroyed the valve, so that the dewar could no longer be filled. A few years later, 1980, Mike Darwin heard about this abandoned dewar and went out to recover it. Wearing breathing gear, he removed Ann DeBlasio's decayed remains by hand. Darwin also reported that another person* had *been kept in this dewar at the same time, but he did not report her identity. (2) —BRS*]

(More "Forbidden Planet"-style sound effects)

Female Interviewer: There's speculation, since no one knows where the grave of Walt Disney is, and since he did express wishes to be frozen, that he *is* frozen.

Cummings: Again, this is a coincidence. When I was doing the David Frost show, one of the stage hands that I got to talking to before going on, happened to have worked for Walt Disney at the time of his death. And as soon as he knew I was going to be on the show, "Oh, I know all about that freezing thing, 'cause I worked for Walt Disney, and he's frozen out there, 'cause I was out there and I know!" Now this man worked for Disney at the time of his death, and you could not shake him from the idea that Walt Disney was not frozen. He says, "Walt Disney is frozen, I know it, and now Roy Disney is frozen out there with him!" But. . . we haven't seen anything, we don't know anything about it. He certainly had the money to do it if he wanted to do it, privately, on his own. But, again, we know. . .don't know one way or the other.

[*In fact, we do know that Walt Disney was cremated, and that his ashes were interred in the family vault at Forest Lawn Cemetery in Los Angeles. (3) The confusion seems to have arisen because Disney's death occurred on the same day that Bob Nelson held a press conference to announce the founding of the Cryonics Society of California. (4) And incidentally, as far as I know, Roy Disney is alive to this day. He certainly was not dead in 1973. —BRS*]

(Rustling sounds)

Male Interviewer: It's like a big freezer chest, with styrofoam inside it.

Cummings: When I first saw this thing, I had absolutely no experience with death, before my father died. In other words, I really, aside from the movies and book, I had no idea what a coffin was supposed to look like, what a dead body was supposed to look like.

Female Interviewer: Really?

Cummings: I never actually saw one. And when I first saw my father, it was in, in this box, as a matter of fact. And when I first saw this box, it sort of reminded me of a hope chest. And I guess in the very broadest sense you could call it exactly that.

Henderson: Frankly, at the present moment, the state of the art of freezing biological material is a product of the cattle industry. Because they made a lot of money. It's the basis of the cattle industry nowadays, because you save so much money by not having to ship the bull around. Now, it's starting with the blood. . . I would say that blood freezing, sperm freezing, blood freezing, that that's, that's the, the, that's what developed the technology of freezing biological materials. Now I know that a few researchers here or there — I say a few, I say probably three or four — that are devoting full time to attempting to find ways to freeze organs, because ever since this organ transplant thing came along, the, the, the whole problem has been donors, and if you should freeze them, and store them, you know, on a rack or in a parts house somewhere, it would make it a lot easier. But as far as any real massive research, even in the area of freezing organs — it simply isn't happening.

Cummings: Actually, freezing people, the whole idea of preserving and bringing back, is only one part of a whole program we'd like to develop, called the whole Life Extension Sciences. This is just one. Now the main idea, the main objective, is to increase lifespan. Bring about — not immortality, that sounds a little bit far fetched — but in, in, almost indefinitely extended lifespan. Let's say "greatly" extended lifespan.

I think this is not for anyone with deep religious convictions. I frankly do not have any. Neither does my mother. Most of the people connected with this don't. A book was written, "Why Call Them Back From Heaven?" Why indeed? If you believe they're there, naturally you want them to stay there. So. . . this. . . on other programs I was asked these questions, where people were always, were permitted to calling telephone questions in, and I was usually asked that question by someone. Usually a vituperative little lady who called in and said, "This young lady apparently has no religious convictions and I feel I'm going to be in Heaven and I wouldn't want this." And instead of trying to argue with her when there really is no argument, I agree with her and say, "Yes, you're perfectly right, ma'am, I admire you for your deep religious convictions and this would not be for you." And there's usually silence on the other end. There are people who. . . there's, one person, who said he was a Roman Catholic and had his wife put into a capsule similar to this, and he had a Roman Catholic priest come and consecrate the capsule. Frankly, I think that is. . . I don't know what you'd call it — hedging your bets, possibly? But, I really do not think you can reconcile the two. My major feeling is that death is for the living. I feel that when you're dead, you're out of it, and (sorry about that, Dad) it's up to those left behind, very frankly, to somehow deal with the loss. Now I was very close to my father, and when he went, you know, it was like the world crashed in on me. And I had to find some way to go on with my own normal life, to not be completely decimated by the loss. Now this for me was the way. I'm not saying it's the way for everyone.

Many people want, want their bodies preserved. They have it written in their wills, and they go into these huge mausoleums for ten, twenty, thirty thousand dollars, thinking it's going to give you preservation of the body but it does not. That's why we seal you up in the walls of the mausoleum — because it doesn't give preservation. Now taken in light of that, this is the. . . about the cheapest mausoleum you can get. It runs about, about ten thousand dollars. That, that's for the initial cost, and approximately a thousand dollars a year for maintenance. The main maintenance cost is simply the cost of liquid nitrogen, which is going up all the time. It costs approximately, you know, well, it costs exactly $106 a month, for, for liquid nitrogen alone. And that's not counting all the expenses that we have maintaining the facility. Not taking wildcat inflation in, in mind, if this would become more widespread, if more people would take up the idea, naturally costs would go down.

We've had several requests of people with terminal illnesses, almost begging that the freezing process could be started on them, thinking it would give them a better chance, it would give them a slight edge, and of course it would. But as the laws stand now, it's against the law, because it would, we would, in effect, be committing murder, the freezing process would be murder. But I've been reading and hearing quite a bit about the euthanasia laws, and quite a few people, and the right to die laws that have been promulgated all around. . . now if that would actually come through, an extension of that could easily be applied to us and would probably be of great benefit to a lot of people who want this service.

The main point is, regardless of what the damage is right now, very frankly, the freezing process has been — and the perfusion process, which is even more important — has been quite crude, up to this point. My father being one of the first was. . . was perfused in one of the crudest ways possible. But still and all, that does not really depress me or deter me that much, because think of the alternatives. There are no alternatives, as far as I'm concerned. I mean, even if he's never brought back, he is no more dead in this capsule, no more or less dead in this capsule, possibly slightly less dead, than he would be in the ground. So there is nothing lost. In other words, there is everything to gain, absolutely nothing to lose, assuming you have no moral objection. Of course, if you do, stay away from us. But, there is nothing really to lose.

Isaac Asimov, 1972, Lunacon: I was thinking about when I was listening to the question of freezing. . . how lobbies manage to produce law. Well, it seems to me that if people are frozen, there will be a large lobby of non-frozen people who will be anxious to keep them frozen . . . (Chuckles from the audience) and prevent them from having any control of anything while they are frozen. In short, we will want to avoid the dead hand. The world is for the living, not for the frozen. So that, in general, I suspect, that we'll have laws that say as soon as the person is frozen by his own volition, he has no more rights than a dead person, and if anything happens to him, there is no, nothing that can be done to compensate him, because he's already dead.

On the other hand, if we think of people being frozen at the point of death, when they have a mortal illness, when they are dying of old age, and the idea is to put them under until such time as medicine can cure whatever it is that's bothering them, in which case they'll be brought back to life and rejuevenated, then obviously we don't have to worry about anything happening to them. Let us say a steamroller happens to go over them, right through the freezing bank, picks out their body, goes over them, makes them flat. Then they just freeze them even longer, until medicine can cure steamroller. . . (Applause from the audience.)

And frankly, I sympathize with that. While I recognize the fact that my frozen body, if it's ever frozen, is of value, I don't see the result of the value of billions and billions of bodies. I say, make room for new people.

[*Isaac Asimov died in 1993, and of course was not frozen. Do* **you** *feel like there's all that much more room in the world? —BRS*]

Saul Kent: If you ask any demographer, I think he'll explain it further, perhaps better than I can. But the fact of the matter is that if you extend people's lives for quite a long period, for twenty, fifty, a hundred, a thousand years or so, and if you do this to a large number of people, it basically has very little effect on the population, unless one of two things happens: either you extend the period of fertility, or in fact you never die, which I doubt it's going to happen, although I would like to be the first never to die. But the fact is, when we talk about immortality, we don't talk about living forever. We talk mainly about not dying at a specific time and not dying at a progressive rate. Not being subject to an inevitable decline in vitality whereby you have to die at a certain point.

Now, if you have life extension, the crucial issue still remains, how many children each couple is producing? And if this simply remains at the replacement level, which is 2.1 for each couple at this point, you're not going to have a significant change in population by extending life. People will die; the curve will just extend, just extend a little bit longer, that's all.

Now, secondly, the fact, the primary fact that we have had what's been called a "population explosion" and, in fact, has only been an explosion in certain countries. It hasn't been in others. But the reason for this is primarily methods of modern medicine which, particularly relating to infant mortality, have reduced the death rate considerably throughout the world. And in the countries for which the death rate has been reduced without a concomitant reduction in the birth rate, you have had a population explosion. Now, this is the reason: we've never had the problem; throughout most of history, the population growth rise was on the order of 0.002 percent. We had a stable population. Why? We had a very high birth rate, we had a very high death rate. Naturally I don't think anybody, I hope, anybody, would, would suggest that we should have let people die, certainly in infancy or at any other point, simply because we were going to avoid a population problem.

The same is true with cryonics. The same is true with life extension. You do not deny an individual a chance to live simply because of a social problem. You handle a social problem within the system, in a more rational manner.

Isaac Asimov: I don't think there's any law now to keep a person from living as long as he can. And this would be, it would be an unpopular law to. . . So that, on the whole, if we have life extension mechanisms where a person is alive and conscious at all times, I don't see that that'll be stopped in the future.

Henderson: We were naive. We thought all these big companies would see what a wonderful idea this was, and would of course have plans (laughs) for storage facilities and making this available to the public. That didn't happen at all. What happened finally was that one of these people in California who had made preparations and had put up the money, died. This is again what I stressed before — at that point, as far as that individual was concerned, you were either going to freeze him with what you've got on hand, or he's going to rot. That's exactly what happened. They froze him, not because anybody wanted to get involved in freezing bodies, but because of even more of us put in a put-up-or-shut-up position.

Cummings: We recommend taking out a $30,000 life insurance policy to, made out to the society. Now that would be used, $10,000 would be used for the initial freezing costs and the rest of it put into a, a trust fund. And that trust fund, the provisions of that would be, would provide for perpetual care and it would be written into that for revival, if and when the time ever comes.

[Currently the Alcor Foundation requires minimum funding of $120,000 for whole body suspension, CryoCare Foundation requires $125,000, and Cryonics Institute maintains its rates at $28,000. --BRS]

No time limit could ever be specified. That in fact is written into our contract. You can read the standard contract. You. . . it. . . it says, you know, before you sign on the dotted line, you know it's experimental and there are no guarantees implicit in the thing. But again, that would, the question of your being brought back would depend on what society is like at the time technology of that advanced degree has evolved.

Not to sound to flippant about it, but "you pays your money and you takes your chances." But to be more specific, there really are no guarantees. Now let's say that the technology to bring you back comes into existence in four hundred years, five hundred years. Let's say it's someone cares enough to bring you back. Someone once asked me, "What happens if the person is brought back, if your father is brought back, and he finds himself in a world where cannibalism is rampant, and they eat him as he just —?" And I said, I'd much rather he be a frozen dinner for humans of the future than a dish for the worms today.

It's been shown countless times again that people would rather live under the most ghastly situations than die. People don't commit suicide. They get along. They adjust. This Japanese soldier who thought the war was still going on until about — the Second World War, that is — until about three months ago. They found him in a tree, and brought him down. Two months later he was married and, you know, getting along swell. The ultimate question is if, if a person is brought back, he is a thinking individual and he does not like the situation, he can always commit suicide.

(Still more electronic sound effects)

Richard Gelman, 1972, Lunacon: As soon as you are frozen, you are legally dead. And all the consequences may occur. Now, then you certainly have the problem of the estate in perpetuity. When you are unfrozen, you are a new person, with a new set of legal rights. So this way, for instance, let's say, a man is frozen, he is legally dead, his wife is free to remarry. At the time, you know, ten years later, that he is unfrozen, he is no longer married, and he may marry anew and there is, there is no bigamy committed.

This is going to take a number of years to work out, and it will be worked out on either (1) who has the most at stake and can push it through, or (2) what makes the most sense for the most people. Definitely we will get a definition of death. They're going to skirt this as long as possible the same way they have skirted the definition of how high up is space.

Henderson: The British medical dictionary's definition of death is that situation, that state, from which the present state of the medical art cannot revive you. So, even death itself is defined in terms of the present level of medical technology. So as technology changes, the definitions — everything — has to change. This whole question of when a person's dead, I know that there've been all kinds of arguments. It's been brought to a head by the donors for the organs. . . as to just when a person is dead. Now in the past, if somebody stopped breathing and their heart stopped beating and you couldn't revive them then they were considered dead. That was it. And they were dead. Now of course they can be resuscitated in many cases. So, they *weren't* so dead. Now, you could keep extending it, and undoubtedly it will to be extended, until you have a situation where if a man is not physically destroyed, vaporized, you will always be able to revive him. So death becomes almost the time when the doctor wants to give up, when he wants to turn the switch off on you. This is exactly what's led to the right-to-death laws and the euthanasia thing, because you are already approaching a point where you can extend, if you were to spend the money and time, you could extend an individual's life in the sense of heart beat and respiration almost indefinitely.

Saul Kent: I've seen certain consequences of death, and I'm not happy about them at all. And I certainly do fear death. It has been said by many people, the apologists for death, that if a person lives a full life, he doesn't fear death, and it's the people who haven't lived a full life who do. And this seems to me just the opposite. If one has lived a full life, then one, it seems to me, should be exceptionally, exceedingly reluctant to give up on this life. I think in very many cases people who have not lived very well are the kind of people who commit suicide.

Immortality, the idea of achieving immortality, the idea of achieving control over reproduction, the idea of achieving control over energy sources, the idea of going to other planets — every one of these go in a specific direction and that is a matter of gaining control over one's life and one's activities to a degree far beyond that which has been possible in the past. We are moving into areas that have been thought of as the province of the gods in the past, and I think we're evolving. . . I happen to think we're evolving quite rapidly into a creature that will not really be human at all. I think a hundred years from now, the people that are alive will look back on the people that are alive now as a different species.

Cummings: The only interest has been to provide grants to freeze, quote, soon to be extinct animals, unquote. As soon as you mention humans, interest dies. But I sort of mention, well, you know, Man is a soon to be extinct animal, maybe we could squeeze in under the wire, but no one seems to agree with me.

Henderson: Our cryonics society was started out to try to get people interested enough so that they would demand some real massive research on this big problem everybody has. An awful lot of research is done on all kinds of things. Most of them don't affect anybody's real personal problem, and this is everbody's biggest personal problem, is the fact that you're going to grow old, and suffer, and die. And you put it out of your mind, and you know, they could, they make enough on cosmetics trying to cover up the wrinkles each year that I'm sure if it was spent... you could get rid of wrinkles in the first place. So, that's all I have to say on the whole subject, is that everybody faces this problem, and if anybody wants a real shock, they ought to tour the cancer wards, the terminal wards of the hospitals, and see really what they're, what they're facing, and not too far away. I mean, you know, for most people it's only thirty, forty years away. So, I know it's very depressing but unless something's done about it, that's exactly what's going to happen.

Kent: We're talking about increasing the quality of life in as many ways as possible, genetically and environmentally. And I think that one of the real problems, one of the reasons we're in the mess we're in, in many ways, is because in the past people have known and were certain that they were going to die, and they took upon themselves certain actions that had disastrous consequences in the future, simply because they didn't consider themselves as part of that future. And I think if you have people who have longer lives and have no definite limit on their time span and life span, they probably will be more willing to take a long-range view.

Cummings: Only Bill Graham knows for sure what the future holds. I frankly do not, and I would not presume to say how far technology will or will not progress. True, in thirty years we could be living in caves again, but then again, in thirty years these people could be perfectly normal again. Who is to say? Again, thirty years ago if anyone had said, "I'm going to be able to watch someone walking on the moon on a little black box in my living room," they would've taken the guy out and locked him up. You know, chained him to the wall, like a mad dog. In two hundred years if he'd said the same thing, he would've been burned as a, as a warlock. The only reason I bring that up is that something so completely impossible, so completely fantastic one day, can be considered completely mundane the next.

Henderson: I've had people say, "Well, all my friends and relatives will be dead." And the next man says, "Wonderful!"

Kent: It's really even wrong to say the chances are slim. The chances are unknown.

When people ask for guarantees, I just guarantee them that if they die and they're not frozen then they won't be back.

(Background music: "When You Wish Upon A Star," from the Disney film "Pinocchio.")

(This program was produced by Jan McNeedo, with technical production by David Rapkin, and musical direction by James Ursay.)

[*Gillian Cummings (*nee *Beverly Greenberg) died in November, 1973 and was not frozen, due to lack of funding and insufficient paperwork. She was found dead in the CryoSpan facility, apparently from carbon monoxide poisoning. (For more about the life and tragic death of Gillian Cummings/ Beverly Greenberg, see Mike Perry's column "For the Record" in this issue.)*

After CSNY effectively folded soon after Cummings' death — losing all of its patients — Saul Kent and Curtis Henderson joined the Alcor Foundation. Kent went on to write "The Life Extension Revolution," and became a millionaire through sales of vitamins and other dietary supplements. In 1993, Saul Kent and a handful of other Alcor members decided to start their own cryonics organization, CryoCare. Not coincidentally, they named their storage company "CryoSpan," in honor of the original CSNY group. —BRS]

Sources:

1) *Cryonics Reports* (newsletter of the Cryonics Society of New York), Vol. 4, No. 9-10, Sep.-Oct. 1969.

2) *Cryonics*, #8, Mar. 1981.

3) Poundstone, William, *Big Secrets, Boston: Houghton Mifflin, 1986.*

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5) Personal conversations with Stephen W. Bridge and R. Michael Perry.

Can a Christian Be a Cryonicist?

by Michel Laprade

Sometime ago, I began to notice a cross (no pun intended) between surprise and intrigue on the part of many cryonicists at the thought of anyone being both a practicing Christian and cryonicist, sort of... well... like me.

Evangelical Christian and Cryonicist

The order here is important. You see I was a Christian before I became a cryonicist and I'll be one long after...

In 1968, I was an 18-year-old working in a bookstore when I stumbled across Robert Ettinger's book *The Prospect of Immortality.* I read it and I was immediately sold on the irrefutable logic of the arguments presented. Initially, this had nothing to do with my being a Christian, I just sought the chance either to live longer or perhaps to have an opportunity to live again sometime in the future.

Soon afterward I began sharing my newfound ideas, and ran straight into other people's "brick walls" of logic. Of course, over the years I've refined my "pro-life" position regarding cryonics in discussions and arguments with the skeptics that surround me. (If cryonics is not the ultimate pro-life position, I don't know what is!) Interestingly, I have not found too much difference in the arguments against cryonics from Christians and non-Christians alike.

We are all quite familiar with the tired and sorry platitudes regarding why we shouldn't be involved with cryonics. For instance, the world tells us that, "When your time is up, your time is up."

To this, I would expect that a cryonicist would say, "I agree. It's just that I don't necessarily think my time is up. I want to take every possible action to extend my time even with the temporary interruption of death as we know it today."

The Christian might also say something like, "The Lord decides when to call me home. I'm not going to try to thwart his plan for me".

As a Christian cryonicist I would answer, "I agree! If the Lord is calling me home *now*, then there is nothing I can do that's going to make any difference and I'll be happy to go. On the other hand, the Lord helps them who help themselves. I choose to take every reasonable action (even if somewhat extraordinary by conventional standards) to *live*."

To me, there is a very short psychological step between a potential cryonic suspension patient and an accident victim who is asked by the ambulance attendant if he wants "extraordinary means" taken to allow his survival. Christians and non-Christians alike seem to agree that they wouldn't send the ambulance packing and simply accept their "fate." I don't think I am trying to circumvent God's plan by asking to be suspended any more than I am by accepting conventional medicine.

Granted, cryonics is a stretch by anyone's reckoning. But frankly, I am surprised that Christians, who have the faith to believe in our Heavenly Father's spectacular eternal promises to us, lack the faith required to accept the possibility of His granting us this amazing but (relatively speaking) *insignificant* achievement called cryonics.

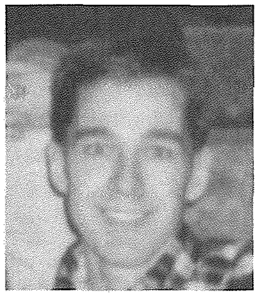
I have been asked to reconcile my faith with my cryonics beliefs. But what are the issues? I have yet to hear any reasonable, spiritually based objection as to why anyone should not be suspended. The reasons given for refusing cryonics are invariably personal: "I don't want to," "I've lived once, that's enough," or "I don't want to come back old and not know anyone."

The closest I have heard to a comprehensible answer is when someone says, "I don't want to delay my 'going home.'" or "I want to be with my Heavenly Father." As a Christian, I can relate to these sentiments. However, if we return to the ambulance discussion, invariably my brothers and sisters are — once again — very anxious to *live*!

Personally, I feel that if I were suspended, revived, and lived a thousand years only to repeat the process a hundred times, this would be but an instant in eternity's time frame. Our Heavenly Father gave us a strong will to live. I don't think he would begrudge us for using our God-given abilities and talents to accomplish this.

Rather than focusing on the possible reasons why I shouldn't be suspended, I choose to focus on the reasons I should. I have found plenty. I feel that as a Christian, I have a *responsibility* to be suspended. I believe that the Lord breathed life into me not intending for me to "check out" the first chance I got. I believe that my purpose is to be a witness for him; common sense dictates that to do this, I have to be *here*. I am saddened by the reported number of cryonicists who are atheists. Perhaps our Father is intending to use me to reach them by having us spend a thousand years together in a dewar.

ALCOR MEMBER PROFILE



Jordan Sparks

Profile Editor: Russell Cheney

Age: 27

Date joined Alcor: A couple of years ago.

Hometown: Salem, Oregon

Profession: Dentist after one more year of school. I really enjoy my work and wouldn't dream of doing anything else. In dentistry, I get to be a surgeon, a mechanical engineer, and an artist.

Military: Army for three years as a Russian Linguist. Stationed mostly in Monterey, CA & Frankfurt, Germany. Spent some time in Texas, Missouri, and Massachusetts.

Marital status: Single

Residence: A medical co-op with 18 other students. I'm the house manager, which means I get to fix things that break down.

Height: 5' 10.5"

Weight: 115 lbs. I'm on a calorie restricted diet as detailed in "The 120-Year Diet" [1]. Besides being thin, I'm sensitive to cold and like to wear thermals most of the time. My family worries about me constantly, but they know I've got my head on straight, so they try to accommodate me.

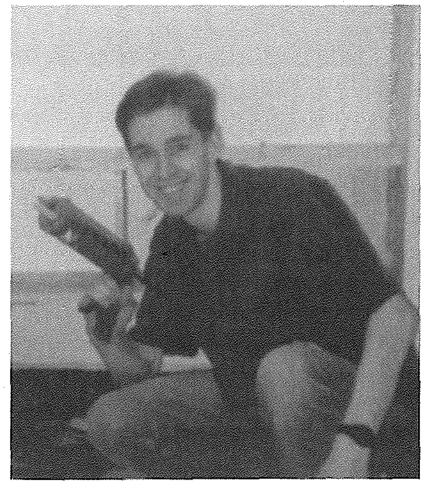
Favorite book: "How to Win Friends and Influence People" [2]. A great book that desperately needs a new title.

Favorite movie: "Highlander," which deals a lot with immortality.

Make of car you drive: White Volvo stationwagon. Yes, even the color is a safety factor.

Political views: I'd like to see more freedom in the world. I feel this is best achieved by increased privatization, and much less government spending. Government should set the rules, but private companies should provide the goods and services.

Religion: None



Personal philosophy: Do unto others...

Short-term goal: Start a dental office in Salem, Oregon, and get out of debt.

Long-term goal: Start a family, and have plenty of free time to enjoy with them.

Long-term goal after reanimation: Upgrade my body to be more durable, resilient, adaptable, and precise.

Quality you appreciate most in others: The ability to listen and be sensitive.

Favorite leisure activities: Reading, picnics, small outdoor concerts, movies, family get-togethers, plays, pubs, walks.

Happiest memory: Riding my motorcycle in Monterey. This was back when I still thought I was invincible.

Secret ambition / fantasy: To raise a clone as my son. I could really learn a lot about myself, but it would also be selfish to deny him a mother. Unless I can find an incredible woman willing to help me raise him as her own, or until significant technological changes take place to enhance human interaction, it will probably remain a fantasy.

Personal strengths: I always think about the future and enjoy delaying gratification to live better. I think about backup plans and contingencies for everything.

Personal weaknesses: Skepticism, which isn't in itself so bad, except that I find myself arguing more than I'd like.

First became interested in cryonics: When I realized I could afford it (I pay $8.00 per year for term life insurance).

Most important physical items you believe should be saved before cryopreservation: Digitized copies of all my photos as well as all the photos that my friends have.

Most effective thing you do to promote your own longevity (other than being an Alcor member): Hopefully, I'll be able to squeeze another 20 or 30 years out of my lifespan with calorie restriction. I also avoid drugs and too much alcohol which are responsible for most traumatic injuries.

Least: Subjecting myself to stress.

Why are you a cryonicist: I want to keep living, growing, and learning.

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[1] Roy L. Walford, M.D., "The 120 Year Diet, How to Double Your Vital Years," 1986, Simon and Schuster, New York, New York.

[2] Dale Carnegie, "How to Win Friends and Influence People," copywrite 1936, Simon & Schuster.

Nanotechnology as Science and as Religion

by Thomas Donaldson, Ph.D.

By this time a substantial number of cryonicists have contributed to the Prometheus Project, which aims to work out how to cryopreserve brains reversibly in 10 years. My own feeling about Prometheus is that, looking only at the science involved, it might well have begun years ago. But now, finally, some real work looks like it will begin on the *central* issue involved in cryonics: our survival through the low temperatures needed for long-term preservation.

However, for some time now there has been another strain of thought within cryonics. The basic idea of its advocates is that nanotechnology will provide, someday, a solution even for those frozen with our current primitive methods. If nanotechnology includes all the different methods we use now and may use in the future to manipulate matter on molecular scales, I would certainly agree. Biochemistry and biotechnology now provide the most important instance of nanotechnology, but other kinds of chemistry (supramolecular chemistry, for instance) and other ideas have been (too slowly!) catching up.

Yet many proponents of nanotechnology, at least within cryonics, seem to believe more than this. First, they believe that all of nanotechnology's many capabilities will arrive suddenly, and soon, perhaps only 30 years from now. Second, they believe that these capabilities will change us, again suddenly, to a society far more wealthy than at present (so much so that it becomes a paradise), for which the problems of bringing back cryonics patients have become technically trivial. (Though at least a few proponents have worried about the social issues involved.) On these grounds, *they believe that we need take no special effort to improve our cryopreservation methods.* The nanotechnological future will provide for us.

Only a little history will make you ask yourself, "Where have I heard these ideas before?" The answer is the Christian Apocalypse, all dressed up in new clothes. Rather than God, we have Nanotechnology, which will put us into Heaven. All the nations will live at peace with one another for 1000 years, followed by the end of the world, at least as we know it. This is Nanotechnology as religion. This simplifies lots of questions and problems...as long as you have faith.

But the evidence does not necessarily support such faith. One of the most important problems with cryonics comes from the likely effects of freezing combined with what we know of memory: current suspension methods, by severing many dendrites and axons, may wipe out our memories. Most neuroscientists would agree that our memories exist not as special molecules, but in the circuitry formed by all the many connections between the neurons in our brain. On a *large* scale, most of the connections of each human brain closely resemble that of any other; but our memories exist in connections on a small scale: just which dendrite connected with which other neuron, and where, and what transmitter(s) the connecting synapses used. No matter how it is done, to recover a patient we must recover most of those connections*.

Repair will ultimately use some form of nanotechnology not only to carry out the repair but to work out just how our neurons were connected beforehand. However, no technology on any scale can accomplish the former without first establishing the latter. How do we know if brain tissue damaged by cryonic suspension will retain enough information about neuron connectivity? This difficult question has been omitted from many discussions of the wonderful abilities nanotechnology will bring to cryonics. The closest such discussions have come has been the observation that in most cases such problems grow harder and harder, until finally they split into many possible solutions. While I have no quarrel with that observation, it fails to tell us about suspension patients at all — and perhaps about our own situation, if our suspension comes too soon.

If anyone claims our present methods will be sufficient, then means to show their claim lie open to them: show, by freezing animals with complex nervous systems at the temperatures we now use and with the methods we now use, just how that problem of connectivity remains solvable. They need not actually solve it in practice, but they

Continued on page 47

* A scientific criticism also may be made here. I've not yet seen any discussion of how molecular nanotechnology will deal with the most likely *practical* problems of revival. Unless rotting has already attacked a patient's brain before his suspension, virtually no molecules will have been damaged — higher level structures will sustain most of the damage. Someone might argue that if we put every molecule back into its former place, and with its former shape and orientation (most biological molecules themselves have quite complex shapes, which change depending on others nearby), then we will have restored the brain. While true, this is *trivially* true. An electrician repairing a damaged circuit does not look first for the location of every molecule in the circuit, but at its wires, connections, and components. Macro-scale repair requires that one look for damaged structures and work out their former undamaged state.

Remembering Beverly Greenberg

by R. Michael Perry, Ph.D.

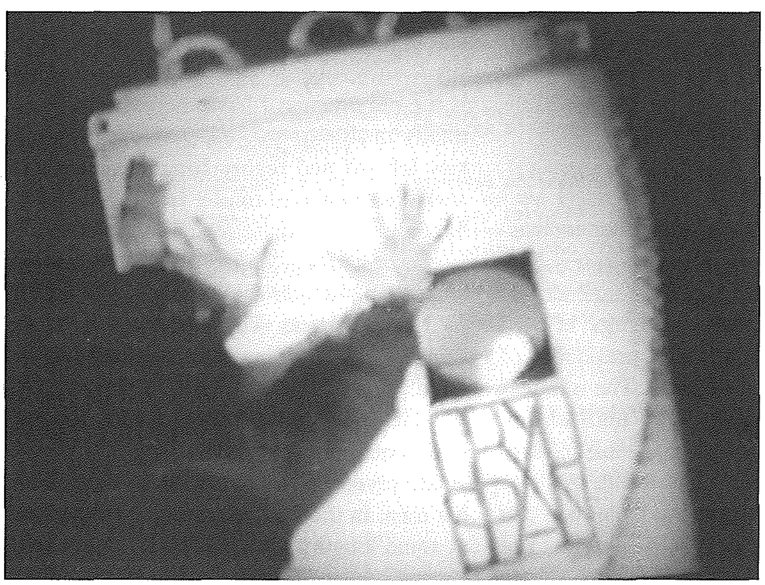
Readers will know Beverly Greenberg as "Gillian Cummings," the young cryonics activist featured, along with Curtis Henderson and Saul Kent, in the two-part transcript that concludes with this issue. Beverly valued privacy and liked to use a pseudonym in public, but her friends used her real name and I'll do so here. The story of her short life, her tragic death, and the circumstances surrounding her involvement in cryonics, is a moving one, though parts of it are not for the faint of heart. I won't be able to cover all the ground — some mysteries remain — but the main outlines are there, and have lessons for us today.

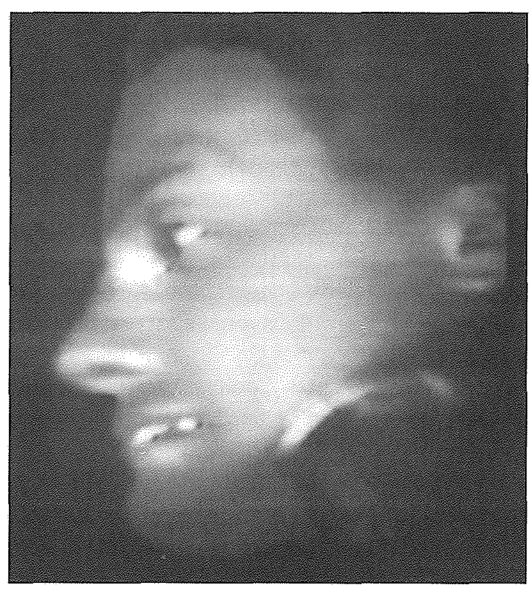
Beverly had seen Bob Ettinger on TV and was interested in cryonics but, at seventeen, hadn't considered it enough of an urgency to involve herself actively. This attitude changed dramatically in the spring of 1970, when her 42-year-old father suffered a fatal heart attack. Beverly, a very bright and talented youngster, was working in Florida as a camera girl on the movie "The Beguiled" (which starred the young Clint Eastwood). Though the family's main residence was in Philadelphia, her father's death occurred at their other house, in Atlantic City, New Jersey. Beverly's mother, who had no interest in cryonics, arranged burial in a cemetery near Philadelphia, but Beverly refused to give up, even though she would later say, "My father's last words were: 'Don't freeze me.'" (Though it appears she wasn't actually present at his death.)

In the words of her friend Mike Darwin, "Beverly hated death, she hated the terrible imposition it was on her freedom to be with her father, and she took the action she did because she didn't believe in giving up — not ever."

Beverly herself said, "I simply could not go on with my own normal existence thinking of my father decomposing in the ground."

And so one morning around 3 o'clock, a call came in to Fred Horn, the mortician who helped Curtis Henderson at the Cryonics Society of New York in Sayville, Long Island. Soon the two of them were on the road to Atlantic City. When they arrived at the Greenberg residence they found themselves in the middle of a dispute: Beverly, who had called on her own initiative, wanted to freeze her father, but her mother was angrily opposed. Curtis noticed that Beverly had dragged big "hunks of the sidewalk" into the house (apparently for some art project of hers); considering the weight of





Videocapture scenes from Beverly never-completed film, "The Ice Men Cometh." Pictured: pushing a CryoSpan dewar upright, and a close-up of Curtis Henderson.

these "three to four foot" sections, he suspected Beverly of having the sort of will that found a way, no matter what. "I knew this was the kind of person who would really go through with this," he later said, and that's the way it turned out.

An insurance policy provided the mere $8,000 required to cover suspension costs at that time. After a quick trip to Philadelphia, where the body was retrieved from its burial plot with a backhoe, Henderson and Horn carted Herman Greenberg back to Sayville for freezing, first with dry ice, then liquid nitrogen. His suspension was not exactly ideal, even by the standards of that primitive era, but who said life is easy? Of course the ground burial, though of short duration (Curtis thought a day or so), did not work to the good. Beverly seemed to realize her father's chances could be minuscule. As she said in the 1973 interview, "There's always that hope on the horizon that he may be brought back. But that was not the primary reason I got into it. I got into it simply to keep him preserved."

To further "get into it," Beverly spent some time in Sayville, staying at the Henderson residence on Holmes Court. Curtis remembered how the teenager had "memorized whole sections of Shakespeare" and was "stunned" by her brilliance and wit.

Cryonics at that point — 1970 — was fading, despite the excitement and publicity of a few years earlier. Ev Cooper's pioneering Life Extension Society, started in December 1963, had effectively ceased to operate. That perhaps was not so great a disaster — LES had never frozen anyone, despite years of effort by Cooper to develop that capability. But other efforts were winding down too. CSNY, started in August, 1965 by Curtis Henderson, Saul Kent and Karl Werner, had been the first organization with the specific purpose of freezing and storing human patients. Curtis and Saul had contacted others on a cross-country trip, and various other organizations began to form, among them the Cryonics Society of California and the Cryonics Society of Michigan. (The latter would be headed by cryonics pioneer Robert Ettinger, and eventually metamorphose into the Cryonics Institute which is still active today.) CSC actually carried out the first controlled human freezing (of James Bedford) and would suspend several others before CSNY's first suspension, that of Steven Mandell, in July 1968.

Within a short time, however, enthusiasm slackened. Relatives who were paying for the maintenance of suspensions were generally not signed up themselves, and quickly lost interest. People who *were* more involved drifted away, among them such major figures as Ev Cooper and Karl Werner. By 1970, CSNY and Cryo-Span, its sister organization that handled the actual details of freezing and storage, existed mostly on paper. Even so, Curtis Henderson doggedly maintained the organization's several patients. Beverly's arrival may have

Beverly Greenberg,
aka Gillian Cummings.

briefly seemed to turn back the increasingly somber course of events; in any case she quickly assumed some prominence despite her youth. "Gillian Cummings" is listed in various sources as "vice president" of one or the other organization. The title was "informal" at best, but her enthusiasm, charm, and dedication were real enough. According to Mike Darwin, "she was one of those truly incredible people you are lucky to meet but once in a lifetime. She was so outrageous, so full of life, so able to captivate, that it seems impossible to have known when she did not exist."

Mike was especially intrigued by pictures Beverly made of her father's freezing, including a short movie, *The Ice Men Cometh*: "The photographs and slides were beautiful, simply beautiful in the artistic sense. Others were awesome, such as the picture of her father immersed in liquid nitrogen; obviously requiring many hours of labor, careful thought and technical perfection. Above all, I think the thing that drew me to those pictures was her aesthetic sense. Beverly knew about the drama of what we were doing. I think she saw it more clearly than anyone else ... In light of the tools and money she had to work with, the film she produced was and is nothing short of a miracle."

The movie in fact showed all the steps of the freezing, with most of the action by Curtis Henderson, from splitting the big white blocks of dry ice at the start to hoisting and pushing the heavy capsule with its frozen occupants upright and filling it with liquid nitrogen. ("Occupants" is correct; someone was already in the capsule — see below.) The drama was intriguingly mirrored in the facial gestures of Curtis as he went about the various tasks, something I've never seen in the many other documentaries on cryonics that have by now been made, often by professionals with far larger budgets. Appropriately, the film concluded not with "The End" but "The Beginning."

Photo talent Beverly had, but that wasn't her only memorable trait. "There was an energy about her personally," Mike remembered, "that was just as vital as what she captured on film. ... Each moment you spent with Beverly was an adventure. She is the only person I have met who left me totally unable to sort out where her fantasies left off and reality began. ... Beverly was going to run off to Hollywood and become the starring voice in a Hanna-Barberra cartoon, or Beverly was making another movie which would catapult her to fame and fortune. There are no words to describe the dizzying world in which she lived."

Her interests went beyond film and entertainment, however, into the heart of the small cryonics movement that she made her own. In the Pacifica interview she talks at some length on the technical aspects of storing humans in liquid nitrogen capsules, the Suda cat brain experiments, the present limitation of cryonics to "perfect preservation," and the pressing need for more research.

Appearance-wise, Beverly disliked her frizzy, black hair, and used a battered old leather hat to cover it. "The hat was always a source of amusement to me," Mike Darwin remembered, "because it had a large bite taken out of the front which, she frequently remarked, gave it much added authenticity." On TV talk shows her black leotards and the bikini bottom with white ruffles became a trademark. Mike also remembered a dinner that he, Beverly, and "Corey Noble" had at a Jack in the Box restaurant. (Noble—a pseudonym — would go on to become a prominent cryobiologist, and for professional reasons would keep his involvement in cryonics confidential.) For some reason somebody didn't get the cheese he had ordered with his hamburger. Beverly made a big fuss, snapping a volley of pictures and taking down the names of incredulous employees. The manager was called, and the matter quickly set right.

While living in California briefly, Beverly became aware that Curtis Henderson and others were wondering about the facilities of the Cryonics Society of California, headed by Robert Nelson. No one could gain access to CSC's facility, and Nelson's cryonics activities were a mystery. Somehow Beverly managed to gain Nelson's confidence, and then was able to inspect the facility at the Oakwood Memorial Park Cemetery in Chatsworth. What she found was not good — apparently the only maintenance being done at the time was of a woman in a box with dry ice. This would have been Mildred Harris, frozen in September 1970, and fits with other information I have about Nelson's ill-fated operation. (It suggests that he had stopped maintenance on the first capsule he placed in the vault, which contained four people, and had not yet placed in the vault the capsule that would eventually hold Mrs. Harris, along with two others.)

Beverly with Curtis Henderson, wearing the famous hat.

Beverly's activities and antics continued for three and half years, until the fateful November of 1973. She was back in Long Island, and had obtained a part-time job, ironically, with an ice cream truck (the company name was "Circus Man"). Meanwhile, she was trying to finish a sound track for her cryonics film. By this time, the CSNY patients were being stored in a West Babylon facility close to Sayville, with part of the building also rented to tenants. Beverly would often come there, drive her car inside, and stay overnight. Just a few feet away her father and another patient, Paul Hurst, rested in a tall, upright cylinder filled with liquid nitrogen. By then these were the only patients CSNY retained. Curtis had a policy that relatives owned the capsules of their patients. (Beverly was an exception; Mr. Hurst's son was the owner of the capsule her father occupied.) When relatives wanted to stop maintenance or otherwise remove a patient from the care of Cryo-Span, they generally took the capsule too.

On November 16th the police, on a tip from a tenant, found Beverly in her car, inside the Cryo-Span facility. The keys were in the ignition and the gas tank was empty. Her rosy but lifeless features pointed to death from carbon monoxide. She must have had the engine going in the closed space,

April 11th, 1973

Mr. [redacted].
[redacted]

Dear Mr. [redacted];

Unfortunately, we've temporarily suspended publication of "Immortality"; turning rather to radio and television to get our message accross.

Also, "Pictorial History" is out of print. We can, of course, send you CRYONICS REPORTS, 2-Year Hard-Bound Volume.

So all of our books balance, and to save further delay, we'll keep your check for $22.00 and enclose a CRYONICS SOCIETY OF NEW YORK check to you for the $12.00 to be refunded.

Now, put very simply, the services offered by CRYO-SPAN CORP. is -- or are -- total! A call to the above number, or the (914) numbers listed in our brochure immediately dispatches the proper personnel to collect the "patient", bring him to the perfusion center, carry out perfusion and initial cooldown, and ensure placement in what are considered the finest cryogenic capsules made today. (As of this writing only CRYO-SpAN uses them.) Naturally, CRYO-SPAN personnel keep constant watch on the liquid nitrogen levels in the capsules.

I don't know if you received a copy of the latest brochure; I'm enclosing one.

Please feel free to contact me with any further questions.

Yours sincerely,

Gillian Cummings

Gillian Cummings (Vice-President,
CRYONICS SOCIETY OF NEW YORK)

Gillian Cummings as CSNY Vice President.

somehow heedless of the danger from build-up of the car's exhaust. By law, all suspicious or unattended deaths required investigation, including an autopsy. Mike Darwin and Corey Noble rushed up from Georgia with perfusate chemicals, trying to save Beverly from the dissecting blade and carry out her suspension — but to no avail. Despite her involvement stretching back several years, Beverly had acquired neither funding nor written arrangements for her cryopreservation. In such situations, next of kin had legal standing; the day after the autopsy, her unfrozen remains were cremated.

There are mysteries we may never solve, such as what went through Beverly's mind during the last hours of her life. Though suicide seems a possibility, Mike Darwin considers it unthinkable for her, if for no other reason than Beverly's devotion to maintaining her father's suspension. Could alcohol or drug problems have contributed in some way? Curtis Henderson says her mother reported that Beverly was taking valium at the time. Beverly also "liked Japanese wine, but didn't drink much."

Unfortunately, this horror was not the end of the incident. Beverly's unusual death came to the attention of the New York State Department of Health, and when they learned about the frozen bodies, they took action that effectively destroyed CSNY and its remaining patients. A letter dated Jan. 29, 1974 ordered Curtis to dispose of "deceased persons" at the facility within 15 days, threatening a fine of $1,000 per day for non-compliance. Beverly's mother also made it clear she wasn't interested in continuing the suspension of her husband. Mr. Greenberg was reburied, and the other patient, Paul Hurst, was reclaimed by his son, thawed, and buried.

Ironically, the event that brought down one cryonics organization would help in the rise of another. Despite the ruling of the Health Department, Curtis remained willing (reluctantly) to freeze cryonics patients, though permanent storage was now out of the question. In February, 1974, "Frank Riley" died and, at his son's instigation, was placed on dry ice by Cryo-Span. Curtis looked around for an organization to take custody of him, and settled on Trans Time in the Bay Area of California. Trans Time hadn't been in existence long, however (about two years on paper, though they had only performed their first suspension that month), and their facilities were primitive. Curtis reports that Riley's son used his funds to build up the fledgling organization. It evidently worked to good effect: Riley's suspension continues to this day.

Perhaps this can offer us some consolation. Still, we are left wondering what Beverly might have accomplished, both in and outside cryonics, if she had lived. We have to be content with what she did manage to do, in her short time here. We can also take steps to forestall, as far as possible, the post-mortem disaster that overtook her: *Make our own wishes for cryopreservation clear, if we haven't done so, and get our arrangements in place.*

HOLLIS S. INGRAHAM, M.D.
COMMISSIONER

STATE OF NEW YORK
DEPARTMENT OF HEALTH
EXECUTIVE DIVISION
84 HOLLAND AVENUE
ALBANY, N. Y. 12208

OFFICE OF THE COUNSEL
DONALD A. MAC HARG
COUNSEL
AMBROSE P. DONOVAN, JR.
CHIEF ASSOCIATE COUNSEL

January 29, 1974

Cryo-Span Inc.
171-C Eads Street
West Babylon, New York

Attention: Mr. Curtis Henderson

Gentlemen:

This department has been informed that you are storing the remains of three deceased persons at 171-C Eads Street. The building located at that address is neither a cemetery nor a mausoleum and therefore we do not consider those bodies to be decently buried as required by section 4200 of the Public Health Law.

You are hereby directed to comply with that section by having the bodies in your possession cremated or placed in a cemetery or mausoleum within fifteen days from receipt of this letter. If you fail to obey this directive, we will be forced to institute more formal procedures.

You should note that violation of the Public Health Law is a misdemeanor. In addition the Commissioner of Health may assess a penalty of One Thousand Dollars a day for each day you fail to comply with section 4200.

Very truly yours,

David V Abel

DAVID V. ABEL
Senior Attorney
A.C. 518-474-3988

DVA/hdm

The New York Board of Health's decree.
(There were two not three "deceased persons" in the facility at the time. Were they trying to count Beverly too?)

Sources:

CSNY archives stored by Alcor Foundation.

Darwin, M. "Beverly," *The Cryonicist* #**13** 2 (Feb 1980).

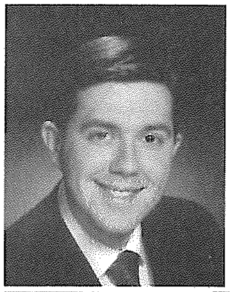
"Freeze-wait-reanimate" part 1 (1973 interview) *Cryonics* 19(1) 16 (1st Q 1998).

The Outlook **4**(12) 3 (Dec 1973).

Perry, M. "For the Record" *Cryonics* **13**(7) 6 (Jul 1992); **16**(3) 24 (3rd Q 1995).

Personal communications from Curtis Henderson, Hugh Hixon, Corey Noble, Art Quaife.

Photo Credits: (1-2): "The Ice Men Cometh," a film by Beverly Greenberg; (2-3) *The Outlook* Aug. 1973; (4-5) CSNY archives at Alcor Foundation.



Miscellaneous Notes

by Stephen J. Van Sickle

Recovery of "Dead" Neurons

Researchers at the Netherlands Institute for brain research have reported at least partial recovery of neurons provided to them 3 to 6 hours *post mortem* by the Netherlands Brain Bank. The tissue samples were pre-incubated at low temperature for 2-3 hours, then bathed in an oxygenated cerebrospinal fluid at room temperature for between 6 and 18 hours. By injection of a tracer that was only taken up and transported by "living neurons," the researchers were able to demonstrate resumed cellular metabolism. The bad news is that, while cryonics patients with long ischemic delays may be suffering less damage than we thought, we still are unable to perfuse them with cryoprotectants, resulting in severe freezing damage. (*The Lancet*, Feb 14, 1998)

Will New Force Make the Universe Last Forever?

Astrophysicists are beginning to suspect that there exists another force in the universe, counteracting gravity at large scales. At a recent meeting of astrophysicists in Marina Del Ray, California, Alexei Filippenkoo of the University of California-Berkeley announced that certain supernova were averaging 10 to 15 percent further away than suspected. The leading explanation as to why the universe is larger that it "should" be is the existence of what Albert Einstein called the "cosmological constant," a force opposed to gravity that he proposed to make his theories fit a static universe. The discovery by Edwin Hubble that the universe is expanding eliminated the need, but the new observations are reviving it. If true, this means that the universe will expand forever, and not collapse back into itself in a "Big Crunch." The down side is that it will get a little chilly in a few trillion years. (*Science*, February 27, 1998)

DNA to Build Nanowires

Researchers at Technion-Israel Institute of Technology in Illinois are reporting a new method of using DNA to construct electronic circuits. By "stretching" the DNA between two points, they are able to use it as a template for the growth of 100 nanometer-wide silver wire. While still at a primitive stage, this work points towards the possibility of using DNA and other biological materials as a sort of scaffolding for non-biological nanodevices. (*Nature*, February 19, 1998)

Swiss Referendum May Forbid Genetic Engineering

Switzerland will hold a national referendum in late 1998 on a constitutional provision to prohibit gene manipulation, use and patenting of genetically modified animals, and cultivating engineered plants. Supported by animal rights activists, it is, naturally, opposed by the extremely large Swiss pharmaceutical industry. While there is little evidence of widepread support, this may be a portent of things to come. (*Nature*, January 22, 1998).

Genomes of Pathogens to be Made Public

Determining the complete DNA sequence of a disease-causing organism is a long and expensive process, so naturally companies working on treatments tend to keep such information secret. Unfortunately, this has resulted in much duplication of effort. The Wellcome Trust, the world's largest medical research charity, intends to change this by providing over 7 million English pounds to sequence the genome of several microorganisms that cause disease. Work has already begun on *Campylobactor jejuni*, which causes food poisoning. This, combined with last year's release by The Institute for Genomic Research of its sequences, will do much to open up and accelerate research in these areas. (*New Scientist*, February 14, 1998)

Controversy Surrounding Xenotransplantation

Xenotransplanation is the process of transplanting organs between animals of different species. Advances in the genetic engineering of donor animals may well lead to the elimination of long waits for cadaver organs for humans in need of transplants. Despite the obvious advantages, the British journal *Nature* has called for a moratorium on Xenotransplantation, even after the U.S. Food and Drug Administration, the Centers for Disease Control and Prevention, and the National Institutes of Health released plans for strict guidelines. Fear of infectious disease jumping from animals to humans and causing a pandemic (much as influenza does with pigs) is at the root of the concern. (*Science*, January 30, 1998 and *Nature*, January 22, 1998).

Truth Machine?

Before Alcor member James Halperin wrote his novel about cryonics, he wrote a novel about "perfect" lie detectors called "Truth Machines" and their huge impact on society. While I have severe doubts about

Continued on page 47

The Physics of Immortality

by Frank J. Tipler, Doubleday 1994

Reviewed by Thomas Donaldson, PhD

Cryonicists have mentioned "The Physics of Immortality" in other venues, and now three years have passed since its publication. Still, I thought this book merited a review, since it brings up several issues of interest to the cryonics community.

First of all, Tipler's theory, when stripped to its foundations, doesn't show any *logical* flaws. (It does have one serious flaw that isn't fundamental, but I shall discuss that later.) However, the absence of logical flaws means only that this theory is consistent, *not* correct.

Tipler explains one particular relativistic cosmology, which he puts forward as that of the real world. In this cosmology, the universe is closed, and will ultimately contract to a single point. Nevertheless, he asserts that life in our universe can have some effect on this contraction such that, by one measure of time, the universe will continue forever. His theory has many other details (including the suggestion that life would have to turn itself into complex particle waves along the way), but I won't go into them here.

Some cosmologists seem to desire a closed universe, in which the Big Bang's expansion is eventually followed by a collapse into the Big Crunch. For no reason I can personally understand, they cannot accept a universe without enough matter to cause such a terminal collapse. Certainly not all cosmologists feel this way (for instance, Freeman Dyson said that he considered a finite universe too constricting) but the closed universe remains a popular theory.

The very first empirical problem with Tipler's theory comes from just that issue. With the Hubble telescope and other means of looking far away and deep into the past, the probability of a closed universe seems progressively smaller. In the December, 19 1997 issue of *Science*, one commentator even voiced the opinion that this question would be finally settled by next year, and probably not settled as proponents of a closed universe wish. Tipler points out in his book that his theory can be empirically tested, an advantage it holds over all of the other theologies humankind has devised. From this we conclude that most probably his theory simply *wrong*, consistent or not.

Moreover, I myself think there is a later flaw: basically Tipler proposes at that the very end of the universe (which he calls the "Omega Point") everyone will be resurrected, and since the Universe will continue forever (in the time scale used by the creature(s) alive then) we will live forever. However, since this Omega Point will likely be so far in advance of us that, by its standards, we are only specks of unconscious dust, why would anyone bother to resurrect us? Tipler argues in favor of our resurrection by applying principles from the Prisoner's Dilemma problem from game theory. Basically, individuals or groups who cannot communicate with each other will find, through repeated play of a Prisoner's Dilemma-style game, that cooperation is in their best self-interest. My problem with such an argument comes directly from the gross inequality of the players in this case.

Tipler's theory has other weaknesses, too. For the sake of argument only, let's suppose that his cosmology is correct. There is still no reason to believe that all life will ever unite into one single entity, the "Omega," which Tipler labels as "God." Furthermore, even if that grand unification were ever to occur, how exactly would the Omega creature merit the status of a deity? In Christian and Muslim theology, "God" is to be worshipped, but no amount of knowledge and power *automatically* compels our worship. If that knowledge and power cared enough, it could certainly force our adoration, but that's hardly a religious message; we see minor tyrants doing that to their subordinates all around the world. If the Omega creature were to command us (as the relatively insignficant specks of dust that we are) to worship it, this would suggest a major character flaw, if not rank insanity!

Why *do* many cosmologists want a closed universe? Perhaps because they fear infinities and the death associated with them. Since Tipler is among these infinity-hating cosmologists, his book says something about the ideas of many others as well as his own. Before you can take action that may increase your lifespan, you must first settle your mind about infinity and death. Tipler and his friends refuse to deal with these issues, and so cannot save themselves. More than anything else, "The Physics of Immortality" may offer us some clues as to how these very intelligent, learned individuals rationalize their way around cryonics and immortalism.

Donaldson Perspective, Cont. from page 40

must show how to work it out from the state of the frozen animal's brain. Even so, only solving the problem theoretically would be cheating; they must first determine the exact damage that *really occurs*, then specify the biochemicals or other concrete items which provide clues to solving the problem

Even if Prometheus succeeds completely, such experiments as the one above could prove quite valuable, because they would show us how to proceed towards repair of *present* suspension patients. More than that, even if we develop fully perfected suspended animation, some unfortunates will always fall through the cracks, and need preservation by less than perfect methods. We've seen that happen already, with Jerry Leaf and Luna Wilson among others, and have no reason to believe it will not happen again. It may even happen to *you*.

Neither God nor Nanotechnology will save us. We must join together to save ourselves, and support research to that end, *now*. Doing so will take work of many kinds, as some cryonicists have already learned and all cryonicists should know.

TechNews, Cont. from page 45

such a machine being possible, the U.S. National Security Agency appears to have been trying, and now you can buy the technology for yourself. NSA's Technology Transfer Program is offering to license "computerized soft-decision-making [hardware] from multiple-sensor inputs, developed to rapidly evaluate polygraph (lie detector) test results." While such a system has a wide variety of uses, it was developed by Johns Hopkins University's Applied Physics Laboratory as the Polygraph Assisted Scoring System. (*Aviation Week and Space Technology*, February 23, 1998)

Much Ado About Telomeres

There has recently been an enormous amount of heat, and not much light, shed on telomerase, the latest magic bullet against aging. Next time, I'll detail what we *really* know, and why telomerase may or may not live up to its hype.

As usual, any comments, suggestions, or submissions can be e-mailed to me at sjvan@csd.uwm.edu, or mailed to Brian Shock at Alcor.

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Alcor business meetings are held on the first Sunday of every other month: January, March, May, July, September, and November. (The July and September meetings are on the second Sunday.) Guests are welcome. Meetings start at 1 PM. For more information, contact Alcor at:

ALCOR
7895 East Acoma Dr., #110
Scottsdale, AZ 85260
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Directions: Take the 10 to the 17 Northbound, exit Thunderbird Road heading East. Thunderbird will turn into Cactus St, stay on Cactus until you turn left on Tatum, and then right on Thunderbird (which will turn into Redfield in about 3 miles), then (after a quarter mile on Redfield) left on 76th Place. 76th Place turns into Acoma Drive; Alcor is on the right at 7895 Acoma Dr., Suite 110.

Bay Area

Alcor Northern California meetings are held the second Sunday of each month at 4:00 PM, followed by a potluck supper and socializing. All members and guests are welcome to attend. For meeting information, call Alcor at 1-602-922-9013

Boston

There is a cryonics discussion group in the Boston area meeting on the second Sunday each month. Further information may be obtained by contacting Tony Reno at (508) 433-5574 (home), (617) 345-2625 (work), 90 Harbor St., Pepperell, MA 01463, or reno@tfn.com (email). Information can also be obtained from David Greenstein at (508) 879-3234 or (617) 323-3338 or 71774.741@compuserve.com (email).

District of Columbia

Life Extension Society, Inc. is a cryonics and life extension group with members from Washington, D.C., Virginia, and Maryland. Meetings are held monthly. Call Mark Mugler at (703) 534-7277 (home), or write him at 990 N. Powhatan St.; Arlington, VA 22205.

Florida

Austin and Glen Tupler, two Alcor members living in Florida, are interested in revitalizing Alcor's local group in their state. For more information about local meetings and organization, please contact them at 954-583-0801.

Los Angeles Area

For more information about local meetings in this area, call Alcor Director Michael Riskin at (714) 879-3994.

Indiana

Alcor's former president, Steve Bridge, has returned to his home state and plans on organizing local meetings. If you would live in the Midwest U.S. and would like to meet other cryonicists in your area, call Steve at 317-375-0968.

San Diego

Alcor's Medical Director, Dr. Thomas Munson, lives in the San Diego area and wishes to get a local Alcor group started. If you would like to get in touch with Dr. Munson, call 619-454-2321.

England

There is an Alcor chapter in England, with a full suspension and laboratory facility south of London. Its members are working to build an emergency response, transport, and suspension capability.Meetings are held on the second Sunday of the month at the Alcor UK facility, and may include classes and tours. The meeting commences at 11:00 A.M., and ends late afternoon. The address of the facility is: 18 Potts Marsh Industrial Estate, Westham, Pevensey, E. Sussex BN24 5NA Tel: (01323) 460 257

If you're coming to an Alcor UK meeting, phone ahead; meetings are sometimes rescheduled. Call Garret Smyth on (0181)789 1045 or send email: Garret@TheOffice.net. You may also contact Mike Price on (0181) 845 0203, or Alan Sinclair on (01273) 612 071.

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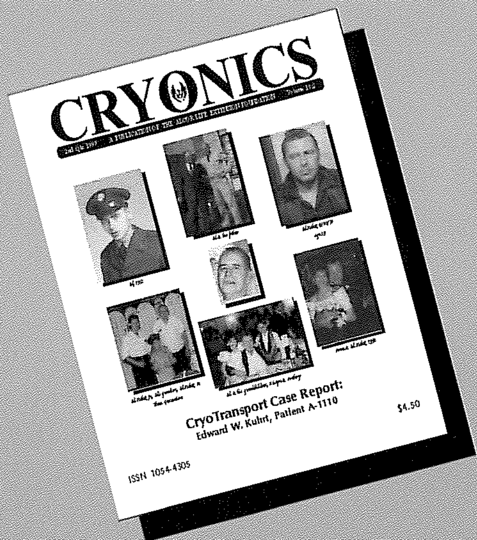

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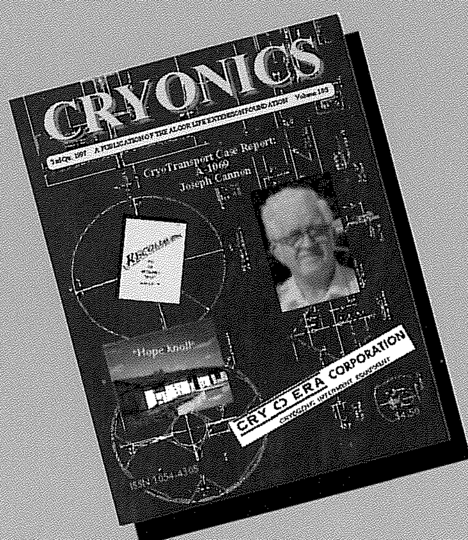

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