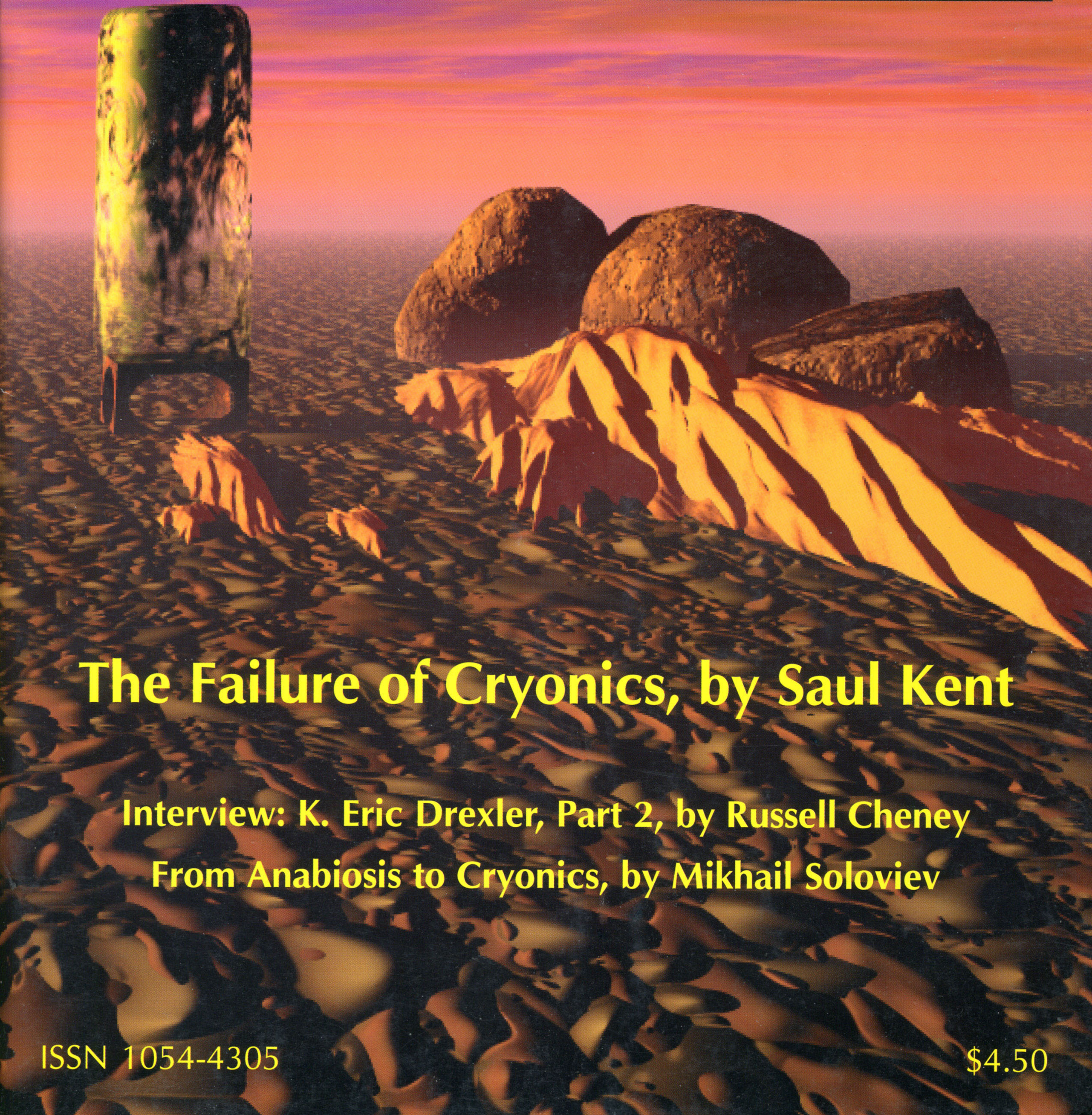
CRYONICS

3rd Qtr. 1998 A PUBLICATION OF THE ALCOR LIFE EXTENSION FOUNDATION Volume 19:3



The Failure of Cryonics, by Saul Kent

Interview: K. Eric Drexler, Part 2, by Russell Cheney

From Anabiosis to Cryonics, by Mikhail Soloviev

ISSN 1054-4305

$4.50

Letters to the Editor

As the *Hitchhiker's Guide to the Galaxy* suggests, "***Don't Panic***." Despite the title of this issue's feature story, "The Failure of Cryonics," I don't believe that cryonics *has* failed and I don't believe that it *will* fail.

Why am I printing this article then? Because I *do* believe that the cryonics community holds valid opinions besides my own. As I promised from my first issue, *Cryonics* is aimed at all cryonicists, not just at Alcor's directors, members, or magazine editors. Almost by definition, cryonicists are independent thinkers; if they are to make the most of this trait, they need as much information as possible.

I'm pleased to note that in the last few months the readers of *Cryonics* have conveyed an increasing number of their "independent thoughts" to me. While I haven't yet received the rich cross-section of ideas that I might want, I *have* received more letters than I can publish in existing magazine space. If you sent me something but don't find it in this issue, please forgive me; sometimes I will print a letter just because it fills the right number of column-inches.

To the Editor:

Your readers may have noticed certain sharp disagreements in *Cryonics* (2nd Qtr. 1998).

In that issue, Author 1 calls for further study of how freezing damage could be repaired by nanomedical technologies. He notes that this effort "...need not actually solve [the problem of inferring neural connectivity] in practice," which would be beyond current technological abilities, and asks instead for scenarios that start with "the damage that really occurs, then specify the biochemicals or other concrete items" enabling the required inference.

Author 2, in contrast, argues that "only solving the problem theoretically would be cheating," and asks not for specifications, but for "experiments" in this area. He criticizes those who "believe we need take no special effort to improve our cryopreservation methods" in order to achieve suspension reversible with future technologies, and ridicules this and associated technical views as being essentially religious.

Undaunted by this attack, Author 1 notes the view "that nanotechnology will provide, someday, a solution even for those frozen with our current primitive methods," and concurs: "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."

In ridiculing assorted ideas regarding the future, Author 2 writes "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..." Perhaps some actual, non-straw person has advanced this notion, or perhaps the nanocritic, Author 2, is merely attacking some imaginary nano-crazy, Author 3, in an attempt to discredit the nano-optimist, Author 1.

I wish the best of luck to these warring authors in sorting out their conflicts, and hope that Author 1 ultimately wins the war of ideas — he fights fair, and I agree with him. Oddly, both authors share one article and byline: Thomas Donaldson.

—K. Eric Drexler

Thomas Donaldson replies:

It seems to me that my statements are quoted out of context, and in many cases context is important.

First of all, there is an issue of what "nanotechnology" is to include. If nanotechnology means the manipulation of matter on a molecular scale, chemists have now done that for over a century, and their abilities to do so have increased a great deal. Biochemists have come on the scene and proceeded to manipulate those chemicals which play a major role in our own chemistry — and in many ways, since that chemistry is quite complex, have moved very far. For instance, it's commonplace to use modified viruses as tools, and our use of these tools has increased in sophistication.

The day will come when we will design bacteria, also, and use them as tools too. And building on that, we will design entire creatures, again to manipulate the biochemicals of human beings.

There are some who want to limit nanotechnology to only particular methods. They argue that those methods will give them great power over matter; at present their arguments are theoretical alone, while various other scientists have proceeded to get their hands dirty and produce something that will actually work and do something. Certainly this does not save the world, but a relatively simple application, such as a modified virus, is still a good tool. And while I am optimistic that our understanding and control of the world will increase to a level at which we'll know how to repair damage to cryonics patients, I doubt that any single research direction will allow us to do that. After all, biotechnologists have run into lots of unexpected problems even while modifying viruses; I doubt that we can deal with such problems purely theoretically, no matter what our idea of *nanotechnology may be.*

Second, I have noted a kind of argument which brings in nanotechnology (the unspecified kind) to claim that repair will become possible, but never examines what is now known about memory or the workings of our brain. It is one thing to be able to analyze the brain of someone who is healthy and in full working condition, and then (say) be able to duplicate it (if that is what you want), and quite another thing to examine the brain of someone who was poorly frozen 10 years ago, and claim that nanotechnology will tell us just how to repair that brain. The first may very well be possible; the second requires some detailed confrontation with the condition of that brain and *similarly detailed knowledge of how brains and memory work. Merely bringing nanotechnology into the argument tells us nothing about the condition of that patient's brain. We have no logical reason to believe that he or she is repairable unless we also use ideas from neuroscience. For all we know, this patient might have been totally destroyed.*

I describe this argument not because I believe that many of our patients cannot be repaired, but because it commits a logical error, and I do not believe that fallacious arguments will do anything to help cryonics.

Thirdly, as many cryonicists (I hope) have observed, human beings and other animals have abilities for self-repair which even yet we do not understand, but which surgeons have taken advantage of for centuries. (I note that even the most modern computers lack such abilities, while any rat or chicken can do so.) Current work in cryonics on vitrification and improved methods of suspension is also trying to find a method which will make use of these self-repair capabilities. If we can do so, then we will be able to repair patients frozen by such methods without *all the need to understand neuroscience, biochemistry, etc etc. Such methods, of course, will do nothing for those already frozen. I am very optimistic that we can find such methods, but they say nothing about what we might do with present and past patients. And we do have a responsibility to them, however long it takes. I do not see any contradiction between this belief and my optimism that, with sufficient knowledge of "nanotechnology"* and *how brains work, we will someday be able to repair many present patients.*

Sirs:

In a recent issue of *Cryonics*, Mr. Thomas Donaldson gave a good book a bad review. The book was *The Physics Of Immortality* by Professor Frank Tipler, and Mr. Donaldon's discomforts with it — well, seemed to me not only to have missed the point, but to have given poor expression to Mr. Tipler's views. In essence, Tipler's argument is that, at some point in the future, a computing entity will be created (some penultimate Windows upgrade no doubt) with such capacity that it will be able not only to compute the molecular pattern of every human being that ever existed (or ever could), but also that of all possible beings, all possible events, and all possible universes. This computer will thus know everything that it is possible to know, presumably including how to do whatever it might wish to do. By definition, then, it would be 'all-knowing,' and hence 'all-powerful' as well. (Hence the 'physics' behind Mr. Tipler's immortality — he believes that some 80 billion years from now the Big Crunch will squash the current universe into a single point, an event releasing so much energy his projected supercomputer will have oomph to spare for whipping up such trivial miracles as a new Heaven and Earth). The least of its abilities would be the capacity to resurrect us all into a VR paradise beyond imagining with the merest wave of a sub-program. And Mr. Tipler feels it will do just that.

How come? Tipler's argument (mutual self-interest!) is of course lamentably shallow. A microbe and Michaelangelo both have a vested interest in avoiding personal obliteration. But would they work together marketing cryonics brochures? I doubt it. Mr. Donaldson rightly portrays that as a poor argument, and wrongly portrays it as the *only* argument. A weak argument for a position doesn't invalidate that position. The world is round, even if I assert that it got that way because Santa's Elves rounded off the corners with sandpaper. I myself would argue that an all-knowing entity would in fact be loving and merciful simply because knowledge implies empathy: to know and not to experience is not to know. We step on ants because we do not know what it's like to be crushed under a shoe fifty times our height; we eat hamburgers because we do not know what it's like to be pole-axed, chopped apart, and fed into a meat grinder. If we really experienced such surreal obliteration — and if (like our projected supercomputer) we could easily replace that agony with paradisial joy — well, we would. I certainly would. After all, if punching you in the face breaks my nose, I won't punch you. If feeding you sweets and cake delights my palate, I'll feed you sweets and cake. If we must fully experience another's experiences, we'd rather have them experience beatific ecstasy, rather than the loneliness, brevity, and horror that is all too often the human condition. The alternative is masochism, and that is not a quality you're likely to find in a God, much less in a supercomputer to end all supercomputers.

Now such a supercomputer is not coming off the assembly line at Intel by next Thursday. It is way off. But the relevant part of Tipler's idea is a lot nearer. If, as Eric Drexler asserts, we shall relatively shortly be able to pack ten thousand Cray supercomputers into a sugar cube, and indeed use nano-assemblers to convert whole planets into arrays of such sugar cubes, then mapping out the few paltry sextillion molecules making up an individual's brain should be no big deal at all. Computation will reach the point where resurrection really is technologically possible, and quite probably likely (which is what Tipler is saying). That being the case, why does Mr. Donaldson dump on Tipler so? Tipler is not only "wrong," asserts Mr. Donaldson, without enlightening us as to why; Tipler, he writes, is "among those infinity-hating cosmologists," who perhaps "fear infinities and the death associated with them," they "refuse to deal with these issues," "rationalize their way around cryonics and immortalism," "and so cannot save themselves."

I can't help but feel that Mr. Donaldson is uncomfortable because the immortality projected by Mr. Tipler is not *our* immortality — cryonic immortality. 'We' are the resurrection and the life, and all other churches are merest hogwash, Satan's helpers. Tipler's ideas are a threat. After all, he seems to be saying, if we're all going to be resurrected anyway, why not wait till a loving, merciful, omnipotent entity turns up to do it right? Better that, surely, than possibly rising up from a miasma of liquid nitrogen eighty years hence, a brain-damaged temporal immigrant stranded in some Orwellian hell. On top of this, Tipler even has the temerity to to use the 'G' word as a label for this all-knowing, all-powerful, loving, merciful Supreme Being. If he'd called him Al or Fred, no one would be much excited. But he calls him 'God,' and this makes the tacit and shallow atheism abounding in the hard sciences (and the flabbier ones like cryonics) nervous and edgy. 'God,' indeed; throw the bum out. This just seems to me to be off the mark. Tipler's views are complementary, not competitive; I would even go so far as to say that they're a necessary complement to a serious cryonics position.

The fact is, one of the harshest consequences of really accepting cryonics is suddenly grasping that virtually everyone we see, meet, hear of, touch, recall, know, is going to irretrievably die. The Holocaust is a grain of sand compared to the vistas of extermination that meet our eyes. Every human being from 1967 to today might have survived in suspension: perhaps fifty will. Of the five billion human beings alive today, a few hundred alone — a few hundred — may live on. Every time you enter a restaurant, or a concert, or a shopping mall, or traffic jam, you think: all these people around me are going to die, to die finally and irrevocably — everyone: Garbo and Elvis, Reagan and Gorbachev, Laurel and Hardy, Janis and Jimi, Sakharov and Sinatra, our parents, our brothers, our sisters, our children, our friends, our enemies, — everyone, irrevocably obliterated. To believe that is spiritually toxic. It is insupportable. Tipler offers us a way to bear it. He offers us the same hope that cryonics gives: plausible resurrection. But resurrection for us all, and resurrection in the far future rather than the near. Why should these hopes be at odds with each other? They support one another, or so it seems to me.

The Omega Point — Mr. Tipler's God — is not going to come into being without our efforts; and we are not going to make much of an effort if we're dead. The moral imperative of cryonics is very much to the point: to do good, you first have to live. Mr. Tipler's notion of general rather than merely individual resurrection is not simply a noble prospect. It is a noble effort. And one can't participate in that noble effort, or any noble effort, if one is dead. Which is one of the most profound arguments for cryonics that I know.

Why shut the door on Tipler or on religion in general for making this argument? Eightypeople are in cryonic suspension; four billion are said to believe in God or belong to some form of organized religion. Perhaps one or two of them know something we don't. Tipler has given religious belief a depth, logic, and plausibility that it may in fact actually have. He has asked a startling question, a question so startling no one has quite grasped all the implications: not, 'are religions like Christianity true?' but 'are religions like Christianity technologically possible?' If they are — as Tipler seems to imply — then like all technological possibilities they can be made true, and religion ceases to be a shouting match of unprovable assertions and becomes instead a battleground of conflicting technologies and historical will. And that is something we ought to think about deeply, not cavalierly dismiss, as Mr. Donaldson dismisses the striking, significant, and profound book under review.

-- David Pascal

Thomas Donaldson replies:

In my review, I pointed out that Tipler listed several conditions of our universe which must be satisfied for his ideas to work. As I understand current cosmology, those conditions are not satisfied. That is sufficient refutation. Moreover, though in Cryonics and elsewhere I discuss biology and biotechnology a lot, I feel qualified to make that judgement because I am a mathematician by training.

As for how I feel about methods of revival which don't use cryonics, I am not conscious of any special problems. I will add, though, that those methods suggested so far do not seem plausible to me; to discuss why would take far more space than available. Of course, given enough time, we will probably use a technology different from freezing to store people whom we did not know how to fix at the time -- but we must deal with the present if we ever expect to deal with the future.

Dear *Cryonics*:

Charles Platt wrote an excellent article, "Of Angst and Activism," in volume 19:2 of *Cryonics*. The article could be a standard statement of a number of issues, concerns, real-life experiences, and dynamics of the cryonics movement. The article is a clear, sensitive, and organized statement of years of discovery and learning.

On the nightly news, we hear of medical authorities transplanting heads, or of lowering the temperature of certain accident victims to improve their survival chances. Every few months, and sometimes every other day, we are told of new medical miracles, advances, and promises, which would have been thought impossible just a few years back. In the media of books, we read James Halperin's recent novel, about cryonics, *The First Immortal*. There are plans to turn the book into a TV miniseries.

Clearly cryonics is entering a new technological and social environment, and like every movement that enters a new environment, cryonics will be offered opportunities as well as threats and challenges. Some opportunities might be new technologies that offer cryopreservation techniques quite

Continued on page 28

Alcor's Third Annual Cryonics Conference

commentary by Brian Shock

If you're a regular reader of *Cryonics*, you probably remember a year's worth of ads for "Alcor's Third Annual Cryonics Conference." If you didn't have the time or money to see this gathering for yourself, you may wonder about the results.

The merest handful of CryoTransport Class participants. Left to right: Hara Ra, Andrea van de Loo, David Hayes, Monica Stephenson, Steve Jackson, Ken Stone. (Photo by Mary Margaret Glennie.)

In a word, the conference was splendid, particularly for those Alcor members who attended the preceding week's CryoTransport Technician Class and were compensated for their conference membership. The 17 class members not only helped to strengthen Alcor throughout the U.S. (as well as the U.K., thanks to Jack St. Clair), they also had a chance to become much better acquainted with Alcor's facility, staff, and day-to-day operations.

The conference proper began on Saturday, April 4th, at the large, well-appointed Holiday Inn Select near Phoenix Sky Harbor Airport. Among the day's highlights:

- Mike Darwin — with the help of a friendly canine test subject — captivated the audience with his work on the recovery of animals from long-term ischemia.
- Brian Wowk brought us up to date on Twenty-first Century Medicine's exciting research toward improving suspension procedures.
- Fred and Linda Chamberlain discussed their new wash-out suitcase for cryonics field procedures [*as detailed in "Alcor's Flashcool Project," Cryonics 2nd Qtr '98 — ed.*], and suggested possible future improvements for Alcor's CryoTransport Team.

That evening, after the banquet (my favorite part of the festivities), a panel of notables that included Marvin Minsky, Ralph Merkle, Max More, and Jim Halperin discussed "What's in It for Me" regarding cryonics and life extension. True to form, Dr. Minsky challenged the audience's intellect and assumptions with his incisive arguments.

The next day, Sunday, April 5th, was an especially busy one for me. An Alcor Facility Tour had originally been scheduled to overlap with a panel about "Identity and Reanimation," featuring Jim Halperin, Max More, and Marvin Minsky. In order to avoid missing this event, conference attendees arranged two early-morning tour facility visits. Imagine my nervousness upon finding such crybiology experts as Brian Wowk and Greg Fahy in my tour groups!

Even so, the stand-out event for that day was a speech by Jim Halperin, author of *The Truth Machine* and *The First Immortal*. Afterward, Jim graciously consented to sign copies of *The First Immortal* brought by dozens of attendees. While his hand was still limber, we even convinced him to sign the fifty-plus copies of this novel that Alcor was offering for sale.

As exhausted as this conference left me, I couldn't argue with the results. The possibility of cooperation between cryonics groups, hinted at during Alcor's 1997 conference, began to seem more and more plausible. Everyone had a chance to meet plenty of old and new friends within the cryonics community. And if a conference attendee wasn't careful, he or she probably *learned* something from the experience.

A panel on Cryonics Service Companies. Left to right: Steve Harris, Bruce Cohen, Brian Wowk, Fred Chamberlain, Linda Chamberlain, Robert Ettinger. (Photo by Mary Margaret Glennie.)

Alcor owes many thanks to its conference guests, and special thanks to such volunteers as Mary Margaret Glennie, Judy Muhlestein, and Lisa Shock.

Highlights of James Halperin's Talk at Alcor's Cryonics Conference (April 5, 1998)

by Steve Jackson

James L. Halperin's novel* The First Immortal *is spreading like wildfire among cryonicists. It offers a compelling view — hopeful without being sugar-coated — of a future that is worth reaching, and a way to get there alive. This book is being hailed as the best possible introduction to the movement for a relative, an interested potential cryonicist, or just someone curious about the idea.

James Halperin was a featured speaker at this year's Alcor conference. His talk was entitled "Get Ready for a Century of Ever-Accelerating Change" ... but, as he put it, "it's really about getting *other* people ready."

He opened by discussing valuable innovations that had "down sides" to some people, most typically those who lose their jobs to technological improvements. People tend to notice the tragedies felt by a few rather than the general benefits to the many. The next century will bring more and more such innovations; almost everything that helps "mankind" will harm some individuals. Predicting and avoiding such harm to ourselves, and predicting and minimizing "collateral" harm that our innovations do to others, clearly becomes the great challenge of the 21st century.

Halperin pointed out that on the average, over the past centuries, life has been improving in an almost steady progression, due mainly to science and philosophy. And the rate of progress is itself increasing. Where will this lead us? There are several possibilities:

- *The "Utopian Singularity"* — when high-speed artificial-intelligence machines become so smart that they take over their own development, accelerating the rate of progress until "five minutes later we don't recognize anything any more." (1)
- *Global conflagration*, perhaps even brought about by a singularity gone awry, if the AIs decide they don't need us any more. Or nuclear war, or a "gray goo" nanotech disaster. (2)
- *Muddling through.* We might simply stagger through adversity into prosperity and immortality, four steps forward and three steps back. This is the scenario Halperin depicts in *The First Immortal*. As he says, "I can't prepare for a conflagration, and I can't prepare for a singularity." But he can — we all can — prepare for a future in which mankind somehow manages to survive without mutating into something completely unrecognizable.

Halperin at the mike (Photo by Mary Margaret Glennie.)

Halperin's own story is one of both careful planning and "muddling through." He had been an entrepreneur since his college days, dividing his time between a number of different businesses. Eventually he concentrated his energy in the numismatic business, selling rare coins to investors. His company was successful, but only one among hundreds. Then, in 1975, he invested much of his net worth in an IBM mainframe computer, and spent a great deal of time in deciding how to use it to improve his company's efficiency. It was a good decision. By 1979, his company had become the largest player in the booming worldwide numismatic industry. At one time, Halperin turned down a $20 million buyout offer.

Eventually the industry stabilized. Other companies copied Halperin's innovations; prices came down, efficiencies increased, and the coin business became more predictable for everyone ... but less profitable for the leaders. He realized that it had become boring. He looked around for other things to do, and decided to try his hand at writing.

His first novel, *The Truth Machine*, grew out of the idea that society might benefit from an infallible lie detector. This led him to study what we might really expect from future society and technology. He surveyed "dozens and dozens" of people, asking what they might expect and when, and developed a chronology which grew into the background events for *The Truth Machine*.

He showed the novel to friends, listened to their feedback, studied, and rewrote *The Truth Machine* ... over and over ... 23 rewrites in all. It was during that period that he first encountered cryonics, in an article in *Spin* Magazine.

He couldn't get any agents to represent him; they read the first few pages of his manuscript, saw the prose style was (as he put it) "workmanlike at best," and never read the story. But after he self-published *The Truth Machine* and put a copy on the net, Ballantine saw a copy and liked it ... and published it ... and has so far sold about 70,000 copies not counting foreign sales.

Halperin had expected that writing one book would be enough. But he found himself wanting to write more, and to write better ... and to write about cryonics. He added a cryonics chapter to a late draft of *The Truth Machine*. And his second book was entirely about cryonics, and about a human race transformed by the defeat of death.

The plot of *The First Immortal* grew out of a short story that he wrote for a night course in fiction writing, in which Dr. Benjamin Franklin Smith (3) attends the funeral of a friend who had saved his life during World War II. TFI is set in the same historical universe as *The Truth Machine*, but instead of cryonics being a background element, it is central to the story. It tells the story of a determined man who manages to bring not only himself, but his family, to a remarkable future ... through cryonics.

"There is nothing altruistic at all in my decision to write *The First Immortal* the way I did," says Halperin. He describes it as his LifePact statement, an act of long-term self interest. "If the 'muddle-through' scenario occurs, my book will be recognized as somewhat prophetic. If not, it won't matter." And, of course, if the book succeeds and attracts others to cryonics, it will increase the chance that he, and his loved ones, will survive to see the future he describes.

"We need to work on legislation. We need to start lobbying." According to Halperin, the most important thing is that the laws concerning cryonics be *predictable*, so everyone involved knows what to expect; legal battles (as vividly depicted in *The First Immortal*) drain both time and energy. In particular, cryonicists need ways to avert challenges to suspension.

"One thing I'd like to see is a more sensible cost structure for cryonics." Halperin is now seriously looking at the creation of a legal/trust company which would invest for cryonicists and defend their rights — and if it gets off the ground, he will be looking for cryonics-friendly staff ... specifically, attorneys and experienced managers.

"If my muddle-through scenario occurs, we find ourselves in a tiny window of history, when cryonics is both available and needed ... and could be profitable. We need ideas ... please e-mail me ... for your own selfish best interests as well as mine."(4)

Footnotes:

(1) This concept has been discussed at some length by Robert Anton Wilson. For another fictional view of the "Singularity," see *Marooned in Realtime* by Vernor Vinge.

(2) "Gray goo" is the archetypal nanotech disaster scenario, in which rogue assemblers turn *everything*, or at least the whole biosphere, into copies of themselves; see Eric Drexler's *Engines of Creation*.

(3) Benjamin Franklin thought about far more than electricity, proverbs, politics and the ladies of Paris. He once expressed the wistful wish that he could be preserved in a cask of Madeira and revived to see a future United States. One might expect that he would have become a cryonicist had he lived today.

(4) Halperin can be reached at jim@heritagecoin.com.

The Failure of Cryonics

by Saul Kent

The following article is taken from CryoNet postings #9556-9557, Tuesday, April 28, 1998, and is published at the request of the author. --ed

In 1964, the cryonics movement was launched by Bob Ettinger's book, *The Prospect Of Immortality*. I was inspired by Bob's book to become a cryonics activist To me cryonics was far more than a chance of survival in the face of death. In 1964, I saw death as being far in the future. I was 25 years old and in excellent health. The first patient had yet to be frozen, and I knew that freezing would cause severe damage to the body.

My primary motive in becoming a cryonics activist was to save my life in the *future*, when I knew it would need saving. I knew that my youth and health were short-lived; that I was programmed to grow old, suffer and die; and that major scientific advances would have to occur to change all that.

I saw cryonics as a dynamic, dramatic force to drive the pace of research forward. I saw it as a vehicle for *me* to play a role in driving the pace of research forward. I assumed that anyone who wanted to improve their chances of survival through cryonics would be *strongly* interested in research. I realized that few people would have the will or aptitude to become researchers themselves, but I expected that everyone who opted for cryonics could contribute to research in other ways. They could help to fund research themselves. They could urge the government, corporations, and other individuals to fund research. And, if they couldn't afford to fund research in 1964, they could dedicate themselves to making money for the purpose of funding and promoting research in the future.

In 1964, I was thrilled to learn that there were groups of mainstream scientists conducting organ cryopreservation research. I assumed that cryonicists would be a major force in helping these and other mainstream researchers advance their research, and that, as the cryonics organizations grew, we would begin to conduct research ourselves. As I saw it at the time, the combination of mainstream research, and the fierce dedication of cryonicists in promoting and funding bold, pathbreaking new research would lead to perfected suspended animation before the end of the 20th century.

With these assumptions in place, I was *highly* motivated to help the fledgling cryonics movement grow as rapidly as possible. I saw every minute, hour and day spent in fostering the growth of the movement as a tremendously exciting opportunity for me to save my life, and the lives of my loved ones, and to advance the most powerful and far-reaching revolution in history...a revolution that would lead to physical immortality and the opportunity to explore an incredibly vast universe of unimagineable riches. It was going to be the adventure of a lifetime...*my* lifetime!

My assessment today — 33 years later — of the cryonics movement that began with such promise and potential is that it has failed, and that there is significant risk of its extinction. At a time when cryonicists continue to debate about the probability of cryonics patients being restored to life in the future, I think it's time to face the unpleasant truth that the cryonics movement is dying, and that, unless it can be revitalized and rejuvenated, our chances of survival may be very small.

I make this assessment as someone who has been an active cryonicist for most of the past 33 years, who has seen and participated in many of the ups and downs of the movement, and who remains, in spite of this overwhelmingly negative assessment of its current state, an optimist about our ability to turn the downward spiral of the movement around in the next 10 years, and, ultimately, to succeed in our quest for physical immortality. However, before I give you my prescription for this turn-around, let's look at the the evidence that the cryonics movement has failed.

The first piece of evidence that the cryonics movement has failed is the fact that we've attracted such a minuscule following in the past 33 years.

When you consider that cryonics offers the most valuable product ever conceived—the possibility of everlasting life — that we offer the only product in history that is essential for everyone on the planet, and that the vast majority of Americans (and a great many people abroad) have learned of its availability over the past 33 years, our ability to attract members has been utterly and absolutely abysmal!

I believe cryonics has received more publicity with less results than any idea in history. Over the years, there have been thousands of radio and TV shows and newspaper and magazine stories about cryonics. Although much of this publicity has been negative, many media stories have presented our point of view fairly, and many have been quite positive about cryonics.

Despite this massive publicity for a variety of cryonics organizations for more than three decades, we have a mere 700-800 people worldwide who have made financial and legal preparations to be frozen.

Despite all the publicity, under 100 patients have been frozen since the inception of the movement, in the face of hundreds of millions of people who died during this period, but chose burial or cremation over cryopreservation.

In the last 33 years, billionaires and an untold number of millionaires, who were well aware of the option of cryonics, chose instead the total destruction of death the "old-fashioned" way.

The facts speak for themselves. In the context of the intense desire for survival on the part of virtually everyone on Earth, we've failed miserably in attracting people to the cryonics movement. Considering the powerful attachment to life that most people have, the almost total rejection of cryonics by the general public is strong evidence that people just don't think it will work!

It's true that it costs money and takes time to sign up for cryonics, but these would not be major barriers to growth, I believe, if people truly believed there is a reasonable chance that cryonics will work.

The evidence also shows that, not only have we failed to attract people to the cryonics movement in general, but more ominously, when it comes to attracting young people, we are rapidly losing ground. This is the evidence for my conclusion that the cryonics movement is dying and moving towards extinction.

According to Mike Darwin, the average age of Alcor members in 1984 (when he was President of Alcor) was 38 years of age. Today, half of CryoCare's members are 50 or older, 80 percent are 40 or older, and only two members are under 30 (One of them is an infant, the child of a member in his 40s). The largest group of CryoCare members is in the 40-to-60 age range. They represent about 20 percent of the *total* age range, but more than 60 percent of the membership. (I'd appreciate it if the other cryonics organizations would post the current age range of their members).

Actually, the aging of the cryonics movement is far more serious than these figures show. When you look at cryonics activists, the figures are even more alarming. Today, the vast majority of cryonics activists are over 40, many of them are over 60, a fair number of them are over 70, and a significant number of them have already died, including such stalwarts as Jerry Leaf, Paul Genteman, Jerry White, Dick Marsh, Walter Runkel, Jack Erfurt and Andrea Foote. A signficant number of others are likely to die within the next 5 years or so.

These people are *not* being replaced by any stretch of the imagination. The cryonics movement is *not* attracting young activists in anywhere near the numbers we need to keep the movement alive and vital. It is *clearly* a dying movement.

The reasons young activists aren't being attracted to the cryonics movement aren't hard to see. When I was a young activist in the 1960s, I saw great hope and promise in a movement that I was confident would, eventually, bring me wealth, fame and physical immortality. I knew that it would be quite a while before these goals would be achieved, but I was young and vigorous, I was working with other young and vigorous people, and we were shooting for the stars!

In 1971, I realized that things were moving much slower than I had hoped, that I was 32 years of age without any money, a viable career, or any prospects for either if I remained a cryonics activist. So I dropped out of activism to make my mark in the "real world" and didn't drop back in until the mid 1980s, when I could afford to do so.

In the mid 1980s, the cryonics movement was already aging fast, but the major activists were still young and ambitious enough to be optimistic, and hardly any of them had died yet. Moreover, as a result of our activism, we *were* beginning to attract young activists, such as Ralph Whelan, Tanya Jones and Derek Ryan.

However, this "youth movement" proved short-lived. Ralph, Tanya and Derek found, after a number of years of toil and trouble, that there was still no future in cryonics. They managed to escape from the movement while they were still young enough to build a viable career in the real world.

Today, as the cryonics movement grows older and older, its attraction to young people grows weaker and weaker. Today, the cryonics movement has *nothing* to offer young people except hard work with little or no pay; apathy, ridicule or hostility from the outside world; internal fighting with aging cryonicists, many of whom have never learned how to work and play well with others; a level of emotional stress from dealing with cryonics cases that is comparable to that found in emergency care medicine, without any of the benefits of being a health care professional; and the fear that you'll end up an institutional cryonicist with little or no hope of success in the outside world.

Further evidence that the cryonics movement has failed has been our inability to persuade mainstream scientists of the value of cryonics. I am not aware of a single mainstream scientist whose negative opinion of cryonics has been changed by anything we've said, written or done in the past 33 years. On the contrary, the position of establishment scientists over the years has hardened into perpetual, and sometimes ridiculing negativism and condescension.

The overwhelming negativity of established scientists for cryonics was *not* preordained or inevitable. In fact, in the early years of the movement, a number of scientists, including prominent cryobiologists, were quite friendly towards cryonics. Reknowned biologist Jean Rostand, for example, wrote the preface to *The Prospect of*

Saul Kent was a founding member of the Cryonics Society of New York in the 1960s. Since then, he has written books such as *The Life Extension Revolution* and *Future Sex*, helped to create and run the Life Extension Foundation (a successful dietary supplement company), and defeated the FDA's efforts to tighten government control of vitamins and supplements.

Immortality. Armand Karow, Jr., an established cryobiologist at the Medical College of Georgia wrote a series of columns for Cryonics Reports, the newsletter of the Cryonics Society of New York. A.P. Rinfret of the Linde Division of Union Carbide, which sold cryogenic equipment in the '60s, was friendly towards cryonics. Jerome K. Sherman, a cryobiologist at the University of Arkansas sought financial help from the cryonics movement. In the 1960s, I was able to put together a Scientific Advisory Board to the Cryonics Societies, which included a number of eminent mainstream surgeons and cryobiologists.

When I was about to go to New York University Hospital to participate in the freezing of Ann DeBlasio in 1969, I called cryobiologist Arthur Rowe (who was then working at the New York Blood Bank) for advice, which he gave me willingly and openly. This is the same Arthur Rowe who has since been quoted over and over in newspaper and magazine articles saying that the belief that cryonics will work is like believing you can turn "hamburger back into a cow!"

It's no mystery why mainstream cryobiologists were friendly towards cryonics in the early days of the movement. They thought cryonicists were a potential source of funds for their research. They thought that anyone who wanted to beat death by being frozen would want the best possible chance of success. That even a small cryonics movement would do everything within its power to help fund cryobiological research.

They soon found out they were wrong. Cryonicists *didn't* fund their research. Cryonicists didn't try to raise funds for their research. Cryonicists didn't even seem interested in their research. Instead, cryonicists spent a great deal of time trying to persuade cryobiologists, and the rest of the world, that people frozen after legal death by the extremely crude and damaging methods of the '60s, had a chance of revival, perhaps even a good chance of revival, in the future.

And so the cryobiologists withdrew all support for the cryonics movement. As the years went by with little or no evidence that cryonicists were interested in research, they turned more and more against the movement. When their government and corporate funding sources began to dry up in the 1970s, some cryobiologists began to worry that the cryonics movement was, in part, *responsible* for their loss of funding. As a result, they became bitterly opposed to a movement in which they saw no redeeming value. In their eyes, the vast publicity that cryonics was attracting was a direct slap in the face of the only people (the scientists) on Earth who could ever achieve the goal the cryonicists were supposed to be seeking. In their eyes, the constant focus of the media on cryonics rather than cryobiology was a sad, cruel joke played upon them by a group (the cryonicists) driven primarily by vanity and narcissism, who preferred sensationalism to science.

As the cryobiologists hardened their stance against the cryonics movement, cryonicists reacted by attacking the cryobiologists for *their* attacks on the practice of cryonics. What could have become a *highly* productive partnership driving us to perfected suspended animation became instead a cold war between two hostile camps who were hurting each other's chances for success.

My thesis that the cryonics movement has failed and is moving towards extinction is so strongly supported by the evidence that it is truly remarkable that cryonicists have failed to discuss it. I contend, in fact, that the failure of these issues to be raised and taken seriously by cryonicists is indicative of an escape from reality that is at the root of our failure, and is a significant threat to our survival. Before we can deal effectively with the threat of the movement's extinction, we must first accept the fact that we have failed.

I believe that, unless we face the truth about the failure of our movement and its possible extinction squarely and unflinchingly, we will be doomed to the very thing we have been trying so desperately trying to avoid...permanent and irreversible death!

A major symptom of our escape from reality has been our widespread denial of the importance of the massive damage caused by the primitive freezing methods we employ. We've not only failed to fund and promote the research needed to improve cryonics methods, but we've actively resisted finding out and admitting to the world (and to ourselves) how much damage we were (and are) inflicting upon our patients.

The result has been the failure to confront and effectively deal with the fact that our failure to *sell* cryonics has been due, almost entirely, to the poor quality of our product. Outsiders don't have to think twice to come to that conclusion. It's self evident to almost everyone....except to cryonicists!

For the past 33 years, we've been bending over backwards to evade the truth about our movement. We've twisted ourselves into proverbial pretzels in our efforts to pretend that we have a good product, when all the evidence screams at us that our product is terrible!

In the process of evading reality, we've sidestepped, twisted and distorted the truth so badly that we've lost our way in a tangled jumble of wrong ideas, false notions, and misleading myths.

Instead of facing up to the crudity of our freezing methods and the importance of the massive damage caused by these methods, we've focused more and more on the possibility of future repair of this damage. This has been easy to do because of the growth of the nanotechnology movement, which has lent credibility (in some quarters) to the concept of future repair of very severe injury caused by aging, disease, ischemic injury, and freezing damage.

When cryobiologists contend we are damaging our patients too much to permit future reanimation, we criticize them for failing to take into account the potential of future repair methods. In doing so, we fail to appreciate that we are, similarly, failing to take into account the severity of the damage our methods cause. Until we have solid evidence that we can preserve the brain well enough to retain enough information to maintain our identities, it is inappropriate, I believe, for us to criticize cryobiologists over their opinion that future repair of today's frozen patients will be impossible. Without the evidence that we can effectively preserve ourselves, the cryobiologists are not only entitled to their negative opinions about cryonics, but we don't have the slightest chance of changing their minds!

Whenever we refuse to admit that the "miracle" of nanotechnology might not*ever* be able to repair the most severe damage to today's patients, we are seen as irrational, wild-eyed dreamers, and our movement as more a cult or religion than a scientific endeavor.

In our denial of the truth and our evasion of reality, we go on and on about irrelevant or imaginary things. Among the myths cryonicists have developed are the following:

1) That all we need is for some billionaire to bail us out with a barrel-full of money. This myth has been with us since the inception of the movement and shows no sign of disappearing, despite strong evidence that it is absurd. Rich people, even rich cryonicists, aren't fools. They aren't going to bankroll a movement of wild-eyed dreamers and rigid ideologues. They'll put their money up (with caution) when they see persuasive evidence that the money will be used wisely, with a reasonable chance of success.

I say this as someone who has been responsible for putting more money into cryonics than anyone in the history of the movement, and who has been accused frequently of being a wild-eyed dreamer myself. Well, the truth is that I *have* been a wild-eyed dreamer at times, and*have* wasted some of the money I've put into cryonics. But, for the most part, I've put my money on horses who had produced evidence that they had a shot at reaching the finish line. Moreover, now that I am older, wiser and more desperate, I am becoming more and more realistic about where I put my money and what I expect to get from it!

2) Another myth that has permeated cryonics from the beginning is that there has never been a really good effort to promote cryonics by a professional promoter/ publicist/sales person, and that if we had the right promoter and enough money to do the job right, there would be rapid, accelerating growth in the movement.

I contend that this is the exact opposite of the truth. While it's true that there has never been a multi-million dollar campaign to sell cryonics, there's never been enough evidence to support the investment of that kind of money in the promotion of cryonics.

On the other hand, there is a long history of competent promoters, entrepreneurs and sales people comitting themselves to the growth of cryonics, with little or no success.

First, there is Bob Ettinger himself, whose book (*The Prospect of Immortality*) persuaded a number of people (including me) to become cryonics activists. In the 1960s, Bob appeared on many local and national radio and TV shows, including several appearances on the highly popular Johnny Carson show.

On one of these appearances, Bob held up a color rendering of a beautiful cryonics facility designed by a company called CryoLife in Kansas City, Missouri. Bob said that he had been told that CryoLife expected to see 30 of these facilities built across the country over the next few years. In October 1966, while on a cross-country cryonics trip with Curtis Henderson, we met with the man behind CryoLife, a successful funeral director, who was the slickest, most persuasive promoter I've ever met. However, CryoLife never got off the ground.

A couple of years earlier, two fast-talking promoters with good track records in other fields — Leonard Gold and Steve Milgram — put considerable time and money into developing a cryonics company (Juno, Inc.). Gold purchased a bankrupt business (the Patton Machine Works) in Springfield, Ohio; raised substantial capital from local businessmen; persuaded a cryogenic equipment manufacturer in Columbus, Ohio (Cryovac) to build the first cryonics storage capsule free of charge; persuaded the local Springfield newspaper to give his company free publicity through regular news stories; and gathered a stack of letters from funeral directors around the country stating their desire to work with Juno.

In May 1965, Juno was involved in the near-miss freezing of a woman in a hospital in Springfield that generated a tremendous amount of worldwide publicity. When Curtis Henderson and I met with Gold near the Whitestone Bridge in late 1965, shortly after starting the Cryonics Society of New York, we asked him what he thought we should do: "Nothing!" he replied, "I've taken care of it all. The first person will be frozen in a few months on international TV with the Pope and other celebrities in attendance. After that, Juno expects to be freezing thousands of people a year, with the company going public right after we freeze a Nobel-prize winning scientist." Suffice it to say, none of this happened.

Among the other people who tried to promote cryonics in the early years were banker and oil speculator Harlan Lane, real estate speculator and politician Don Yarborough (who came within a few votes of becoming Governor of Texas), businessman Forrest Walters (who formed ContinueLife); businessman and biophysicist John Flynn (who formed the first incarnation of BioPreservation), and businessman and real estate speculator E. Francis Hope (who formed the first incarnation of CryoCare). All these people were successful in other ventures; none were successful in cryonics.

The most impressive team I met with in those days was a group of well capitalized businessmen and scientists from Cleveland, headed by the Vice-President of a major cryogenic equipment manufacturer. This group had developed specialized equipment, including a multiple-body storage device that had been patented, and included a Prof. of Biophysics from Case Western Reserve University whose research team had frozen pigs at Case Western. Despite all this, they went nowhere with cryonics.

In later years, a number of other competent people, with track records of success in other business ventures, tried their best to promote cryonics. These included, Irving Rand, a crack insurance salesman, who spent a great deal of time and money attempting to sell cryonics, without success.

Then there is what I consider the best and longest standing campaign to promote cryonics...the efforts at Alcor in the '80s and early '90s, which led to a growth rate of 30% a year for a number of years until Jerry Leaf's sudden and untimely death, which destabilized Alcor and led to its breakup, resulting in the formation of CryoCare in 1993. I'll get back to what Ralph Merkle has deemed "The Golden Era of Cryonics" later, but first I want to discuss another of the myths that has plagued the cryonics movement for years.

3) This myth is that the biggest thing holding back growth in cryonics has been the continuous and persistent attacks on us by cryobiologists...in newspaper and magazine stories and on radio and TV shows.

I don't deny that a less hostile attitude towards cryonics on the part of the cryobiologists would have helped the movement, but I completely disagree with the notion that the hostility of cryobiologists has been a major reason for the failure of the cryonics movement to grow.

I say this because history shows that it is possible to achieve major growth in an industry in spite of hostility from the authorities in the field.

A good example is the growth of the vitamin supplement industry. In the 1950s, virtually every medical doctor and nutritionist in the United States contended that "supplemental vitamins are worthless" and didn't hesitate to voice this opinion to their patients and to the media. At that time, the relatively small number of people who took vitamins were considered "health nuts."

However, in the 1960s and '70s, the use of vitamins grew rapidly in spite of continued opposition from the medical profession and little scientific evidence to support it. By the 80s and 90s, the growth of the vitamin industry had accelerated dramatically, in large part because of an avalanche of scientific studies in favor of taking vitamins.

Another example is the practice of birth control in the United States among Catholics in spite of continuing opposition to the practice by the Pope and the upper echelon of the Catholic Church. Surveys have shown that just as high a percentage of Catholics practice birth control in the U.S. as non-catholics.

The common thread in these two examples is that it has been possible to generate tremendous growth in two industries despite the opposition (and hostility) of the authorities for one critically important reason: the products work!

In the case of vitamins this became apparent to regular vitamin takers long before scientific studies confirmed the health benefits of vitamins. It didn't take rocket science for vitamin takers to discover that they felt better and got sick less often when they took vitamins.

Similarly, Catholics defied their Church by using birth control because it stopped women from becoming pregnant far more effectively than the rhythm method advocated by the Church.

I'm very confident that many people who believe in the religious concept of an afterlife will opt for cryonics as soon as they believe it will work better than the notion of getting to heaven, which brings me to the final cryonics myth I want to discuss:

4) That the failure of the cryonics movement to grow is some kind of mystery. The only mystery I find difficult to fathom is why — after 33 years of failure — anyone in the movement remains puzzled in any way about *why* cryonics has failed to grow.

To put it in a nutshell: cryonics hasn't grown because nobody thinks it will work! After 33 years of failing to convince people that cryonics can work, you'd think we'd all agree that, except for a handful of people, it's difficult or impossible to sell cryonics, and that "a handful of people" cannot be translated into significant growth.

But all I hear about is other reasons for our failure to grow: that signing up is too hard; that religious beliefs stop people from signing up; that people find it hard to confront their own mortality; that people don't want to confront the opposition to cryonics of family members and friends; that young people don't think they'll need to be signed up for years...etc., etc.

I'm well aware of all these reasons and more and there's some validity to all of them, but the truth is that all of them together don't compare to the simple fact that we've got a terrible product that virtually no one wants!

Now it's time to get back to Ralph Merkle's "golden era of cryonics" when Alcor's growth rate was 30% a year.

First, I want to say that the growth rate in Alcor at the time was the result of a tremendous amount of effort and energy on the part of a number of dedicated people, which began to dissipate after one of these people — Jerry Leaf — died suddenly.

Second, I want to say that, although there were strong promotional efforts carried out during those years to increase membership growth, the critical heart of Alcor's program that, I believe, was most reponsible for its growth was the research program carried out by Jerry Leaf, Mike Darwin, Hugh Hixon and others, which led to advances in the methods by which we freeze our patients.

This research effort was the core activity around which everything else revolved. It was the major source of energy that lent vitality and excitment to all Alcor activities. Anyone who doubts this should understand that if it hadn't been for Alcor's research program, the "golden era of cryonics" would undoubtedly have been known as the "dark ages of cryonics" and the movement would be even closer to extinction today.

I say this because I know beyond a shadow of a doubt that four of the key people in Alcor at that time would *not* have been activists if it hadn't been for the Alcor/Cryovita research program.

They are Jerry Leaf, who brought professional research and cryonics services into the movement, who played a major stabilizing political role in Alcor, who funded virtually all of the initial research through his company Cryovita Laboratories, and whose presence at Alcor attracted a wide variety of competent people.

Jerry's primary interest was research. He agreed to head Alcor's cryonic suspension team reluctantly, and thought it unlikely that current methods of cryonics were preserving enough of the brain to permit future reanimation. His dream was to achieve suspended animation, and he would never have considered becoming involved in Alcor without being involved in research.

One of the people that Jerry attracted to Alcor was Mike Darwin. Mike was living and conducting research in Indianapolis, Indiana when Jerry Leaf started Cryovita. It was Jerry's experience in conducting research at UCLA Medical Center, his desire to conduct research at Cryovita, and his willingness to invest substantially in that research that caused Mike to move to Southern California. Shortly after Mike moved to SoCal he became President of Alcor and the "golden era of cryonics" began.

Another person who came to Alcor because of Jerry was Brenda Peters. Brenda interviewed Jerry about his interest in suspended animation around the time that Jerry was beginning to get involved in Alcor. Brenda then became involved herself, eventually becoming a member of the Alcor Board of Directors. She participated in and played a significant role in Alcor's research, and played a major role in recruiting members to Alcor and in raising funds for research.

The fourth person who played a signficant role in Alcor's growth, but would not have done so if not for Alcor's research program was me. When I stopped being a cryonics activist in 1971, a major reason for doing so was that, after 6 years of intensive efforts, the cryonics movement had failed to fund or promote any signficant research. I vowed never to become an activist again unless the organization I was part of had a significant commitment to research. In the 1980s, I donated significant funds to Alcor, wrote and developed promotional brochures and other mailing pieces, organized and directed conferences, and helped promote the research program.

Without the active participation of Jerry Leaf, Mike Darwin, Brenda Peters and myself, Alcor would have remained a tiny backwater cryonics organization or would have disappeared into the night. Certainly, Alcor would *never* have made the research, legal, medical, public relations and administrative strides it made in the '80s and early '90s. In fact, I think it's highly unlikely that

Ralph Merkle and hundreds of others would have joined Alcor if Jerry, Mike, Brenda and myself had not become activists.

Throughout most of the 33-year-old cryonics movement, I was almost as guilty as others in denying the truth about cryonics. I, too, put less money and time into research than I could have. I, too, pursued tactics aimed at cryonics growth rather than the improvement of cryopreservation methods. I, too, became involved in internal political conflicts within the movement. I, too, castigated the cryobiologists for their attacks on cryonics.

But, in comparison with most other cryonicists, I was enlightened. Despite my myopia over certain issues, I have been investing money and promoting research since the 1960s.

At the time of Jerry Leaf's death, he and Greg Fahy were well into the planning stages of a brain cryopreservation research project, which I had already raised some money for. We had also planned to continue the full-body washout hypothermia research we had conducted for a number years, and had other research plans as well.

When all this was derailed by Jerry's death and subsequent events at Alcor, I made up my mind to work harder than ever to make enough money to support a research program that would not be so dependent on one person (such as Jerry Leaf). For a number of years, I (and Bill Faloon) were not able to make enough money to achieve this goal because of a long-standing legal and political struggle with the FDA.

Fortunately, Paul Wakfer, who had come to SoCal in large part to help out with the research program, began to put in substantial amounts of his money, time and effort to help Mike Darwin put together a research facility in Colton, California, which was the precursor to the 21st Century Medicine facility in Rancho Cucamonga, which Paul also played a major role in creating.

Finally, in February 1996, Bill and I were able to win our war with the FDA and, as a result, were soon able to increase our funding for research dramatically. Today, we are investing about one million dollars a year in 21CM research, as well as hundreds of thousands of dollars more per year for anti-aging research, while Paul Wakfer continues to raise money for brain cryopreservation research through the Institute For Neural Cryobiology (INC), which has taken over what was formerly known as the Prometheus Project.

Over the last few years, I've come to the conclusion that major research advances leading to better and more credible cryonics services is the *only* hope we have of salvaging the failed cryonics movement and preventing its extinction. I think it would be a huge mistake for us to keep on trying to sell an inferior product that almost nobody wants to buy. That's what we've tried to do for the past 33 years. Our failure can be seen in a rapidly aging movement whose principals are dying off without being replaced.

I believe that the *only* way we can attract young people to our movement is to provide them with irrefutable evidence that we are improving cryonics methods and moving towards suspended animation. Research will not only attract scientists who can contribute to it, but will also attract young people from all disciplines, who will see cryonics as a vital, growing, dynamic movement that's going to change the world!

Research is also the only means of improving the credibility of the movement. It will not be possible for us to win over mainstream scientists, physicians, media leaders, politicians, attorneys, businessmen and professionals of all kinds in any way other than through research.

We now have an unprecedented opportunity to make major progress in cerebral resuscitation, organ cryopreservation, and human vitrification, which will lead to great improvements in cryonics services, greater credibility for cryonics, the ability to raise capital to develop even better services, major profits which can be reinvested into research,and the transformation of cryonics from a tiny, dying oddball movement into an integral part of mainstream 21st century medicine.

What we need to acquire legitimacy for cryonics from young and old alike, is hard, published evidence that major organs such as the kidney and heart can be cryopreserved effectively; that the information in the brain can be cryopreserved effectively; that apparently "dead" people can be restored to life, health and vigor, that we can convert laboratory breakthroughs into advanced human cryopreservation services, and that we can deliver these advanced services to consumers at affordable prices.

Once we develop a product that people really want, they'll be "breaking down our doors" to get it, and we'll have more growth than we can imagine.

However, if we do *not* conduct the research to develop cryonics and gain credibility in mainstream science and medicine, the movement will grow weaker and weaker, and will likely, in my opinion, become extinct within the next 20-to-30 years!

The choice is ours! Unless we invest our money and time in research, I believe we are doomed to oblivion...both individually and collectively!

Anyone who wishes to donate money to research can do so through the non-profit Institute For Neural Cryobiology. INC is funding a hippocampal brain slice cryopreservation project at a mainstream medical center that is an important step towards suspended animation. You can find out more about this project on INC's web site: http://neurocryo.org. You can donate to the project at http://neurocryo.org/funding.html.

21st Century Medicine (21CM) is a for-profit company that occupies two buildings in Southern California. One building is devoted to cerebral resuscitation research, the other to cryopreservation research. 21CM has an ambitious research program that features kidney, heart, brain and whole-body vitrification. Later in the year, 21CM will be offering stock in the company to investors. Anyone who wishes to be put on a waiting list to receive a 21CM Prospectus should send their name, phone number and postal address to: Joan O'Farrell, Chief Financial Officer, 21st Century Medicine, 10743 Civic Center Drive, Rancho Cucamonga, CA 91730; or call her at: 909-987-3883 or contact her via email at: ofarrell@aol.com.

I've written this essay to provide evidence for my contention that — at this time in history — we should devote most of our attention, time and money to suspended animation research. I invite comment, criticism and discussion of the ideas in this piece.

The Editor of *Cryonics* Comments on "The Failure of Cryonics"

by Brian Shock

First, let me state unequivocably that I agree with the underlying message of Saul Kent's preceding article: ***Cryonics research is vital to us. There hasn't been enough of it. There must be more!***

Of course, not everyone is cut out for research. If you'd seen me in my college organic chemistry lab, you would certainly feel much more secure in knowing that I edit a magazine instead of fiddling with test tubes! (Ever try to synthesize sulfa drugs? In my single attempt at it, the glassware apparatus exploded, dissolving the lab's ceiling with a gout of chlorosulfonic acid and fogging the entire room with deadly chlorine gas.)

My primary disagreement with Saul Kent revolves around the method by which he attempts to convey this rallying cry for more research. At worst, the casual reader of Mr. Kent's article might conclude that cryonics has indeed failed, and that cryonicists' only viable option is now to scrap all publicity, all membership organizations, and all suspension teams, and plow the equivalent of these resources into research. At best, this same casual reader is unlikely to feel motivated about participating in *any* aspect of cryonics, research or otherwise.

Even so, these are questions of marketing and mass psychology, and so are infinitely (perhaps pointlessly) debatable. In the interest of journalistic accuracy, I am far more interested in addressing some of the statements that Mr. Kent employed as facts.

"According to Mike Darwin, the average age of Alcor members in 1984 (when he was President of Alcor) was 38 years of age. Today, half of CryoCare's members are 50 or older, 80 percent are 40 or older, and only two members are under 30 (One of them is an infant, the child of a member in his 40s). The largest group of CryoCare members is in the 40-to-60 age range. They represent about 20 percent of the total age range, but more than 60 percent of the membership. (I'd appreciate it if the other cryonics organizations would post the current age range of their members)."

Alcor shared its figures with CryoCare president and *Cryonics* columnist Charles Platt, whose article on the subject immediately follows this editorial. The average age of Alcor members is approximately 43, with the greatest concentration in the 30-to-50 age range.

"The cryonics movement is not attracting young activists in anywhere near the numbers we need to keep the movement alive and vital. It is clearly a dying movement."

As Alcor Membership Manager in addition to Editor of *Cryonics*, I must attribute this statement either to lack of information or to unreal expectations. Alcor continues to grow at a slow but steady rate of approximately one member per week (not counting attrition of existing members, which still allows for a significant net gain). Of the new Alcor suspension members who completed their arrangements in 1997, 60% were in their 40's or younger.

Moreover, I feel personally discounted in this assertion about the lack of "young activists"; although I am paid to work as a cryonicist, I still consider myself an "activist," and although I'm 37 years of age, I still consider myself "young." Right behind me are similar individuals such as Lisa Ferrington Shock (my wife and a regular Alcor volunteer), Steve Van Sickle (*Cryonics* columnist), Steve Jackson, Monica Stephens, and James Wade (who participated in the CryoTransport Training Course preceding Alcor's latest conference in April), Tim and Ailing Freeman (who have hosted cryonics sign-up parties in their home), and too many others to count. (For the dozens of you in Alcor, ACS, and Cryonics Institute whom I failed to mention, please accept my humblest apologies. *I* know you're out there!) Perhaps these numbers aren't large enough to satisfy any of us completely, but these "young activists" *do* exist and their ranks *are* growing.

"In the mid 1980s, the cryonics movement was already aging fast, but

the major activists were still young and ambitious enough to be optimistic, and hardly any of them had died yet. Moreover, as a result of our activism, we were beginning to attract young activists, such as Ralph Whelan, Tanya Jones and Derek Ryan.

"However, this "youth movement" proved short-lived. Ralph, Tanya and Derek found, after a number of years of toil and trouble, that there was still no future in cryonics. They managed to escape from the movement while they were still young enough to build a viable career in the real world."

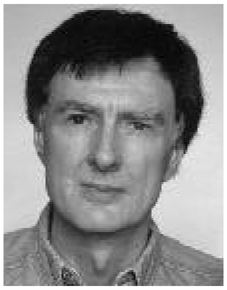
Although Ralph Whelan, Tanya Jones, and Derek Ryan are no longer Alcor employees, they *are* still very public Alcor suspension members. Further, Tanya Jones and Derek Ryan participated in the latest Northern California CryoTransport Training session during February, 1998; both recertified themselves as Alcor CryoTransport Technicians. Finally, in May, 1998, Derek Ryan was elected to Alcor's Board of Directors.

The reader may decide for himself whether these three individuals have "escaped the movement."

"Now it's time to get back to Ralph Merkle's "golden era of cryonics" when Alcor's growth rate was 30% a year."

A minor note: Ralph Merkle's denies ever using this phrase, "the golden era of cryonics," although he has frequently spoken in favor of 30% growth per year.

While Mr. Kent states several other opinions that I feel are not substantiated by fact, I must grant that *my* personal opinions are no better documented. Let me suggest only that unremitting pessimism is probably no more productive than mindless optimism.



Growth and its Consequences

by Charles Platt

In my previous column I provided a personal overview of real-life problems afflicting cryonics and its activists. In this and future columns I'll narrow the focus to concentrate on specific issues.

One concern that I mentioned last time was the possibility of two cryonics patients requiring emergency transport and perfusion simultaneously—a risk that obviously increases as an organization acquires more members. But precisely how much does the risk increase? To what extent should a cryonics organization worry about this problem, now and in the future? So far as I can tell, these questions have never been answered.

At first glance the chance of simultaneous cases resembles the "birthday problem" (well-known among mathematicians), which asks how many people must be in a room to reach a 50-50 chance of *any two* of them sharing the same birthday. But the cryonics version is more complex, because people of different ages have differing mortality risks, and the age distribution within cryonics organizations has changed, and will continue to change, as time passes.

Why should this be? The answer becomes clearer if we think of cryonics as being like a nation. Four factors determine national population and age distribution as time passes: birth rate, death rate, immigration, and emigration.

In cryonics, very few babies are "born into" the community and signed up by their parents, and relatively few people "emigrate" from the community. Thus, the cryonics population is affected primarily by two factors: immigration (i.e. new members joining) and the death rate.

So far the death rate has been low, because the "nation" of cryonics was established only 30 years ago. Most of the early cryonicists were young, and few have died yet; they have merely grown older. Meanwhile, most people who signed up for cryonics during the past three decades are also still alive, and growing older. Consequently the average age of cryonicists has increased and will continue to increase until elderly members start to die in larger numbers.

The increase in average age of cryonicists has already become noticeable just by casual observation. At the Alcor conference earlier this year I saw more white hair (or absence of hair) than at similar meetings a decade ago. Possibly, as Saul Kent believes, aging cryonicists are not being supplemented fast enough by young new cryonicists, and most activists now are over fifty. I haven't examined this proposition in detail, so I can't confirm or refute it; but I do know without any doubt that the *average* age of cryonicists has increased over the past thirty years, for reasons I have described above, and it will continue to increase for at least the next twenty years, until age-related factors cause cryonicists to start dying in larger numbers.

So, two unpredictable variables — membership growth, and average member age — affect the number of deaths per year. This makes it very difficult to derive a formula predicting the probability of simultaneous cases.

My answer, therefore, is to forget about formulae and do what demographers do when they want to predict the future status of a population. They simulate it via a computer program.

As many readers will be aware, demographic simulations have achieved a very poor record over the past 40 years. Back in the 1960s the UN made computer-based projections of global population growth that turned out to be far too high, because no one at that time believed people in less-developed countries would voluntarily have fewer children. Also, the idea that European nations such as Italy would suffer a population *decrease* seemed inconceivable; but today, with a birth rate of 1.2 children per female lifetime, Italians (like most European nationalities) are reproducing below replacement level.

We can try to avoid gross blunders of this kind in our cryonics simulation by allowing very flexible assumptions. For instance, we can assume that there will be zero growth in Alcor's membership over the next forty years, and then we can run the simulation again assuming a constant compounding growth rate of 30 percent per year, which is the highest the organization has ever achieved. This provides "worst case" and "best case" scenarios, with the truth probably lying somewhere in between.

Methodology

First, with the helpful cooperation of Alcor, I obtained the known birth dates of Alcor members. Since these dates were not accompanied by any names, Alcor felt that the data was not confidential. From this I constructed a demographic profile of Alcor, which is shown in the bar chart below, alongside a profile of CryoCare Foundation, the other organization allowing easy access to data. CryoCare is about one-sixth the size of Alcor, but its age distribution is similar, with the median lying in the 40-49 group. Alcor has relatively more members aged 30-39 while CryoCare has a larger group aged 50-59, probably because CryoCare was established by a core of "Alcor refugees" who were already in their middle years. Also, CryoCare has not recruited new members as actively as Alcor. Both organizations, however, are similar at the demographic extremes, with relatively few elderly members (presumably because most people sign up before retirement age) and relatively few members aged under 30. The under-30 group constitutes 5 percent of the CryoCare membership, and about 10 percent of Alcor.

Of course this still does not prove that cryonics has lost its appeal to young people; we would need to know the ages at which members signed up, rather than their current ages, to resolve that issue. Possibly I can examine it in my next column.

Having acquired the birth dates, I turned to a valuable volume published every year by the U. S. Census Bureau: *Statistical Abstract of the United States*. It contains data on every aspect of American life, and is available on CD-ROM.

Buried among its many tables is one supplying the number of deaths per 1,000 Americans, tabulated by age. Actually the table is inadequate for our purposes because the Census Bureau doesn't bother to include persons over 85. By plotting the data for younger people, however, and extrapolating the curve, I derived a rough estimate.

Now I knew the age of each Alcor member, and the average risk of death at each age. This enabled me to write a very simple program that figures the probable number of deaths during the next year. My program then extends its simulation into the future by increasing the age of each surviving member by one year, and enlarging the total membership by a predetermined growth percentage. Now the program repeats the death-rate calculation, discards the deceased members, adds new members, and goes through another iteration . . . as many times as necessary.

At the heart of this process is a pseudorandom number function. Suppose a member aged 75 has a 1 in 10 chance of dying during the next year. The program chooses a pseudorandom number from 1 to 10; if the number happens to be 10, the member is eliminated from the membership list, while if the number is less than 10, the program increases the member's age by 1 year. During the next iteration, the program runs the random-number test again using the appropriate (higher) chance of death for someone aged 76 ... and so on.

By performing the random-number test for every Alcor member, the program provides an *approximate* idea of how the population is likely change in the future. Of course, the random number generator creates different numbers each time the simulation runs—but if we repeat it, say, 100 times and then average all the results, this leaves us with the most likely scenario.

Already this is a useful tool, because for the first time it enables a cryonics organization to *plan ahead* for the likely number of member-deaths per year. Now, how can we enhance the program to predict the probability of simultaneous cases?

Easily. The program assumes that death is equally likely on any day of the year. So, it assigns a new random number, from 1 through 365 (ignoring leap years for simplicity) to each person who dies during a year of the simulation. Suppose we define "simultaneous cases" as two that occur less than three days apart, bearing in mind that a standby team needs at least a couple of days to complete one case and start the next. For each member who dies, the program chooses a random day, then checks whether it falls within two days of any previously calculated random death-day that year. If it does, the program increments the number of simultaneous cases.

Here again, the results are obviously affected by the choice of random numbers; but if we run the simultaneous-death test 100 times for each year of a projection (which itself will be repeated 100 times), once again the results can be averaged to get a most-likely scenario.

The program still needs to take account of variations in membership growth. Presumably, new members will join Alcor each year, and I don't know how numerous or how old they will be. To allow for this, program allows the user to specify different values for these variables. This creates another useful tool: instead of sitting around arguing and worrying about the number of additional cases we'll have to deal with if membership grows at, say, 3 percent per year, we can specify the growth rate and see what happens. Also, we can see the consequences if the median age of signups is higher or lower. My default value is 40, and the program chooses random ages grouped around the median in an approximate bell curve with a cutoff at +/- 12 years.

Caveats

Cryonics could be affected by factors that are totally unpredictable. If researchers freeze and resuscitate a mammal, for instance, this could catalyze the growth of cryonics far beyond the 30-percent-per-year maximum allowed by my program. Conversely, we can imagine a federal law that would decimate membership growth by rendering cryonics illegal (as has happened

Age distribution of 80 CryoCare members, as of January 1, 1999

Age distribution of 426 Alcor members, as of January 1, 1999

already in British Columbia).

Such singular events obviously are beyond the scope of any simulation. Even without any singularities, however, my program still contains some assumptions that could introduce minor inaccuracies:

■ After the user chooses a growth rate, the program applies it constantly throughout a future period. In reality, growth is not constant.

■ The definition of growth, in a cryonics organization, is tricky. Suppose we begin with 210 living members, and in the course of a year we have 10 deaths and 20 new signups. Since only 200 members were alive at the end of the year, while 20 new members were added, my program interprets this as 10 percent growth. This may not be strictly accurate, depending precisely when the deaths and signups occurred during the year.

■ To establish an arbitrary cutoff point, the program assumes that anyone aged 99 has 100 percent chance of death within the subsequent year.

■ The program assumes that maximum life expectancy and age-related death rates will be the same for Americans 20 years from now as for Americans today. Obviously I hope I'm wrong about this, but I wanted to provide a conservative prediction, so I did not allow for the development of successful life-extension therapies.

■ The program doesn't allow for members quitting Alcor before they die. We don't have enough experience, yet, to determine the percentage of members who are likely to let their financial arrangements lapse; so I ignored this factor.

■ I assumed that people who sign up for cryonics are in average health. I did not include "last minute cases," where someone who has a terminal condition seeks membership, or a relative wants to freeze someone who has already died. Currently Alcor (and CryoCare) are extremely reluctant to accept such cases; therefore, I saw no need to include them in the simulation.

■ I used mortality rates averaged for all Americans — white and black, male and female. Actually whites tend to live longer than non-whites, and females tend to live longer than males. Since most cryonicists are white (implying a higher life expectancy than average) but male (with a lower life expectancy than average), I believe the mortality rate that I've used is reasonably appropriate. Of course many cryonicists like to believe they'll increase their life expectancy by using vitamins and other supplements, but in my experience they eat junk food like anyone else, which may be a more relevant factor when assessing their death rate.

■ I couldn't obtain figures for countries other than the USA, so non-American Alcor members have been assigned American death rates. Fortunately, life expectancy in Canada is similar to the US, and Alcor has few members in other countries.

Despite these compromises, I do believe the program provides an approximate guide to the likely number of deaths per year and the probability of simultaneous cases.

Results

Because I serve as President of CryoCare Foundation, initially I ran the simulation for CryoCare members. I found that the smaller number of CryoCare members more than compensates for their higher average age, and offers one advantage: we don't have to worry much about simultaneous cases or standby-team burnout. During the next 20 years, for each CryoCare member who dies, the chance of another member dying less than 3 days later remains around 1 percent, even if there is 3 percent compounded annual growth. I believe this risk is low enough that we do not require more than one standby team, at least during the first half of that period. Also, one standby team should easily handle the predicted average of one CryoCare death per year.

I'm not advocating small membership as a desirable goal, because obviously a large organization is better able to pay employees, more likely to be financially secure, and more likely to find members with useful skills who may be able to facilitate further growth. It's a fact, though, that sooner or later, members do die and will need to be frozen, imposing a future burden that we can't afford to ignore today.

Table 1 on the following page illustrates this. It shows averaged results from 100 runs of my simulation program using Alcor member data, under various growth assumptions.

This table shows that with low-to-moderate growth (up to 6 percent per year) Alcor can expect around 5 cases per year on average, during the next couple of decades, with a peak of around a dozen cases a year and a 3 or 4 percent chance that any case will be followed by another case within 2 days or less. Since I am not an Alcor member, it would be presumptuous of me to make any recommendations, but personally I find the chance of simultaneous cases slightly worrying, and I wonder if a single standby team could deal with 10 or 12 cases in one year without suffering battle fatigue. Fortunately, Fred and Linda Chamberlain are making strenuous efforts to recruit more volunteers, especially at the local level. This is reassuring, assuming the outreach is successful.

If higher growth rates are sustained, the table suggests a need for enough volunteers (or paid staff) to constitute two separate response teams. On a non-emergency basis these volunteers could be rotated on and off duty, allowing recuperation time and guarding against burnout. If two cases should occur simultaneously, the two teams could both be activated. Of course, in this situation duplicate equipment would be needed.

Lastly the table illustrates the power of compounded growth. If a 30 percent annual growth rate (which was sustained for several years in the past) is maintained over two decades, Alcor would end up with about 75,000 members by the year 2020. Meanwhile, fewer than 1,000 would have been frozen during the preceding years—because, statistically, the chance of death does not begin to increase rapidly until members are over 60, while my simulations assume that the median age of new members will be 40.

If we extend the projection for an additional 20 years, the picture changes drastically as many more patients need to be frozen. In Table 2 we see that even if there is no membership growth at all, by 2040 Alcor would need to find space for 260 more patients than it houses today, necessitating a much larger storage facility than anything currently contemplated. If we assume a modest annual growth rate of 6 percent, the patient population more than doubles to 525 during the same period. Also, with a peak of 38 deaths per year, even two teams of emergency personnel might not be enough—unless of course the teams are employed on a full-time basis. Clearly, moderate growth has significant consequences if we look far enough ahead.

With 20 percent annual growth for the next 40 years, the numbers become surreal, leading ultimately to more than half-a-million members, more than 10,000 people frozen, and a peak of 5 cases *per day*. Anyone who believes that growth will solve all the problems in cryonics should ponder carefully the infrastructure that would be needed to sustain this load.

Finally, if we assume a 30 percent annual growth rate for 40 years, Alcor will sign up more than 13 million people (about 5 percent of the current U.S. population), while 150,000 more will be frozen. This, incidentally, represents the upper practical limit on the functionality of my program. Even with some optimization (using long integers and minimizing floating-point operations), the program required four hours, on a 200 MHz Pentium, to run the 40-year, 30-percent growth projection 100 times.

Conclusion

As I suggested in my last column, those who join Alcor under the impression that they are buying a service in exchange for membership dues may be disconcerted to learn that the organization needs their help in order to provide the service. There's no way around this hard fact; cryonics is still a fledgling science, cryonicists are pioneers, and like all pioneers, they need to pitch in and lend a hand.

In the past, people could dismiss this kind of statement as idle rhetoric. My computer simulation, however, dramatizes the situation and supplies actual numbers illustrating the growing need for standby/transport capability in an aging cryonics population. Therefore, I urge you to consider participating in the training programs that Alcor is offering.

Incidentally, if anyone wants to check my program, I'll email a copy of the source code and the compiled .EXE file which runs under any version of MS-DOS. (So far, computer scientists Mike Perry, Art Quaife, and Kevin Brown have received copies and have not reported any errors, which gives me some confidence that the methodology

Table 1

20-year projection, Alcor Foundation, from January 1999.
Based on birth dates of 426 members.
Median age of new members: 40.

	Percent Annual Growth Rate During the 20-Year Period					
	0	3	6	10	20	30
Living members as of 2019	338	641	1,173	2,523	14,848	74,639
Additional frozen members by 2019	88	98	113	143	317	872
Average number of cases per year	4	5	6	7	16	44
Maximum cases in any one year	10	11	13	18	51	196
% chance of any case occurring 2 days (or less) from another case	3	3	4	5	16	43

Table 2

40-year projection, Alcor Foundation, from January 1999.
Based on birth dates of 426 members.
Median age of new members: 40.

	Percent Annual Growth Rate During the 40-Year Period					
	0	3	6	10	20	30
Living members as of 2039	168	822	3,050	14,782	524,448	13,248,722
Additional frozen members by 2039	258	351	525	1,058	10,878	150,488
Average number of cases per year	6	9	13	26	272	3,762
Maximum cases in any one year	15	22	38	98	1,782	34,316
% chance of any case occurring 2 days (or less) from another case	5	7	12	27	85	99

is correct.) For simplicity, the program was written in an extended version of BASIC and is heavily annotated. It can be recompiled under Microsoft QuickBASIC with minor modifications. I invite computer-literate Alcor members to test my assumptions and suggest revisions if necessary.

From Anabiosis to Cryonics

We saw in ice that fish were stuck and bound,
But some of them then also came to life.
-- Ovid. *Tristia* (III:10) [1]

by Mikhail Soloviev

Introduction

Anabiosis[2] is a term for the full, reversible cessation of vital activity in a living creature. Although the existence of this state is now scientifically proven, the scientific community needed hundreds of years and countless experiments to accept it. Aside from a general lack of biological and biochemical knowledge through the ages, we may attribute the slow progress of anabiosis research to differing philosophical interpretations about the phenomenon of life, as well as the conservatism and occasional narrow-mindedness of scientists. (Intriguingly, the situations of anabiosis and cryonics seem reversed: with anabiosis, a great deal of experimental proof existed, but it was resisted for lack of theoretical grounds; with cryonics, a great deal of theoretical grounds support its feasibility, but relatively little experimental proof exists.)

The history of anabiosis research is dispersed and fragmented over many publications ranging back through many centuries. The historical analysis of such publications [3] tends to be poorly connected with the general development of biology. In this article, I try to eliminate some of these deficiencies and offer a modern, brief review of the history of anabiosis.

Anabiosis in an organism can occur through desiccation as well as freezing, and also through supercooling [7]. Many authors don't distinguish freezing from supercooling; here, I consider supercooling a form of anabiosis, and use the term "freezing" for any cooling below 0°C.

Antiquity: Observations

Certainly the ancients knew about the effects of cold on living organisms. Empedocles noted that the complete cooling of the blood causes death, and Aristotle mentioned the winter "sleep" of animals in his *History of Animals* [8].

Later, in the early years and centuries A.D., observations on the reviving of frozen fish were recorded by Ovid, Pliny the Elder, and Athenaeus [4]. These observations referred to northern countries, usually around the Black Sea, there being no heavy winters closer to the major centers of civilization of the Mediterranean. Even so, such records suggest only that the ancients derived fascination from the phenomenon of anabiosis, while failing to comprehend it real potential.

The 17th Century: Experiments

The rise of economics and culture during the Renaissance caused a revision of old philosophical and scientific dogma, and led to the rapid growth of experimental science. The experimental approach was advocated by Francis Bacon, whose work inspired the creation of the Royal Society in England, with its motto "*Nullis in Verba*" ("Nothing in Words"). Besides Bacon, the works of Hobbes, Locke, Galileo, Descartes, Gassendi, and Spinoza fostered the material and atomistic interpretation of nature and life. But materialism was not the only philosophy of scientific repute during that and subsequent centuries; many scientists were dualists [9] and vitalists [10], which prevented the general acceptance of anabiosis for a long time [4,8,11].

Still, the experimental paradigm and associated technological progress (especially the improvement of the microscope and thermometer [12]) saw the accumulation of genuine anabiosis-related data, generally relating to research on cold temperatures. This in turn was

Mikhail Soloviev is a cryonics and life-extension advocate living in St. Petersburg, Russia. He holds the Russian equivalent of a Masters degree in biophysics from St. Petersburg State University. Mr. Soloviev has also worked with design and development of models for neurocomputers, molecular computers, and complex biological systems.

stimulated by (A) the controversy on the essence of heat (the atomic motion theory of Bacon, who experimented much with cold, vying with Galileo's attribution of heat to a mysterious warm fluid or "caloric"); (B) the wide use of snow-salt mixtures for freezing [11]; and (C) the rise of scientific activity in the Northern European countries, where cold was a common phenomenon.

In 1664, Power detailed a series of freezing experiments in his book *Experimental Philosophy*. He successfully froze vinegar eel-worms [13] in a mixture of ice and salt for several hours, and kept them in frost overnight. Significantly, he considered the freezing nonlethal — the creatures weren't dead. [4,5,6].

In 1677, Leeuwenhoek reported his observation that microscopic animals (apparently rotifers [14]) appeared in water after it had been frozen and melted[6].

About the same time, Boyle experimented with the freezing of frogs and fish, publishing his results in a book, *New Experiments and Observations Touching Cold* (1683). Short-term freezing could be successful, he concluded, though long-term freezing killed the animals. Also, he expressed the opinion that, in principle, mammals could be frozen safely [5,6].

The 18th Century: Discovery

Despite these early successes, experimentation didn't give rise to any hypothesis that freezing "suspended" life. This may be explained in part by the still insufficient influence of materialism. Only further developments in the 18th century by the French materialists (Lamettrie, Diderot, Holbach, Helvetius) allowed this philosophy to compete with vitalism in the interpretation of life-related phenomena. Advanced scientists were then willing to consider both reversible freezing and drying as methods of suspending life.

Leeuwenhoek is usually considered the discoverer of anabiosis. At the very beginning of the 18th century, he experimented with rotifers living in moss on the roof of his house, preserving them by drying. Leeuwenhoek found that the tiny creatures could be revived by adding water, even after several years in a desiccated state. However, he decided that the creatures remained at least partially hydrated; he didn't realize that their life was actually suspended. Although Leeuwenhoek sent a letter about this phenomenon to the British Royal Society, no one took any notice of his discovery at the time [4,5].

Meanwhile, scientific proof continued to mount in regard to the resuscitation of different animals after freezing and drying. In 1736, Reaumur published data about freezing butterfly pupae and caterpillars down to -23°C. Since he found that they were incompletely frozen, however, he formulated no hypothesis about suspended animation [4,6].

In 1743 Needham observed that wheat-infesting eel-worms could be revived after two years of desiccation. Expressing a belief that the dried worms were dead, he described them "taking life" when rehydrated. Not surprisingly, this interpretation was disparaged by most scientists of the day. So great was the opposition, in fact, that Needham later changed his views, calling the dried state a special "vitality." Again he was criticized, this time by advocates of anabiosis, who were finally making themselves heard! [4,5].

In 1748, Buffon repeated Needham's experiments on eel-worms; he too believed that they died and were reanimated. In his writing, he compared them to "machines" that began to move when they were put into water [4]. (The interpretation of animals and humans as machines was typical for French materialism.)

However, Baker was possibly the first to understand the true nature of anabiosis. In 1753, he repeated both Needham's desiccation experiments on eel-worms (some he would revive after 27 years) and Leeuwenhoek's on rotifers. Baker wrote: "We find an instance here, that *life* may be suspended and seemingly destroyed ... and yet, after a long while, life may begin anew to actuate the same body." Even so, Baker remained philosophically confused about the nature of life. At one point he wrote that animals were suspended "without being deprived of their *living power*" and then accepted that "What life *really is*, seems as much too subtle for our understanding to conceive or define, as for our senses to discern and examine" [4,5].

Many scientists still considered experiments with eel-worms either artifacts or spontaneous generation of life. This was not surprising — almost nothing was known of eel-worm biology, and reviving them was a rather odd practice. To improve the scientific evidence of anabiosis, in the 1770s Fontana and Roffredi conducted careful experiments on these animals. They confirmed the previous results — anabiosis *did* exist [4,5].

Spallanzani, initially a skeptic, was favorably impressed by these findings and others, and in 1776 started his own experiments. After first repeating the dehydration work with rotifers and eel-worms, he discovered another creature that survived drying: the tardigrade [15]. In further pursuit of anabiosis, he went on to freeze and revive rotifers (-24°C) and eel-worms (-18°C). However, he found that although insects, frogs, and salamanders could be safely cooled to high subfreezing temperatures, they were killed by deeper freezing.

Drying and freezing, Spallanzani decided, were the same sort of phenomenon, both stopping life in a way that made true "resurrection" possible. Since he was a priest, such an interpretation put him into a theological bind. "An animal which revives after death is a phenomenon," he wrote, "as incredible as it seems improbable and paradoxical. It confounds the most accepted ideas of animality; it creates new ideas." Although Spallanzani's authority lent new credibility to the potential of anabiosis, his views were not generally accepted, partially because they lacked

A Who's Who of Anabiosis

Aristotle (384-322 B.C.): Greek philosopher and scientist.

Athenaeus Naucratita (2-3 cent. A.D.): Greek and Roman philosopher.

Baker, Henry (1698-1774): distinguished English naturalist and microscopist.

Bakhmetiev, Porfiry (1860-1913): Russian physicist and anabiosis researcher.

Becquerel, Paul (1879-1955): French biologist.

Bernard, Claude (1813-1878): French physiologist and pathologist.

Boyle, Robert (1627-1691): famous English chemist and physicist, one of the founders of the Royal Society of London.

Broca, Paul (1824-1880): distinguished French anatomist, surgeon, anthropologist. He discovered the speech zone in the human brain named after him.

Buffon, Georges Louis Leclerc de (1707-1788): French naturalist, author of comprehensive "Natural history."

Doyere, Louis-Michel-Francoise (1811-1863): French naturalist.

Empedocles of Acragas (about 490-430 B.C.): Greek (lived in Sicily) philosopher (materialist and immortalist), poet, physician, and statesman (democrat).

Fontana, Felice (1720-1805): versatile Italian scientist.

Hunter, John (1728-1793): prominent English surgeon and anatomist.

Keilin, David (1887-1963): European (born in Polish family, lived in Moscow, worked in England) biochemist and anabiosis researcher.

Kravkov, Nikolai (1865-1924): Russian physiologist and pharmacologist.

Leeuwenhoek, Anton van (1632-1723): Dutch naturalist, one of the founders of microscopy and microbiology.

Lidforss, Bengt (1868-1913): Swedish botanist.

Mantegazza, Paolo (1831-1910): Italian scientist.

Maximov, Nikolai (1880-1952): Russian botanist, one of the founders of ecological physiology of plants.

Mayakovsky, Vladimir (1893-1930): one of the best Russian poets, headed futurism (avant garde poetic movement).

Needham, John Turberville (1713-1781): English Roman Catholic divine and researcher of microscopic organisms.

Ovid, or Publius Ovidius Naso (43 B.C.-18 A.D.): Roman poet.

Parkes, Alan Sterling (1900-1990): English cryobiologist.

Pictet, Raoul-Pierre (1846-1929): European (born in Switzerland, worked in France) physicist, low-temperature researcher.

Pliny the Elder, or Gaius Plinius Secundus (23 A.D.-79 A.D): Roman statesman, naturalist, writer and historian.

Pouchet, Felix-Archimede (1800-1872): French biologist.

Power, Henry (1623-1668): English physician and scientist.

Preyer, Wilhelm (1841-1897): German physiologist.

Reaumur, Rene Antoine Ferchault de (1683-1757): French scientist, devised the Reaumur thermometric scale. The author of work on natural history of insects.

Rostand, Jean (1894-1977): French biologist.

Schmidt, Petr (1872-1949): Russian zoologist and anabiosis researcher.

Spallanzani, Lazzaro (1729-1799): Italian abbe, one of the foremost scientists of his time, studied reproduction, digestion, circulation.

philosophical and scientific explanation, partially because of the influence of spiritual and vitalistic concepts. Study of the problem was continued by his contemporaries and a generation of biologists who followed [4,5].

Despite skepticism, the scientific community was gradually showing interest in anabiosis. The significance of the preceding experiments was becoming clear, both for biological and philosophical knowledge, and for possible medical applications such life extension. This was reflected in the ideas of Hunter, who published in 1778: "I had imagined that it might be possible to prolong life to any period by freezing a person in the frigid zone, as I thought all action and waste would cease until the body was thawed. I thought that if a man would give up the last ten years of his life to this kind of alternate oblivion and action, it might be prolonged to a thousand years: and by getting himself thawed every hundred years, he might learn what had happened during his frozen condition." Unfortunately, Hunter's experiments with fish were unsuccessful, which possibly discouraged him from developing these ideas further[4,5].

The 19th Century: Proof

Progress in biological knowledge made the complexity of life increasingly clear. At that time, materialism was relatively primitive (in the form of mechanicalism [16]), and many scientists were not satisfied with how it explained the aforementioned complexity of life. As a consequence, vitalism was dominant at the beginning of the century. Over decades, however, materialism developed into more progressive forms such as positivism and dialectical materialism, and after mid-century began to hold its own.

Initially, several factors conspired to hamper the credibility of anabiosis research: imperfection of microscope technique, insufficient knowledge about microorganisms, and lack of experience in some researchers. In 1860, the Biological Society of France decided to resolve the controversy over anabiosis by some carefully controlled experiments [17]. The project became a scientific duel between two researchers with sharply opposing views. Doyere, an organicist [18], supported the idea that organisms were fully determined by the molecular composition and arrangement of their tissues; such organized matter had the potential for life, even in a desiccated state, and could be restored to life by an appropriate physical process. Pouchet, a vitalist, held that "no organism can survive complete desiccation, nor return to life, once all life processes have been arrested."

Doyere conducted the first experiments, and Pouchet followed. Their results were a resounding victory for materialism over vitalism. Anabiosis was real. Desiccation under various harsh conditions was reversible, even with heating up to 100°C and high vacuum. The ample report from the special commission of the Biological Society of France, headed by Broca, confirmed the possibility: "... animals ... reaching the most complete degree of desiccation that can be realized ... with present scientific techniques, may yet retain the ability to revive in contact with water."

This outcome signified a true scientific understanding of anabiosis and an end to serious controversies over its possibility (though doubts would return). Later, Broca's report was improved by Preyer's book *Research of Life*, which cataloged data on previous experiments and introduced the term "anabiosis." Further advances were made in the works of Bernard [4,5].

Interest in anabiosis developed rapidly in different fields of biology, stimulated by problems of both fundamental and practical importance. Among the issues that attracted interest were: discontinuity of physiological processes (or whether all life processes could be reversibly stopped); adaptations to seasonal and climatic changes (i.e. hibernation, anhydrobiosis, diapause etc); preservation of biological material (for transplantation, artificial insemination etc); and hypothermia in mammals and humans [5]. Mantegazza addressed the latter issue in 1866, when he demonstrated that human spermatozoa could survive freezing to -17°C [6]. Pictet (1893) successfully froze algae, rotifers, frogs, snakes, and fish to subzero temperatures, but failed with dogs and guinea pigs, which died when their temperatures fell 10°C below normal [4,6]. Numerous polar expeditions provided data about the reversible freezing of animals (mainly fish and insects), and the technical feasibility of reaching cryogenic temperatures helped to maintain interest in this direction.

The 20th Century: Applications

The rise of anabiosis research continued into the beginning of the 20th century. One of the foremost investigators in this field was Bakhmetiev, who successfully froze butterfly pupae down to -10°C. Precise control of freezing conditions allowed him to determine that during freezing the pupae crossed the boundary between a supercooled and fully frozen state (true anabiosis). Based on this data, in 1901 Bakhmetiev hypothesized that man could be safely frozen for the purpose of life extension. He began promoting this idea, and private donations allowed him to start experiments on animals and later organize a laboratory at Shanyavsky University in Moscow. Bakhmetiev achieved successful freezing of bats to below 0°C, but his untimely death in 1913 — as well as the beginning of the First World War — interrupted further research [4,19,20].

To some degree, others continued the work of Bakhmetiev. In 1907, Lidforss discovered the cryoprotective action of sugars and glycerol for plants. The next year, this same discovery was made independently by Maximov, who researched this problem in great detail and published a book on the subject in 1913 [4].

In 1920s Russia, the idea of life extension through anabiosis was propagated by the "biocosmists" [21], who espoused suspended animation through drying (based on Kravkov's experiments on the storage of dried rabbit ear and human finger tissue [4]). The more familiar approach of resuscitating frozen people through future medicine was suggested by the plays of Mayakovsky, although political oppression in Russia prevented any realization of anabiosis there. Even so, Mayakovsky's 1928 play "The Bedbug" did influence the origin of cryonics in America, later inspiring Evan Cooper [20], author of *Immortality: Physically, Scientifically, Now* and founder of the original Life Extension Society. Another indication of the worldwide popularity of the anabiosis idea was a 1931 science fiction story by Neil Jones, "The Jameson Satellite," that fired the imagination of a youthful Robert Ettinger [22].

Despite ongoing scientific progress in anabiosis, doubts still arose about its reality. Experiments conducted by Becquerel, 1904-50, and Rahm, 1919-26, helped to address such doubts [4,6]. These researchers froze many small living specimens (seeds, moss, bacteria, mushroom spores, algae, rotifers, infusoria) to nearly absolute zero and successfully revived them. However, other scientists' concurrent experiments in freezing larger animals encountered fundamental difficulties. Multicellular organisms the size of mice or rats could not be frozen or desiccated quickly enough to prevent physiological damage, and their cells had no built-in protective mechanisms [23].

In answer to this, the protective action of glycerol was discovered (anew, for animal tissues) by Rostand in 1946 and independently by Parkes in 1948 [6]. (Thus glycerol protection was discovered four times: by Lidforss, Maximov, Rostand, and Parkes.) Cryobiologists began extensive studies of cryoprotective action from glycerol and other substances. Among the important discoveries of the time, rat ganglia treated with 15% glycerol were successfully frozen down to -76°C for 24

State of the Art: 20th Century Facts about Cryobiology

Many relatively large animals can tolerate different amounts of freezing. The most impressive examples are pupae of the butterfly *Cnidocampa flavescens* that can be frozen down to -180°C [6], and the Siberian newt [25] which tolerates -40. The latter, moreover, can be revived after several years in permafrost. Data based on radiocarbon dating suggests revival even after 90 years [26], which could furnish an argument for permafrost burials.

The general explanation for freezing tolerance in animals appears to be the following:

(1) Extracellular ice-nucleating proteins provide many centers for ice formation.

(2) The extracellular space also includes antifreezing proteins and other freeze-resisting substances (e.g. glycerol), which inhibit the growth of ice crystals. Jointly (1) and (2) provide the formation of many tiny, nondamaging crystals that inhibit further crystallization.

(3) Certain intracellular substances like trehalose (a sugar) and proline (an amino acid), increase the flexibility of cell membranes. This provides protection against the bending and stressing that occurs when the cell loses its water during freezing and its volume decreases significantly.

(4) Other intracellular substances, such as glycerol, sorbitol (an alcohol), and glucose, substitute for water that leaves the cell during freezing. This maintains a minimal cell volume during freezing and stabilizes the intracellular surroundings.

Mechanisms providing freezing tolerance (including synthesis of the above substances) are launched in the organism by seasonal changes (e.g. the length of daylight) or by decreasing the body temperature below a certain limit [27].

hours. Once other tissues and organs had been frozen reversibly, researchers began to consider medical applications of these techniques.

Although successful freezing of complete organisms remained elusive, researchers managed to revive golden hamsters cooled to slightly below 0°C, and achieved similar results with humans cooled to 9°C. With perfect glycerol perfusion, some suggested, a mammal might be frozen to -70°C and stored for an extended period [6]. Many leading cryobiologists spoke favorably about the possibility of someday safely freezing humans [6, 23, 24].

Progress in cryobiology and other fields (especially cryogenics technology, molecular biology, and computer science) lent further credibility to ideas about reanimation. Robert Ettinger's 1964 book, *The Prospect of Immortality*, offered a scientific argument that human freezing for the purpose of life extension could be realized immediately for the newly deceased, whose resuscitation would be carried out by future medicine [24]. Cryonics, the practice of freezing for this purpose, finally got its start.

Why didn't cryonics appear earlier? The technical, scientific, and philosophical foundations existed long before the 1960s, as we have seen. (In retrospect, I believe that the basic conditions necessary to practice cryonics may have existed as early as the 1920s, especially in Russia.) The idea first emerged decades before and resurfaced repeatedly, but somehow it never overcame the various unfavorable environments. Perhaps too many qualifying factors were necessary before the actual practice of cryonics could appear; consider that the U.S. of the '60s offered especially favorable conditions: a strong economy, political freedom, and a large educated class. Even when cryonics organizations finally started freezing people, this movement remained the preoccupation of a tiny minority, as is still true.

Anabiosis research during the 20th century echoed the work of the previous eras: experiments demonstrated the possibility, doubts dominated, and then new proofs followed. The idea of freezing humans seems to have recurred again and again at roughly 100-year intervals (Boyle, Hunter, Bakhmetiev, Ettinger), with each recurrence taking a more extreme form. How will our latest version of anabiosis fare, and what might replace it?

The 21st Century: Prospects

There is little doubt that the safe freezing of humans will be realized in the next century. Perhaps progress in conventional cryobiological methods will make it possible. Perhaps some unexpected technology such as "ultrasound freezing" could emerge. Perhaps it may even require the fixation of cell structure by artificially designed molecular devices (as proposed by Drexler) [28].

Or perhaps the problem requires a totally different approach: instead of freezing extent *Homo sapiens*, we might use genetic engineering to convert humans into a species more amenable to this state. Human cells have no mechanisms to tolerate freezing, and current perfusion techniques do not provide sufficient cryoprotection; advanced genetic engineering methods might offer us built-in cryoprotective mechanisms, such as intracellular glycerol synthesis. Such a characteristic incorporated into the human genome could provide perfect freezing preparation for the body if the temperature should fall below, say, 15°C. A similar characteristic might enable suitable fixation of body structure *without* freezing, or with freezing at relatively high temperatures (e.g. at -79°C). Once such "cell programming" became possible, it might be applied at any time before a person's death. . . or maybe even afterward.

References and Notes:

1. Probably the most ancient recorded observation that frozen fish can become alive. Ovid wrote his poem "Tristia" about 9 A.D. during his exile to the shore of the Black Sea (in Tomi, now Constanta, Romania). The original Latin reads: *Vidimus in glacie pisces haerere ligatos, Sed pars ex illis tum quoque viva fuir*.

2. Anabiosis originates from the Greek words "ana" (up) and "bios" (life), and means "return to life." (Originally used for the "return to life" only, later extended to the suspended state too.) It is considered rather improper by many authors, and the synonymous terms "suspended animation," "biostasis," "cryptobiosis," "abiosis," "latent life," "seeming death," and "lethargy" are often used instead. However the term "anabiosis" appeared when its possibility was scientifically proven and then was used for a long time (especially in Russia). Also, this term was used by early cryonicists [29]. Moreover, as it means both "return to life" by its name and "suspended life" by its usage, possibly one might consider it more proper for cryonicists than other terms.

3. There are several approaches for the analysis of history based on different interpretations of motive forces for historical development. Usually these forces are economical or political, as suggested, for example, by Marx or Kuhn. Actually, I think human history is such a complex (hence random and chaotic) thing that the interpretations cannot be absolutely true, but can still be useful as heuristics. Moreover, to my mind, the history of science and technology resembles an heuristic search (with random elements) in the space of possible theories and technologies. Of course, the heuristics become more and more powerful, and the size of unexplored space decreases.

4. Schmidt, P. *Anabiosis* (1955) [In Russian].

5. Keilin, D. "The problem of anabiosis or latent life: history and current concept" *Proceedings of the Royal Society B*, 150:939 (1959).

6. Smith, A. *Biological Effects of Freezing and Supercooling* (1961).

7. Supercooling: decreasing the temperature of a liquid below its freezing point. As a rule the full (true) freezing (meaning all liquids solidify) of living organisms occurs at about -150°C [23]. This value is considered the upper limit of *cryogenic* temperatures by low-temperature physicists [11]. Thus the state before full freezing should be referred to as a "supercooled" one. However, metabolism could be almost completely arrested at much higher temperatures; anabiosis can exist in the supercooled state, too [23].

8. Mikulinsky, S. (ed) e.a. *History of biology* Vol. 1 (1972) [In Russian].

9. Dualism: the philosophies combining material and spiritual interpretations. Usually the act of creation and/or the human consciousness/soul were interpreted spiritually. All other facts were viewed materially. In the 16th and 17th centuries many scientists were dualists.

10. Vitalism: the philosophies postulating the existence of the special "force" (or soul) that animates (or moves atoms in) living beings, distinguishing them from the non-living world. Vitalists are the strongest opponents of the anabiosis idea. To them the lack of movement means the loss of this "vital force," hence death. Moreover the acceptance of the mechanical character of living processes, their full dependence on a material substrate and external conditions, means negating the soul entirely.

11. Brodyansky, V. *From Solid Water to Liquid Helium (History of Cold)* (1995) [In Russian].

12. Indeed a simple thermoscope was known to the ancient Greeks. It was only re-invented at the end of the 16th century by Galileo. Thermometers were imperfect until the beginning of 18th century. It is usually accepted that the microscope was invented at the end of the 16th century (though some primitive one-lens constructions were used earlier) and then was greatly improved by Leeuwenhoek.

13. Eel-worm: small animal (several mm length) of class *Nematoda*, phylum *Nemathelminthes* (*Turbatrix aceti, Anguillulina tritici, Tylenchus tritici*).

14. Rotifer: small animal (several mm length) of class *Rotatoria*, phylum *Nemathelminthes* (*Callidina constricta, Philodina roseola*).

15. Tardigrade: small animal (length about 1 mm), separate type (*Hypsibius oberhausteri, Milnesium tardigradum, Macrobiotus hufelandi*).

16. Mechanicalism: a philosophy explaining the world through the mechanical movement of atoms. The early (16th-18th centuries) materialists (as well as dualists) were mechanicalists, following the ancient materialists and atomists. Industrial development stimulated technology, and the latter science. Mainly this science consisted of mechanics and the related fields of physics and mathematics, since these were important for technology of the time. In its turn, the development of mechanics influenced philosophy.

17. Another reason for the Biological Society of France's interest in anabiosis was the controversy on spontaneous generation also current at the time. These controversies were related, since anabiosis was often explained through spontaneous generation, and vitalists were both the opponents of anabiosis and the advocates of spontaneous generation. Pouchet also was among the main proponents of spontaneous generation, in which he was defeated by Pasteur in 1861 [4,5].

18. Organicism: a material explanation of life as the result of a certain organization of living beings, a simple manifestation of features of organized matter.

19. Chulkov, A., Azanov, V. *Bakhmetiev's Will* (1980) [In Russian].

20. Soloviov, M. "The 'Russian Trace' in the History of Cryonics" *Cryonics*, 16:4 (1995).

21. Biocosmism: a movement in Russia in the 1920s, originated from universalism (an anarchist movement). Its goals were cosmic flight, personal immortality, and resurrection of the dead (i.e. the achievement of basic freedoms in time and in space).

22. Ettinger R. "The Past, the Present, the Future, and Everything" *Cryonics*, 15:3 (1994).

23. Lozina-Lozinsky L. *Studies in Cryobiology* (1972) [In Russian].

24. Ettinger, R. *The Prospect of Immortality* (1964).

25. Siberian newt: an animal of the class *Amphibia* (*Salamandrella keyserlingii* Dybowski, earlier named *Hynobius keyserlingi*). It is similar to a salamander or to newt, and so has this name in English translation, but has its own name in Russian: "uglozub" (angle-tooth). It lives in the European part of Russia and in Siberia (including the permafrost area). Its length is about 5 cm, but can grow as long as 16 cm. Its main cryoprotective substance is glycerol.

26. Vorobieva E. (ed.) e.a. *The Siberian Newt. Ecology, Behaviour, Conservation* (1995) [In Russian].

27. Storey, K., Storey, J. "Frozen and Alive" *Scientific American*, Dec. (1990).

28. Drexler K.E. *Engines of Creation* (1986).

29. Ryan, D. "The Prophet of Immortality (interview with R. Ettinger)" *Cryonics*, 16:3 (1995).

30. Generally known information (i.e. contained in encyclopedias, dictionaries, handbooks) is not referenced.

Voluntary Biostasis?

by Scott Badger, Ph.D.

I once heard that there are over one million human beings dying every day. Just now — *just a second ago* — hundreds died. Some died of old age, some were killed in accidents, some were murdered, some starved, some lost their lives to cancer, and some commited suicide. For most of us, the moment of another person's demise goes by and we go on, accepting this human death march as a natural and inevitable process. Meanwhile, an unfathomable amount of information is lost as these people breathe their last and are relegated to their graves. Their lives were rich with experiences, discoveries, insights, dreams, hopes, and much, much more. Only a small fraction of what they learned was passed on to their children, their students, or their colleagues. The rest of who they were, the majority of the information that constituted their lives, is gone.

One of these people who will disappear in the next few months is my mother. A little over three years ago, she was diagnosed with Alzheimer's Disease. Since then, my father and I have watched her mind gradually and agonizingly slip away. Today, there is little left of my mother's identity. When death comes to her, I will not grieve in the same way that I will for my father when it is his turn (neither of my parents have any interest in cryonics, by the way). The pain that will come when I lose my father will be relatively sudden and sharply felt. The pain of waiting for my mother to succumb to this Degenerative Brain Disorder (DBD) has been more chronic and blunted. At 85, she has outlived all of her siblings. My father and I are all she has left. Her burial will not be extravagant or ceremonial. Neither of us are religious and neither of us *honor* her death.

My mother *has* made me think more about death, though. All of us recall our first experience (and perhaps our early fascination) with death. I remember the moment as a young child when I fully comprehended the concept that I *would* die someday. Alone in my room, I cried for a half-hour feeling bitterly disappointed and afraid. Death has humbled us, frightened the hell out of us, intrigued us . . . and even tempted us. As a psychologist, I have listened to the suicidal ideations of many clients. Most of them have two psychological elements in common; hopelessness and helplessness. They have decided that life will only get worse and worse, and they believe they are powerless to change things for the better.

The great majority of people would never approve of somone attempting to commit suicide. If asked why, most would probably say that the suicidal person dosn't understand that things *can* get better and life *is* worth living. Our culture has, however, tempered its views toward *assisted* suicide, when the individual has a terminal disease and is in great pain. It is clear that the public will only sanction assisted suicide if the situation is truly hopeless and the victim is truly helpless.

Assisted suicide is still a thorny and controversial issue, an affront to most religious doctrines. That controversy is compounded when we are faced with patients who are terminally ill, but not yet at death's door. How would we react to "healthy-appearing" individuals who wish to be cryonically suspended rather than go through an expensive treatment regimen designed to slow the progress and minimize the pain of what is undeniably a terminal disease? These individuals may prefer to avoid the burden placed on their families by what is often highly expensive palliative care designed to comfort but not to cure. (Indeed, I suspect the cost of palliative care typically exceeds the cost of cryonic suspension.)

Every day, people discover that they have developed Parkinson's, Alzheimer's, or some other DBD. Quite likely, any structural information in the brain (i.e. *you*) lost during the course of such a disease will be irretrievable. In such a situation, devout cryonicists would want to take action to preserve the integrity of their brains' structure as well as to avoid compromising their rational decision-making capacity. In other words, such individuals would want to make arrangements to undergo suspension well before they die. This places the the cryonics facility in a very difficult position. Although we as cryonicists might not perceive this to be an act of suicide, the justice system would.

A case has already come before the courts in California addressing this issue. An individual who had contracted a brain tumor wished to undergo cryonic suspension before any further damage occurred. The courts ruled against him. [*Long-time* Cryonics *readers will*

Scott Badger is 48 years old and currently works as a school psychologist in the Dallas, Texas area. He received his Bachelor's degree in Biology and his MBA (marketing specialization) from Indiana University in Bloomington, Indiana. After working in various business environments for several years, he returned to school and earned a Ph.D. in Counseling Psychology from Oklahoma State University.

recognize the Thomas Donaldson case, detailed by Mike Perry's "For the Record" column this month. --ed.] Although the justice system may have only intended to avoid legislating assisted suicide, its legal definitions clearly prevented this person from choosing voluntary biostasis as an alternative to costly palliative care. Voluntary biostasis remains in the same legal condition to this day.

I'm not a card-carrying Libertarian, but if I am judged to be of sound mind, as determined by a psychologist or psychiatrist, then I should be the master of my body and my fate. I feel that voluntary biostasis should be an option for all mentally competent persons facing a terminal disease or a non-terminal degenerative brain disorder.

Of course there will be many dilemmas. What happens when prisoners on death-row wants to be cryonically suspended upon being executed? Or what if the individual is no longer a prisoner, but has a history of violent crimes? As a private institution, a cryonics facility has every right to refuse services to anyone. But if cryonics catches on and the cryonics industry grows, then anyone will probably be able to find a willing provider. If cryonics truly comes to be regarded as a life-saving medical treatment, then it will be increasingly difficult to refuse someone services. It would be like a hospital emergency room turning a critical patient away. Will we, as a society, insist that all are provided for, or will we want to have some choice regarding who is revived and who isn't? Will cryonic suspension become a service that is awarded to those who meet certain social/political criteria?

Let me conclude by saying that for the last 30 years I have been complaining about being born in 1949. I have been haunted by the morose suspicion that I may *just miss* the breakthroughs that will allow for greatly extended life spans. I look at today's children and wonder if they have any idea how much closer to that reality they are than I am. My only chance is cryonic suspension, and if that's all I have, I want to be able to take full advantage of the technique. I want to have the legal right to undergo voluntary biostasis. I do not want to be constrained from exercising this right by laws born out of religious dogma. To borrow a slogan from a completely unrelated social movement, "My body, my choice."

Letters to the Editor
Continued from page 4

a bit less damaging to the structures of the brain. A further opportunity might be a much larger cryonics awareness in society. Even if society still questions cryonics, it might question it significantly less. Threats or challenges might be that new technologies along with understanding will undermine confidence in cryopreservation techniques used thus far. Another challenge might be that new and significantly better cryopreservation techniques may become available at some uncertain time just a year or so down the road. What difficulties does this cause both for people who perform, and for people who undergo, cryonic preservation in the interim?

Generally, no one can predict exactly what a new environment will bring. But a primary component in preparing for change is to develop a sound, full, forthright understanding of a movement's existing dynamics as well as its product and services. Charles Platt's article is a solid step in the development of such an understanding, garnered over years of experience.

(Comments may be sent to my email address tropbob@aol.com)

Sincerely yours,
Robert Elschlager

Dear *Cryonics*,

I was watching a Sinatra obituary yesterday. CNN quoted Ol' Blue Eyes as having said, "I've learned a lot in this life and I don't want what I've learned to die with me."

Though I think what he was referring to had more to do with his legacy and those who came after, building on his achievements rather than any physical attempts at immortality, an idea occurred to me...

I would think that one celebrity endorsement or even membership could do more to raise Alcor's profile than any number of magazine advertisements could.

Has Alcor ever attempted to target celebrities? One would think that we have a product which would have a natural appeal to individuals with limitless resources. After all, Hollywood sorts often go in for experimental medical procedures aimed at restoring youth, beauty, and vigor.

If we could perhaps choose a few dozen, tailor a "Who We Are, What We Stand For, and How We Can Help You" letter, and then canvass them through their publicists or whatever other access we can think of, this could be a very low cost operation yielding potentially large dividends. (There could be many millions in bequests from a single success.)

It's not just the old timers who should be targeted — there must be many young stars with an open mind who might be persuaded that their only realistic chance of a reunion with loved ones in a material rather spiritual world is with us.

D. Levine
London

Brian Shock replies:

Back in the early 1960s, Robert Ettinger tried to drum up interest among well-known authority figures by mailing out copies of his book Prospect of Immortality. In the late 1970s, Mike Darwin and Steve Bridge offered noted science fiction writer Fred Pohl a free suspension (which Mr. Pohl did not accept). Cryonicists put a great deal of effort into recruiting the late Dr. Timothy Leary, but despite his many years of cryonics arrangements, Dr. Leary eventually decided against suspension.

On the other hand, we have *been successful at drawing in* scientific *celebrities such as Ralph Merkle, Eric Drexler, Marvin Minsky, and others.*

In the Name of Liberty: The Thomas Donaldson Case.

by R. Michael Perry, Ph.D.

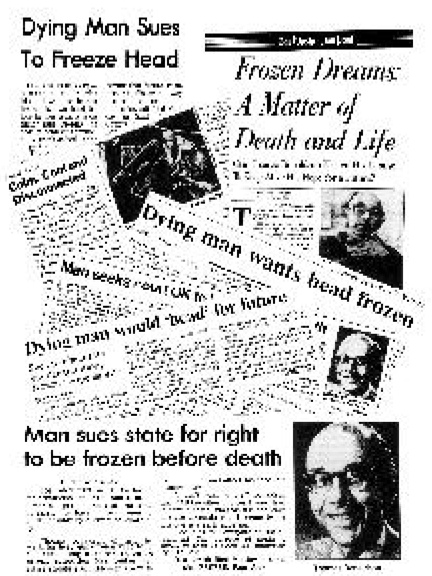
"The only purpose for which power can be rightfully exercised over any member of a civilized community, against his will, is to prevent harm to others. His own good, either physical or moral, is not a sufficient warrant."
—J.S. Mill[1]

As cryonicists, we are well aware of how certain outsiders would seek to limit our freedom to act, purely "for our own good." For example, we wish to be frozen under the best possible conditions, when the time comes. This would often call for starting suspension procedures before death, a practice that is not yet recognized as legal. For many of us, this issue is an academic one for now; we are in good health and our suspension is not imminent. Others are not so lucky.

Thomas Donaldson, a Ph.D. mathematician and long-time cryonics activist, was diagnosed with a brain tumor in August, 1988. The tumor, an astrocytoma, was a particularly dangerous sort that usually resulted in death within a few years. By the time this fatality occurred, however, Donaldson would suffer substantial brain damage. To avoid this, the freezing procedure would have to begin while he was still alive. By legal criteria it would be "assisted suicide" at best and "first-degree homicide" at worst. Donaldson sought relief in the California courts, and his case was supported financially by his cryonics organization, Alcor.

The Donaldson case was not simply the instant product of a medical emergency, but had a long gestation.[2] Thomas was born in Kentucky in 1944, and attended the University of Kentucky before moving on to Illinois and the University of Chicago. Although he found the Chicago atmosphere depressing, darkened as it was by the Vietnam War and by people who were "very negative about the future," he managed to earn his Ph.D. in mathematics there in 1969. Emigrating to Australia soon afterward, he then made an excursion to New Guinea where an encounter with a primitive culture, the Chimbu, opened his eyes to new facets of human thought and behavior.

The Chimbu thought the airplane in which Thomas arrived must be a living creature and wanted to know where its genitals were. "They were not used to the idea of people actually being able to build something like that," Thomas later reported. But the Chimbu were eager to learn about Western culture. "They had a lot of misconceptions as to how things worked, but in their terms, they were actually being very logical." Thomas was impressed by "the very matter-of-fact way in which these people responded [to new things] ... they were not *astounded* by anything. They were *interested*."



Thomas had earlier learned about cryonics, and now found his interest growing. "I remember reading Ettinger's book [*The Prospect of Immortality*]. And when I came back from New Guinea, I said, Gee, these people have come from twenty thousand years ago. Where will we be twenty thousand years in the future? And so I was even more interested. And, I was beginning to understand that ... I had the death problem too."

Thomas started corresponding with other cryonics enthusiasts, and by the late '70s was writing articles for *Long Life Magazine*, then the leading publication in the field. In 1975 he signed up for cryonic suspension; in 1985 he came back to the U.S. In the '80s he started writing science articles and book reviews for *Cryonics*, a practice that continues today.

Then, in 1988, came the brain tumor. Suddenly, time seemed short and options narrow. There were three basic alternatives. One was that it would turn out to be a false alarm: the tumor would go into permanent remission or otherwise become manageable. (This in fact is what has happened — the tumor is still in remission, thanks in no small part to the expert treatments Thomas received at the time — but the benign outcome did not seem likely.) The second alternative was a grim and cruel one of allowing the disease to run its course without intervention, damaging or destroying the brain of the patient until, when death finally intervened, there might be little left that was worth suspending. The third was to wait until the time seemed right, then hasten one's death to escape brain destruction. The problem with hastening one's death, which legally amounted to suicide, was that an autopsy was required in most cases. The main method that would *not* require autopsy was self-starvation and dehydration. That was a tough proposition — one of Alcor's patients, for example, had taken over ten days to die by that route[3] — but it would be the best way out under the circumstances. The time seemed right to try for something better.

On April 30, 1990 Thomas Donaldson filed suit in Santa Barbara Superior Court for the right to have cryonic suspension started *before* his legal death. Assisting him was Christopher Ashworth, a talented Constitutional lawyer who had helped save Alcor in the Dora Kent crisis. Still, it was an uphill battle, as everyone realized. Meanwhile this suit attracted the media like bees to honey, and they converged on the Alcor facility, then in Riverside, California. Mike Darwin reported "an unprecedented wave of media attention, like nothing we've ever experienced before. In the space of 14 days we had 31 film and TV crews, print reporters, and other assorted journalists through here. There were major stories on the front pages and first sections of hundreds of daily and weekly newspapers across the nation. The *Washington Post* featured a major, thoughtful, and very well done article on the Donaldson case, cryonics, and Alcor, and *Time*, *Insight*, and other magazines featured shorter articles describing the suit. CNN and a number of news stations in large local markets (L.A., San Francisco, Minneapolis, Seattle, and New York) carried stories ranging from a brief announcement of the suit to in-depth four-part reports."[4]

Perhaps the high-water mark was the Phil Donahue Show which was taped May 19 and aired a few weeks later. In addition to Thomas, the show featured Mike Darwin and Carlos Mondragón who at the time were, respectively, Alcor's Director of Research and its President. At first there were awkward moments while Donahue, an obviously bright but not too informed host, struggled to understand the essence of this case.

That done, however, Donahue easily sympathized with Thomas, inasmuch as the basic issue was one of rights — not whether cryonics was a good or bad idea, or would or wouldn't work, but whether someone should have the freedom to choose this option in the manner Thomas wanted. Mike and Carlos did an able job describing how and why cryonics might work, and how one's arrangements were handled financially at Alcor. Thomas came across as a rather nerdy egghead (baldness enhanced by his radiation treatments) who nevertheless had a point worth making — and he did make effectively. The general audience reaction showed a healthy amount of doubt and skepticism about cryonics, yet considerable sympathy for Thomas, too. When pressed, almost everyone seemed to agree that, yes, one should at least have the *right* to choose the freezing option, and even to have the procedure started before death, if one were terminally ill and wanted it done that way.

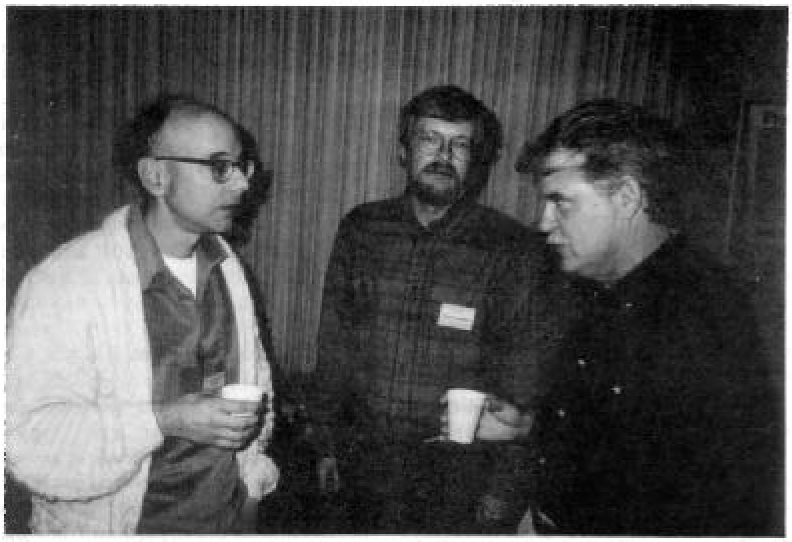
Interests of the State were represented by Alan L. Lasnover, M.D., of the California Medical Society, with its opposition to physician-assisted suicide and by implication, premortem cryonic suspension. "You're looking for something," he told Thomas, "which to me is pie in the sky." But again, the issue was one of rights, not whether one believed in an option that was being sought by someone else. Again, the audience seemed to understand and to sympathize more with Thomas than his uncomfortable opponent.

Video capture scene from the Phil Donahue show. Left to right: Thomas Donaldson, Carlos Mondragon, Mike Darwin, Phil Donahue.

What followed after this — the actual court case — seemed by comparison anticlimactic. Ashworth did his best, yet the law was the law. Thomas was asking for physician-assisted suicide, under the narrow legal definition, something that had not been legislated in California or anywhere else at the time. An initial, unfavorable ruling September 14, 1990 was upheld in the California Appeals court January 29, 1992 — Thomas lost his case.[5, 6] With insufficient funds to pursue it any further, there the matter rested.

Yet this tactical defeat was, I think, a strategic victory for the cause of cryonics. This is not to pretend that things were just as we'd like. Later in 1992, for example, a brain tumor victim would be frozen by Alcor, without the benefit of a premortem suspension.[7] But I think we can temper our unhappiness with some optimism. The Donaldson case did generate a lot of favorable publicity. Arguably, this more than offset the cost of the unsuccessful outcome. It can also be seen in a larger context, as a significant milestone in a generally favorable, developing trend. There is widespread feeling now that individuals do have the right to make choices affecting their own life and death, and that current laws are too restrictive and should be modified. Modifications, though contested desperately by certain conservative groups, are finally appearing, as in the recent legalization of physician-assisted dying in Oregon.

Laws allowing physician-assisted suicide might help cryonicists eventually, though there are still many obstacles to overcome. Cryonics, however, is not about suicide, but instead about saving and continuing one's life. (This point indeed was made with some vehemence by Thomas on the Donahue show, in his confrontation with Dr. Lasnover.) It will take research for cryonics to be seen by the public, and legislatures and bureaucrats in particular, as anything more than a treatment for dead bodies — whatever its present prospects may be. If



Thomas Donaldson, Gregory Benford (science fiction author), and Christopher Ashworth (attorney) at the December, 1990 Donaldson Legal Defense Fund Dinner. (Photo: Steve Harris)

we can demonstrate reversible suspended animation, *then* we can hope to see cryonic suspension accepted as a medical procedure, one to be applied, when needed, to *save* a life and not simply to end it.

REFERENCES:

1. Mill, J.S. *On Liberty* Introductory 342-6.

2. Background information on Thomas Donaldson is based on Whelan, R. "The Donaldson Perspective," Cryonics (Jan. 1992) 12ff.

3. Darwin, M. *Cryonics* (Jan. 1991) 17.

4. Darwin, M. "What's New," *Cryonics* (Jun. 1990) 2.

5. Mondragón, C. "Donaldson Gets His (First) Day in Court," *Cryonics* (Oct. 1990) 6.

6. Whelan, R. ed. "Appellate Decision on Donaldson," *Cryonics* (Mar. 1992) 1.

7. Glennie, M.M. "A Well-loved Man," Cryonics (Sep. 1992) 8-9; also see Jones, T. "More on Jim's Journey," ibid. 10-13.

I thank Thomas Donaldson for reviewing this article and making useful suggestions. I am also indebted to Jerry Searcy for supplying information on the Phil Donahue Show that featured Thomas Donaldson. And credit is due our Editor, Brian Shock, as it often is, for his work on the text leading to further improvements. MP

Errata:

Last quarter, in "For The Record," I reported on the case of Beverly Greenberg, a young cryonics activist who died under tragic circumstances in 1973. Written documentation from the period is hard to obtain, and I had to rely somewhat on an "oral tradition" which, I now have good reason to think, had two significant errors, though the overall gist of what happened is still pretty much the same.

First, Beverly probably did not die of carbon monoxide poisoning. This information comes from Mike Darwin, who saw the body in the Suffolk County (NY) morgue shortly after death. Her face, he emphasized, was chalky white, *not* the cherry red usually observed in victims who breathed the deadly gas. (Carbon monoxide, when breathed in, produces carboxyhemoglobin which gives blood a bright red color but is metabolically useless, so that poisoning victims generally have a flushed or rosy appearance.) True, she was found in her car, the gas tank *read* empty, the keys were in the ignition, and it was in a closed space (in the Cryo-Span facility in West Babylon, New York, where her father was stored in suspension). All of this *sounds* highly suggestive of carbon monoxide poisoning, and in fact two individuals I talked to, both longtime cryonicists who had, years ago, independently spoken to Mike Darwin about this case, reported him telling them it *was* carbon monoxide. (One of them even recalled him saying her face *was* cherry red.) With both of these seemingly reliable sources saying the same thing, I didn't consider it an urgent matter to check with Mike firsthand — until too late. As for the gas tank being "empty," Mike said that at the time Beverly's funds were meager and she tended to run her car nearly empty much of the time.

So what did Beverly really die of? In the first place, with carbon monoxide probably ruled out, there is no particular reason to suspect suicide either. A more likely cause of death was simple, accidental hypothermia, something to which some are more susceptible than others. It could have been aggravated by such factors as hunger, valium (she was taking this at the time), and possibly alcohol. The date of her death, we recall, was the middle of November, when New York gets very cold. Then too, the Cryo-Span facility was unheated.

Death records could perhaps settle this question. Unfortunately, when I recently contacted the New York State Dept. of Health, Vital Records Section, they told me the records would be sealed, for privacy reasons, for another 25 years.

There is another error I made in this article. Perhaps I misunderstood Curtis Henderson, but I thought he meant that CSNY froze "Frank Riley." No, Mike Darwin tells me it was he and "Corey Noble" who carried out the initial freezing to dry ice temperature. Riley, however, had been a Trans Time case from the beginning, and was never in New York nor "placed on dry ice by CSNY." Curtis did go out to the Trans Time facility in California and assist with the later stages of the cooldown, and helped get a capsule for the patient. Most importantly at least, Riley's suspension does continue to this day.

Sorry about the errors — history can be a tricky business — but it's an interesting one too.

Cryonics Interview: Eric Drexler

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

Part II of II

by Russell Cheney

Eric Drexler (ED): Regarding the effects on expected time of realization: my sense is that to the extent that there are some individuals with a vision of where this [*molecular nanotechnology*] can go and concern for it that in part come from their desire to see a really advanced and capable medical technology — to the extent that those individuals become involved in making things happen on the path — yes, there will be a substantial effect. But nothing that I see in the structure of the US research community today suggests that having clearer scenarios of the down-stream phase that starts to look less like wet chemistry or biology, would have much effect on speed. Though it might have a tremendous effect on people's perception of the practicality of the long-term goal. Or it might have a tremendous effect on the extent to which people sign up for cryonic suspension today.

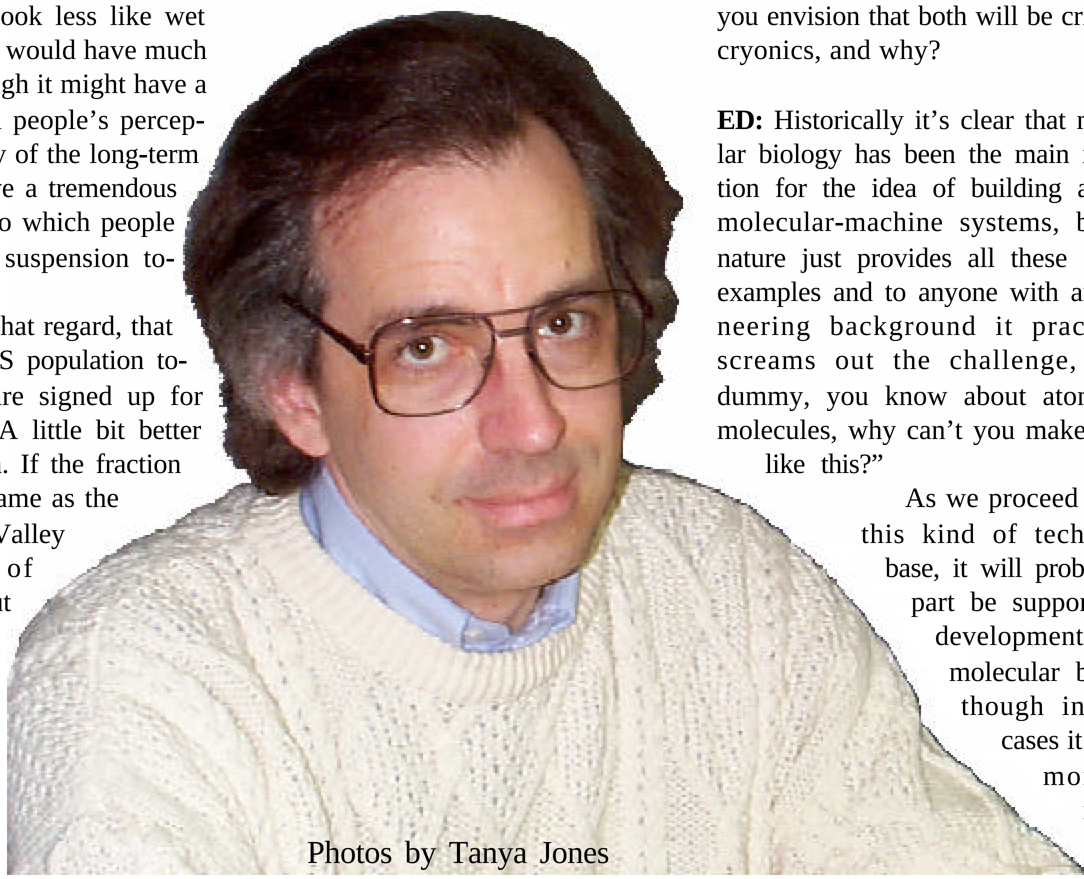
I would note, in that regard, that if you look at the US population today, what fraction are signed up for cryonic suspension? A little bit better than one in a million. If the fraction signed up were the same as the fraction of Silicon Valley programmers, or of people who have put in some time as researchers at Xerox PARC in the last ten years, then what you would just naively expect is that the number of people signed up today in the US would be in the millions.

Russell Cheney (RC): Right.

ED: So what this obviously shows is that cryonics is preying on the gullible and the ignorant.

RC: (Chuckles.)

ED: People who don't know much about the brain, you know, people like Marvin Minsky [7].



Photos by Tanya Jones

RC: (More chuckles.) I hope there's some easy way to clearly designate facetious comments in the final written article of this interview.

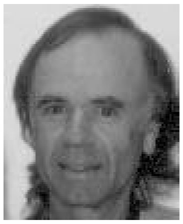
ED: "With his tongue in his cheek, he remarked..."

RC: I think so, something like that.

How do you see the relationship between molecular nanotechnology and the molecular biology disciplines that are currently able to create designed proteins, etc.; is molecular biology a subset of molecular nanotechnology; do you envision that both will be critical to cryonics, and why?

ED: Historically it's clear that molecular biology has been the main inspiration for the idea of building artificial molecular-machine systems, because nature just provides all these striking examples and to anyone with an engineering background it practically screams out the challenge, "Hey, dummy, you know about atoms and molecules, why can't you make things like this?"

As we proceed toward this kind of technology base, it will probably in part be supported by developments from molecular biology, though in many cases it will be more a matter of



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.

people learning lessons there and applying them to different physical systems. Protein-like molecules that aren't proteins are starting to become popular. As was suggested some years ago, there's no particular reason to think that biology has come up with the optimum polymer for engineering of protein-like molecules. And lo and behold, researchers are now concretely coming up with examples of things that hold more stable and predictable patterns.

So that's proceeding. It's in some sense an outgrowth of molecular biology, but it's also starting to move away from molecular biology. Ultimately I think that the big intersection will be in the application of new molecular devices and sensors to molecular biology. Already the progress that's been made in the understanding of the biology at the cellular molecular levels is noteworthy. Which often from a distance seems kind of puzzling; I mean, how can they tell all these things about these little tiny structures?

Much of the information is gained by indirect paths that lead through the use of other molecules as tools. For example, the polymerase chain reaction, which has been so important in DNA work in recent years, uses molecular machines borrowed from bacteria that live at high temperatures, to duplicate DNA in the test tube, and do that for us.

So already we're making heavy use of molecular machines borrowed from nature, and recently tinkered with a little bit, to learn about biological systems. What we'll be able to do in the future is to have non-biological devices that can be used to study biological systems and do so in enormously more detail than is possible today. Just for a concrete picture of how one could get the kind of understanding of cells that I think James Watson was saying was impossible in his second edition of *The Molecular Biology of the Gene*; he makes some statement to the effect that we'll never really be able to understand the molecular-detailed picture of the structure of a cell and of DNA [8].

Here's a scenario: you do what people can do in the laboratory today, which is take cells and put them in a little droplet of water and if you want to add a little bit of glycerol that helps, but in this particular case you don't need it. And you take the droplet of water and you slam it into some very conductive material, copper if you're feeling poor, a chunk of diamond if you make the investment, which is not that big an investment because we don't need that big a chip to use as a heat sink.

In any case, you have your conductive material at liquid helium temperature, and the droplet of water splats onto it, and cools so rapidly that you don't get formation of ice. That's not an effective technique for biological purposes and preserving cells, but on the other hand it does a marvelous job of keeping everything almost exactly where it was while you then, with molecular machines that can work at very low temperatures, go in and take apart the structure, roughly speaking, one molecular layer at a time, keeping notes on what was where. And if you do that, you have a really complete map of something that's a reasonably good approximation to a snapshot of a normally-functioning cell. Now do that for enough different cells, and abstract the patterns from that and you've got a reasonably good idea of what's going on in biological systems that's not the kind of data you could get today, by a long shot.

I certainly expect to see enormous contributions to molecular biology, and part of what makes the cryonics reanimation scenario a reasonable one is that in the future we're going to have enormously better tools for characterizing biological structures, both healthy tissue and frozen tissue, and the relationships between healthy tissue and frozen tissue. And you'll be able to make 50,000 identical blocks of one cubic millimeter of healthily-structured neural-tissue, and freeze them under 50,000 different conditions and look at the results in molecular detail and see what the correspondence is between the results and previous conditions, and do just such an exquisite job!

RC: It will become practical to do that.

ED: Yes; the bulk of what I'm describing would not necessarily require anybody's attention; it's people's attention that would be expensive.

RC: Could you share your current thoughts on the specifics of the reanimation process, and the role molecular nanotechnology and other technologies and sciences might encompass?

ED: I will just say in outline that if I had to sit down and sketch out a reasonably detailed technology scenario for how, given a lot of technology base, given a lot of knowledge in place, how would one go in and effect repair in a particular clinical case: I would say that, roughly speaking, first you start by not causing any thawing injury, sort of like reperfusion injury only much worse. So you would stay at liquid nitrogen temperature, or even below; it might be that there is an advantage to additional stabilization during some of these processes.

There's a lot of ice in the tissue; I think a good first move is to remove that ice, by a sort of mining operation. Have structures that would go in and say, "Ah. yes, there's an icy surface and we'll remove a little bit of this material and yes, that's ice, a little bit of this." And say, "Ah, this here is stuck in place, this isn't ice; this is a protein, OK." Once you had removed the ice and the ice crystals, keeping track of course of how much sodium and chlorine and potassium, and so on, were lodged in the crystal in different places, you'd find that you had a whole lot of working room and not a whole lot that's terribly blocking access to surfaces worth working on.

Where I think the scenario would proceed from there is essentially to moving things around so that they're in the right locations. OK, there's been dehydration and some tissue's been compressed. As a next step you do some stabilization. At some point here you probably want to raise the temperature so that various materials are a bit more pliable and flexible and not brittle. So now you have what in effect is a structure that is sort of cross-linked, but it's not by chemical reactions that just occurred haphazardly, maybe not chemical reactions per se at all, but rather there're a whole lot of little links holding things in place.

Now you can, at a gross morphological level, put things back where they belong. And at a finer scale move in and put things back where they belong. Once you've put everything back where it belongs and gone back to a lower temperature, you would put water back in. But now you put the water in without all the disturbances that are caused by an actual freezing process.

The naive idea of what freezing would do in an ideal world is that it makes everything just sort of stop, and maybe you get little microscopic bits of crystallization, but they don't really do much and everything is reasonably in place. Part of what Greg Fahy has been doing with vitrification [9] shows that we are able to come increasingly close to that ideal with actual technologies of perfusion and cooling. But here you're not doing it by perfusion and cooling, but by construction, if your aim is to construct an ideal frozen state. What would a perfectly cryo-preserved tissue look like if you didn't have the nasty, concentrated cryoprotectants in there, but you had all the effects you wanted on the ice?

Then, given that we already know that so many biological materials can tolerate thawing injury from accessible frozen states, it would seem that thawing from an idealized frozen state, that you can't get to by a real freezing process, would be pretty much a piece of cake, especially if you still have devices in there to do on-going adjustment of this and that. Presumably you'd like to have the right ion concentrations and the right ATP concentrations, and there's some little corner where there are some stray molecules or something that wasn't convenient to mess with until there was a water phase for them to diffuse in, so you'd wait for the water phase to happen, then you'd catch them as they diffused.

Probably what you'd like to do is to be sure you had enough mechanisms in place to prevent any metabolic activity. Although it's hard to say how the details will work out in practice, I think the sensible thing to do might well be to inhibit a large portion or some crucial subset of the enzymes and active transport mechanisms in the cells, and keep them in that state until you're up in some reasonable temperature regime, like 98 or so degrees.

RC: And you're envisioning that inhibition might be done by means other than temperature?

ED: Yes, the inhibition is initially done by temperature. You substitute a nonthermal mechanism for inhibition, stabilize, warm, and then after making sure that things are where they ought to be, and the concentrations of the various substances are what they ought to be, to be ready to roll. You then remove the blocks from the wheels and let her go.

Given the robustness of biological systems, that scenario probably actually is a little bit more careful and cautious than is necessary. But on the other hand, why not?

RC: This approach guarantees that, cell by cell, the organism is reconstructed.

ED: Yes, if all the cells have been decrumpled and de-torn, by our conservators, then the entire fabric of the organism is in good healthy shape.

I would contrast the above scenario to the image of cryogenically preserving and recovering someone without molecular machine technology. They start in some medical condition that made it possible to label them as dead (a legal convenience). They are then subjected to freezing injury, thawing injury, and finally something perhaps close to current conventional medicine. It seems to me if you were very very very successful, you'd still have a very very very sick mammal. Whereas, on the other side of this technology transi-

"I would contrast the [molecular machine-based repair] scenario to the image of cryogenically preserving and recovering someone without molecular machine technology. ..."

tion, there's no particular reason why anyone should be left in some semi-functional state.

RC: Right. So if I'm understanding your vision here correctly, we're not just refabricating the cells to the condition that they were in at the time of cryopreservation, but we may be actually passing a judgment on each cell as to whether it needs to be refurbished in some way.

ED: The conservative thing to do would be to be restored to a healthy condition that's not terribly unlike the condition that they were in before suspension, but enough different that they obviously don't need suspension -- to what is by present standards considered healthy. Then if people would like to arrange for a little bit more work so that they don't look quite so wretchedly unhealthy by the standards at the time of repair, then that would be a matter for voluntary choice, one would hope.

So in an era in which medicine has a very broad ability to bring about desired outcomes, it seems that the conservative approach for patients in suspension is to assume that the desired outcome is, as I was saying, much like where they were before they needed suspension, so that then they can decide what they would desire as a later outcome.

Basically there's a big issue of patient consent in these procedures, and you'd like to get your patient into a condition where the patient can be informed and pass judgment while raising as few ethical questions as possible along the way.

RC: How much importance should be placed on finding less-damaging suspension methods to improve suspensions today, compared with supporting research on the longer-term problems of repair and revival?

ED: I would say that for the cryonics community, the importance of supporting research on longer-term problems of repair and revival is very slight except for the value of having a better concrete scenario to present, to explain to people why it is that one should expect the procedures to work. So again, the main value of a better understanding of what kinds of techniques could be used in the future isn't to make the techniques happen faster — it isn't to predict what they will be, because you would probably be wrong if you were making that prediction — but rather to get a clearer picture of the kinds of things that will be possible and to have that picture be an active picture in the minds of people living and making decisions today.

That's what I see as the relevance of research or exploratory engineering in the longer-term problems. The total amount of effort that can reasonably go into that is fairly modest, but I think somebody putting in another block or two of time on that, and doing some good write-ups, with particular attention to not trying to guess what will happen, but rather trying to see what you can make a plausible case for: what sounds sensible today and is sensible given our best present knowledge — does the job, is attractive, and not needlessly peculiar in some fashion. So that's what I see as the issues there.

With respect to finding less-damaging suspension methods, I know that's currently a contentious issue, and it seems to me that a crucial question here is, "What are the criteria for what constitutes damage?" What are we talking about here? If tearing and crumpling is regarded as fatal damage, then it's not clear that you're going to be paying adequate attention (in the earlier analogy) to fire prevention. And I'm more concerned with the fire prevention aspect than the disruptions which merely make it obviously impossible to warm up the organism and have the organism go scampering off and be happy. Until someone has a really credible scenario for taking a patient who is currently in need of suspension services and putting them through a process that does *not* involve molecular repair systems, and having them be healthy at the other end, then I don't know what one is talking about. I don't know what's worth discussing.

Now in fact it's hard for me to imagine such a procedure, even a halfway reasonable procedure, being thoroughly worked out, tested on small animals, scaled up to large animals, and gotten to the point of FDA approval, or some kind of wide-spread acceptance anyway, such that one could perform it on people who are not in dire need of suspension, in less time than it will probably take to get to the technology transition that we're looking forward to.

There are a lot of people who are working on the molecular machine problem, and it seems to be just of a straightforward-work nature; it's not a matter of taking a very complicated physical system, like the human body, and doing something simultaneously to all the cells in all the organ systems that is way outside what they were evolved to cope with, and having everything come out OK at the other end. That seems very hard, if your idea of everything coming out OK at the other end is, "Warm her up and shake hands."

" It seems to me if you were very very very successful, you'd still have a very very very sick mammal."

> "So from that point of view, what we have is a conservative medical procedure. And I think that it's important to present cryonics that way. Not to say, 'This is weird and radical,' but to say, 'Here's the idea, here's how it works, here's why it's conservative.'"

So I think that research that's aimed at minimizing damage by the conventional criteria of viability is good to the extent that it tends to also deal with what are, from the point of view of the molecular repair scenario, the real problems of taking pieces of tissue and homogenizing them and obliterating information in them. Clearly if your tissue is viable, you have not done very much that's equivalent to burning things and blowing away the ash. In fact you're probably not even doing much tearing and you've got it down into the crumpling range or less.

If you can meet that very high objective, you've made progress. On the other hand, if you say that that very high and desirable objective is *necessary* for success, then to the extent that you persuade anyone and as a consequence they don't sign up for suspension when they would have otherwise, and they in fact needed to be signed up, then you have a death on your hands, and I think your conscience should not perhaps be feeling quite as comfortable as it might otherwise.

I think that the question of what the criteria are for a successful procedure is crucial, and there are at present two paradigms, if you will, loose in the world. One paradigm comes out of biology and has a continuity that stretches back to the roots of biology and Aristotle, based on observing organisms and the distinction between plants and animals, and living things and dead things, and all sort of mobility and function. And then there is a new perspective that focuses on structure and information content and future repair capabilities. And there's a lot of overlap; if you succeed by the first you've surely succeeded by the second. But the reverse is not true.

And if anyone would like to argue that a suspension performed under favorable circumstances today is to be regarded as a failure or a fatality for some reasons of cryobiology, then I would like to hear that person explain how it is that freezing under good conditions is like burning and blowing away the ash, rather than like crumpling and tearing. I've heard no such explanation.

RC: Do you have a probability you would assign to the successful revival of those patients currently suspended? What factors should be considered when developing such a probability?

ED: The probability of successful revival: let me move to what I think is a second crucial conceptual issue in this area. That is the application of the standard medical model, in which you do an experiment with a control group and an experimental group, and you see what the outcome is. I think the standard medical model is both a good thing and a bad thing. It's a bad thing, as Ralph Merkle likes to say, for an experiment like a suspension: you have to wait awhile, then when you have the data, it's no longer of much use to people.

You want to figure out whether it works before it happens, because you're not interested after that, roughly. OK, so that's one problem with the standard medical model viewed as one kind of conservative clinical approach.

There's a more fundamental notion of conservatism in medicine which I was outlining to the last Extropian Conference; they had me in as keynote speaker so I gave a talk on "How to be Cautious and Conservative" [10]. What I argued is, among other things, that suspension is obviously a cautious and conservative medical procedure. Look at the outcomes; look at the outcomes of alternatives. Anyone with any sense can, I think, decide which procedure is more conservative in the sense of conserving and maintaining and preserving. So from that point of view, what we have is a conservative medical procedure. And I think that it's important to present cryonics that way. Not to say, "This is weird and radical," but to say, "Here's the idea, here's how it works, here's why it's conservative."

As to being successful, which is where we started here. By standard medical criteria, I think it's obvious that if patients make it to the future, if the world doesn't fall down around our ears, if the cryonics care is as continuous for the next few decades as it has been for James Bedford in the past [11], that the patients will get to this kind of medical capability — the type of medical capability in which these sorts of medical procedures are cheap and easy. And they'll be revived, and it will be successful. What does that mean? If their patient gets up and walks out of the hospital, doctors say, "Hey, it's a success." Clearly these patients will be able to get up and walk out of the hospital.

Somewhere in the back of our minds, if we've been reading the cryonics literature over the last decade and half or more, we might ask, "What about personal identity?" Here's where I think the standard medical model is excellent. Medical doctors never talk about personal identity that I've noticed. And likewise I don't hear educators talking about it, or bartenders, who give you mind-altering substances, talking about it. Brain surgeons certainly don't want to talk about it. Maybe they do a little bit on occasion, but it isn't a central conceptual issue in medicine. Rather the question is: the patient has come in the door, we do a procedure; can the patient get up and walk out, can the patient hold a job afterward, talk to friends and family? Have we damaged the patient's memory? Has the patient forgotten the last few days before the procedure? (With some procedures, or some accidents, certainly.) Does the patient remember his or her name? How much amnesia are we talking about in neurological cases? Ah, virtually none, or none detectable? Great!

But that's the framework in which these things are discussed. So, will reanimation be successful? By medical criteria, yes. By more general functional criteria and so on, since physical health is not an issue with this kind of medical technology in place, the only remaining question is, are we talking about no amnesia or a little amnesia? And I think the answer there, in cases of suspensions performed using present techniques under good conditions as best I can judge from what I see in Greg Fahy's electron micrographs and discussions, and from what I understand from paying attention to the neurobiology literature for the last twenty years with this question in mind, is that: yes, we should be fine!

RC: In your judgment patients will not only be able to walk away, but will be able to remember.

ED: The patient will not regard this as being a whole lot different from having been wheeled into a time machine, without any intervening freeze and repair process. I say that simply because of what the structure of memory seems to be, and what the nature of the perturbations caused by freezing seem to be. It's like asking, if you take a written page, and you rip it into four quarters and crumple it, and hand it to an art conservator, "How many words will it forget?" Answer, "None."

If it's a photograph, a half-tone photograph reproduction, you're probably going to lose a few half-tone dots, but I don't think anybody cares about a few half-tone dots in a page of print. Particularly since you can tell what the color was from either side in almost all cases. So, if one isn't concerned about learning something new, or forgetting the telephone number that you had when you were in dormitory in college, or the effect of a glass of wine, or the effects of living for the next five years — if those aren't terrifying things that you feel threaten your personal identity — then I basically would say, again premised on suspension under good conditions, forget the problem. Unless someone has something new to say that's negative, it's not a problem. I don't know any reason to think it's a problem, except the habit that people have of talking about it as though it is. The brain does not seem to be some delicate ethereal thing that evaporates when you chill it, or even freeze it.

One could actually argue that one purpose of medicine based on molecular nanotechnology is to make cryonics obsolete.

RC: What new horizons is Eric Drexler currently pursuing?

ED: I'll remind you I'm not giving very many interviews these days; this is the first one I can recall having given in months. For awhile I was talking to the media because I wanted to get some basic ideas out there. And now it seems to me that the time has come to look more seriously at the real consequences for the future, which are a little bit more complex, a little bit more radical than one can talk about in today's press. And so, Foresight Institute is concentrating more on the Web, improved technologies for critical discussion, and exchange and refining of ideas. I'm more inclined to do an interview with you here than talk to somebody from *Time* Magazine.

RC: When you say real consequences for the future, you're referring to implications of these technologies for our entire culture?

ED: There remains a staggering gap between the picture of the future that informs today's ethical decisions, debates on Social Security, discussions of global warming, resources, population, on down a list of concerns and issues -- a staggering gap between the framework that's behind those discussions, and anything that strikes me or anyone I know well and have serious discussions with, as being at all reasonable. It's as though . . . oh I don't have a good comparison here . . .

RC: You're saying, at all reasonable in the context of the inevitability of the development of molecular nanotechnology?

ED: Yes. We're in the middle of a technology explosion: a whole set of more or less exponential trends that have been rolling along for quite some time now. The basic physical capabilities of molecular nanotechnology actually fit pretty well, as Ralph Merkle found, on the trend lines for miniaturization in the semiconductor field. If you just extrapolate their lines, they actually expect to be hitting the atomic scale in the early 21st century; before 2020. So all this is going on, and the discussions that occur in society mostly seem to be premised on nothing much happening.

RC: As though the future is just the same as today.

ED: Yes. One little symptom of that: have you heard of the Millennium Clock Project?

RC: No.

ED: Well, consider yourself lucky. They're a group of people actually led by the highly respected and respectable and imaginative Danny Hillis [12], with various people from the future-oriented Global Business Network involved, who are working on building a clock which is supposed to operate for the next 10,000 years.

RC: A clock, OK.

ED: A *big* clock. And as nearly as I can tell it's being designed to survive for 10,000 years not into the future, but into the past; one of the design criterion is that it be maintainable with bronze-age technology. Now I've heard many serious discussions that take for granted the idea that civilization will collapse and will return to the bronze age, or something like that, by people who would dismiss the notion that say 200 years from now we'll be in the middle of an interstellar sphere of influence that is 200 light-years wide, roughly the distance light will have traveled between now and then.

Let's say civilization is going to collapse on the East coast, yes, and the West coast, and in South America, and Australia, and New Zealand, and Korea, and Japan, and Mongolia, and Europe. Is it going to stay that way for long, despite people knowing how to build something like the sailing ships that the Europeans used to kick the rest of the world into competitive economic and technological action very recently? I don't know even of any attempt to construct plausible scenario for the long-term fall of civilization, and yet because that collapse resembles the past and people are fixated on the past, that's regarded as a much more serious consideration than how to manage a world with machine intelligence and rapid interstellar expansion, which gets one one-thousandth or one one-millionth of the attention, even though it's hard for me to construct a scenario in which that does *not* happen.

I think that many people have a basic misconception about the advance of technology in that they think that it's a delicate process that could go wrong, and going wrong means that it would stop. The bad scenarios have plenty of "progress," but it's misapplied, or the social framework goes sideways in some unpleasant way.

RC: Right, but the fundamental progress is almost inevitable.

ED: Yes. Once the Cambrian explosion was underway, it didn't really matter how many organisms refrained from developing legs, refrained from developing eyes, and just remained as worms. There were still legged, flying creatures that would swoop down and pluck them from the grass and take them back to the nest. Competitive evolutionary pressures did a fine job of producing robins. And I think that the difficulty of getting things to happen in concrete ways in concrete places tends to confuse people about the reliability and the robustness of advances around the world. If you try to do something really new, most of the time it fails. If there are a thousand researchers, you can have almost all of them be intensely frustrated, and yet have great breakthrough advances come poring forth and fill the journals, and that is somewhat of the situation that we're in. I think it's responsible for some of the misperceptions.

RC: Thank you so much with sharing your insights with us.

ED: My pleasure.

Biography: K. Eric Drexler

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).

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."

Journey to the Centers of the Mind

by Susan Greenfield, WH Freeman and Co, 1995

Circuits of the Mind

by Leslie G. Valient, Oxford University Press, 1994

Reviewed by Thomas Donaldson, PhD

These books differ from one another like plants differ from animals, but still deserve to be reviewed together, if only because each one raises important points which the other ignores.

Greenfield discusses the problem of just how our brains produce consciousness, a subject which only recently has attracted the interest of neuroscientists. After discussion of the problem, she argues for her own theory. It's important to understand that her ideas remain a hypothesis only, although she uses both psychological observations and neurobiological observations to support it. One major feature of her proposal is very interesting: essentially she suggests that consciousness must involve some kind of arousal. Essentially this says that any device or person capable only of pure knowledge or computation (whatever "pure" may mean!) cannot be conscious.

However arousal alone isn't sufficient for consciousness. Basically, her idea is that we continually have groups of neurons forming and producing electrical signals in synchrony. These groups each consist of neurons related in terms of the memories and actions they support. (There is no requirement that these groups must be physically contiguous). Formation of such groups involves some degree of arousal (and in return, arousal can cause formation of some groups). Consciousness occurs when one of these groups becomes dominant; that dominance adds further neurons to the group. When we are awake, these dominant groups change over time, as our thoughts and perceptions change. The interplay between arousal and awareness goes on constantly.

One major problem that Greenfield tries to avoid is an error which neuroscientists have come to call the Cartesian Error: the idea that some special small group of neurons causes our awareness. (In its original form 300 years ago this idea really just put the problem of how awareness worked onto that small group of neurons rather than the entire brain. Amendments, such as the idea that some small group of neurons in our lower brainstem might play a critical role, have much more merit — loss of some areas by injury or stroke can cause permanent unconsciousness.)

When Greenfield discusses how arousal works, she points out that a variety of neurons from our lower brainstem have projections widely spread throughout our brain. These neurons use substances such as dopamine, acetylcholine, epinephrine, and others; we now know that none of these substances plays a direct role in memory (for which glutamate is the main transmitter). However, they do tend to activate not only the neurons to which they connect but those nearby. Neurologists using transplanted neurons have even noted that most of the effect of such neurons comes from their output of acetylcholine or their other transmitters. They actually require no neural connection at all to work, though in uninjured brains they usually do connect to particular neurons.

It's important here that neurons in our cortex also send projections down to our brainstem. This is a constantly acting feedback loop. As to the exact anatomy of these loops, Greenfield does not commit herself. (Given the relatively large size of our brain cortex, we may find that the source of these activator neurons is actually relatively small.) One major consequence of her ideas, which she states clearly, is that many vertebrates are aware in the same way we are, but not to the same degree. They all have the same kind of feedback loop between their cortex and their lower brain; their cortex, however, may be far smaller than ours, both relatively and absolutely.

Greenfield's book is actually an easy read, requiring no special background in neuroscience. I would have preferred a more technical appendix discussing anatomy in more detail, but certainly recommend her book for anyone interested in consciousness and how it may work (after all, she presents a theory only; we'll need many more experiments to really answer the question). I must also say that perhaps she did not discuss details of anatomy because they may well point to particular special areas ("only a few cells") from which all the arousal neurons might come.

The second book, *Circuits of the Mind*, is in computer science, with only a few bows to neuroscience and neuroanatomy. Its author, Valiant, basically tries to work out how the neural nets which constitute our memory can work so very quickly, especially given that they consist of neurons which act very slowly compared to present electrical components.

My own major criticism is that this author spent much less time on neuroscience than he should have. His assumptions about how brains work are false or strongly questionable. First, by ignoring one major class of neuron (interneurons in our cortex, which tend to suppress activity rather than promote it), his ideas about the dynamics of our brain's neural nets require much more discussion than he gives, and may turn out too wrong for any simple repair. Second, he also ignores the possibility of change in neural connectivity (which many neuroscientists believe certainly happens in children, who should *not* be ignored in any study of memory and brain activity), and so his computer model of a brain neural net begins with yet another faulty assumption.

The merit of his study comes directly from the fact that he does indeed provide one means by which a properly designed neural net, even with very slow processors, can act much faster than any present computer. It's important to understand that the activity here is that of a database, not an engine to compute scientific problems, and his idea of our brains as a database with very large capacity and very swift retrieval fits real brains a lot more specifically than the notion of a general computer. Neural nets are a major example of parallel computers, which can reach very high speeds on some problems; Valiant designed his to do problems of the sort brains might do.

Though his ideas of how brains work do have faults, modifications may well give us a better idea of brain processing. Moreover, databases are constantly needed, and his ideas may also suggest means to use neural nets much more deeply in construction of many computer databases. As for how our brains work, the simple idea of a database *is* much more specific. Few people can really do mental calculations well at all, and no one can solve complex differential equations in their head alone. But that is not a criticism of brains: I'd hardly demand the solution of a differential equation from a computer database, either.

Valiant's book should be accessible to anyone with reasonable knowledge of computers. Just don't confuse his ideas with a real statement of how our brains might work — though he does have worthwhile insights in that direction.

Alcor Member Profile

Gordon Shippey

Profile Editor: Russell Cheney

Date joined Alcor: April 9th, 1997

Place of birth: Birmingham, Michigan (just outside of Detroit)

City and state of current residence: Atlanta, Georgia

Date of birth: 12/15/71

Occupation: Currently earning my Ph.D. in Artificial Intelligence at Georgia Tech.

Marital status: Married July 24, 1995

Children: None.

Educational background: Graduated with highest honors from Emory University in 1994, majoring in Psychology and Computer Science/Mathematics.

Height: 6'1"

Best feature: My height.

Favorite author: Robert A. Heinlein

Favorite book: *Time Enough for Love*, by Robert A. Heinlein. (A book about an immortal, not surprisingly).

Book you are currently reading: *The Fountainhead*, by Ayn Rand.

Favorite non-cryonics magazine: I don't have time for magazines outside of AI journals I read for work, but when I had the time, I used to really enjoy *WiReD.*

Favorite movie: *2010.*

Favorite TV show: *Star Trek: The Next Generation.* It was to me the height of the Star Trek universe and the Star Trek concept as Gene Roddenbury envisioned it. Whether aliens exist or faster-than-light travel is possible, those things aren't nearly as relevant as the fact that humanity has a bright future ahead of it if we just play our cards right.

Favorite artist: MC Escher.

Hobbies: Science, science fiction, philosophy and political science. Japanese animation (anime). I jog with a friend as time allows and am slowly working my way into strength training.

Make of car you drive: Toyota Celica convertible.

Make of car you'd *like* to drive: Mitsubishi 3000GT convertible (no longer in production).

Greatest adventure: When I was sixteen, I wanted to get my pilot's license, to my parents' objections. They relented and I spent many happy hours (and a few scary moments) up in the air, learning to fly. I had to earn all the money for this by flipping burgers and later working in a one-hour film processing lab. The work wasn't rewarding but the cause was, so I had no trouble sticking with it. Due to logistics, I was never able to get my license, but it was a great time all the same. When time permits, I'll go back and get my rating eventually.

Favorite vacation destinations: Beaches. My favorite is at Destin on the Florida panhandle.

Political affiliation: Officially none. None of the typical labels really fit, but "libertarian" might be the closest. I'm a rabid individualist. I believe in laissez-faire capitalism, minimizing government cost and control, maximizing everyone's individual rights up to the limit where they interfere with another individual's rights. Some especially important rights that tend be threatened or ignored: the right to keep earned wealth, the right to trade freely, the right to private property, the right to die (suspended or otherwise), the right to choose medical treatments or practitioners not recognized by the government.

Religion: None. I was raised Methodist, but it never "took." I'm agnostic only because I can't prove a negative: that god (or gods) doesn't exist.

Most-prized possession: I'm a materialist, in that I think wealth is important, but I don't tend to attach great meaning to individual items. Right now I'm very fond of my new Celica, but it's a mass-produced item and if something happened to it, another one just like it would be just as good. I value the ideas and skill that went into building it more than the object itself. This is the same way I'd value a well-written [computer program] subroutine. This ties right into cryonics philosophy, too. Before I'm reanimated, if I have to be downloaded, transcribed, whatever, as long as they don't change the way that my mind works, I'm still me, no matter what bits of matter happen to embody my identity at the moment.

Most-prized possession you've arranged to have upon reanimation: My body expects to have certain objects on it right now: my watch, my wedding ring, and lately my Alcor wrist tag. As a neuro patient, even if my body is restored to look and work just like the old one (with lots of little corrections...I'm making a list), will the old expectations for certain ornaments remain? If not, the old familiar sights will still provide me a little continuity.

Personal hero: John Waszak is a very personal hero to me: he was my sixth-grade teacher. I spent exactly one year in a crummy southern public school. I was having what was probably the worst year of my life. He wasn't just a good instructor. He was a great person and he taught by example more often than even he may have recognized. I learned a lot, and I think that's what turned me around.

On the first day of school I didn't know anyone; the question of the day was "who's your teacher?" A lot of kids didn't know who Waszak was but the ones who did said the same thing: "oooh...he's *weird*." And just before classes started, I saw this very distinctive, young, tall fellow with glasses and a beard walking down one of the breezeways. He was not at all like the old ladies that had taught me since kindergarten. "Could that be him?" I thought. I walked into the classroom and there he was. From him I learned that being different isn't just okay, it's necessary. If the world isn't the way you want it to be, and yet you're trying to blend into it, then you're becoming something you don't like. That's an unacceptable compromise.

Favorite famous quote: "The only way to discover the limits of the possible is to go beyond them into the impossible." —Arthur C. Clarke.

Another favorite quote: "No mysteries are sacrosanct, no limits unquestionable; the unknown will yield to the ingenious mind." —from the *Extropian Principles, v2.6*

Personal philosophy: Life's meaning is what you make it. Think of yourself as an artist and the universe is your canvas. Paint something beautiful.

Short-term goal: Finish my Ph.D. and get started on a productive career building intelligent systems.

Long-term goal: Build a machine that's capable of passing the Turing test — a machine that can think with the skill and flexibility of a human mind.

Immediate goals upon reanimation: For neuro patients, I'm guessing there's going to be a ton of physical therapy required to get the old brain on speaking terms with a new body. Once I have control of my internal environment, I'll have to learn how to communicate again (or find a good interpreter system), because I seriously doubt that English as we know it will be the last and only language of humanity. I'll want to catch up on history, travel and get myself reintegrated into society. Hopefully the Life-Pact folks will be there to help me out with this one.

Longer-term goal(s) after reanimation: Help reanimate other suspendees, then find something worth doing in the world that I can do—and then do it. Being more specific than that would probably be foolish.

Achievements for which you are most proud: Graduating from Emory, marrying the love of my life, and building two small AI systems as part of my graduate work.

Pet peeve: Ignorance, failure to think, or worse not thinking on purpose.

Greatest fear: Humanity won't make it. We'll do something very stupid, and go out with a bang. Or we'll fail to make the right decisions and just fade into mediocrity.

Happiest memory: Falling in love with my wife. It's a memory that's still being made.

Secret ambition / fantasy: Living forever doesn't count anymore, does it? I've always wanted to travel in space. It's hard to predict whether I'll get that chance in my natural lifetime, but a suspension gives me a second chance at it.

First choice to share your dewar: If I can convince my wife to sign up, I'd like for us to be in the same dewar in the hope that we might be reanimated at the same time.

First became interested in life extension: My first exposure to the suspension idea came by watching an old *Twilight Zone* episode. I might have been eight at the time. Later, I kept bumping into Alcor through subtle references on TV and on the WWW.

Who was most instrumental in your sign-up and why: Mary Naples, my life insurance agent. For reasons beyond her control, it took several months to get some lab work done. Mary was unflappable and kept on working until things were sorted out.

Sign-up administrator: Brian Shock

Most effective thing you do to promote your own longevity (other than being an Alcor member): Taking good care of my body. I've been jogging on a regular basis and eating more fruit and vegetables and less fat.

Least: Getting too much into my work and not enjoying life enough. Making it into a second life cycle requires you to want to live and have the mental flexibility to adapt to whatever happens. If you do just one thing, even if you love it, someday that activity isn't going to have the same importance in society, and then what will you do? Cultivate mental flexibility now.

Biggest surprise since becoming a member: Nobody asks me about my tag. During sign-up, I had nightmares of having to try and explain cryonics to every Tom, Dick and Harry who saw the tag on my wrist. But I've never had a question about it from anyone who didn't already know my plans for suspension.

Cryonics idol(s) and why: Robert Ettinger, since he's one of the people who first thought seriously about the problem and had the belief that suspension was really workable technology. Being first counts a lot in my book. Similar kudos go to K. Eric Drexler, one of the few people who got a Ph.D. in the field of study he founded (nanotechnology).

Why are you a cryonicist: It's a bit more complex than just wanting to live forever. Since I don't have religious faith, it helps to have something to fill the gap. Being a cryonicist is about daring to expect much more from this life than anyone has expected before and then taking steps to make it real. Even if my suspension were to fail completely, choosing to be suspended is worth it because of the heightened sense of hope and possibility I have right now.

Advice would you have for other cryonicists:

1. If you're not signed up, but know you should be, do it now. Life is unpredictable. You and I will probably live to a ripe old age, but getting affordable life insurance requires you to be in good health, which isn't nearly so certain. Unless you're loaded, lock in a good rate on whole-life (not term) insurance now while you can.

2. Once you've signed up: Work all the time to find more and stronger reasons for living. Lately we've seen that very serious cryonicists lose their resolve when health and social support systems collapse. So start now. Make friends who understand what you want to do with the rest of this life and make promises to them that you won't change your mind later, no matter how bad things seem at the moment.

The Donaldson Perspective

Death?

by Thomas Donaldson, Ph.D.

In 1975 I was in the United States when a passenger airplane crashed into the Potomac during very cold weather. For a while the news was full of reports of dead bodies found in the river; the death rate from this crash was reported as high. Ever afterwards I have wondered just how many victims of that crash might have been saved if knowledge of the effects of cold on our survivability had been known much more widely.

This crash and many other incidents raise one major problem, not just for cryonicists but for many rescue teams not involved with cryonics at all: *death is* not *simple.* It is complex, and it has been complex ever since the first intimations of the 18th Century (and perhaps even before) that death could sometimes be reversed.

In films and television, death comes in two forms. In one, it's very quick and totally unexpected. In the other, the person dying is generally old and retains his mental abilities completely, calling together the family to give his last words, then dying with a turn of his head. Both kinds do happen, but only to a small minority.

Often we do not die suddenly, but only after an extended period in which doctors do everything they can to keep us breathing, even at the cost of damaging our brains. When death comes slowly, it brings with it a slow loss of any ability to comprehend just what is happening. This feature in particular already causes a great deal of trouble for doctors, who are not oblivious to the possibility that a body capable of heartbeat and breathing may survive while the *person who used to inhabit that body* is gone.

Misconceptions about what really happens have also raised many problems for us as cryonicists. In the first place, we find ourselves trying to explain the definition of death to people unaware that any special definition is needed. The notion is perfectly clear, yes? Well, perhaps not. To see just how *un*clear it is, even now, requires that you think seriously about many cases of "death," something few people want to do.

If many believe that death occurs quickly, the difficulties faced by a suspension team will seem much more important than they actually are. If I'm just going to drop dead someday, then how could a cryonics team reach me in time? Clearly (so goes such thinking) if the cryonics team takes hours to reach me, my brain will probably be mush. Why should I bother?

The other case, of someone dying while in full possession of his mental abilities, raises another kind of problem. Why should a person bother about signing up now if he can wait to do so just before he dies? (When we describe the problems such a strategy will have, we are treated skeptically, as if we were salesmen pushing for immediate profit.)

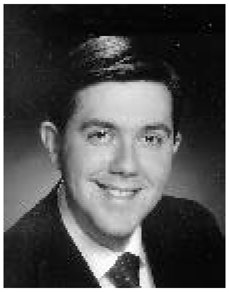
So what do we do for cryonics?

I am suggesting that popular ideas about death provide one more motivation for people to avoid thinking about cryonics. You can almost hear them saying to themselves, "Why should I bother worrying about death until I must?" To combat this mind set, I would suggest that at every instance in which such ideas are raised, we describe just what really happens: how vague the standard criteria for death really are. However, given that most people take offense at being confused by the facts, we should not raise these issues directly. Rather, we should try to make it clear that the popular picture of death simply isn't true.

Years ago I reviewed a book in *Cryonics* which described the actual circumstances of death. That book will now be out of date. It may be a very useful (but large) project to update this work; if anything, due to medicine's greater ability to keep people "alive," the notion of "death" has become even more confused. Not only might such an updated study help us plan just what our suspension teams need, but we could publicize the fact that we had such an objective study.

Most of all, we should not ourselves become beguiled by popular thinking into making plans which fail to fit reality. Right now many cryonicists are involved, if only as contributors, in an effort to improve suspension methods to the point where we can actually reverse suspensions of brains (in experimental animals). I personally think that such work not only stands a good chance of success, but has been badly needed for years.

Yet for cryonics, this work will also raise a major question: *just when do we suspend someone?* If we ourselves pay close attention to the *real* cases of "death," we can rationally decide just when we want suspension for ourselves. Others, who insist on reversibility while not understanding "death," just might cause even more problems for us than they do now. We should require, then, that anyone who joins a cryonics society must become conversant with death as it *really* happens, not as it is portrayed in myth.



Small Steps

by Stephen J. Van Sickle

Cardiac Arrest in Rats

Recent experiments at the Centre National de la Recherche Scientifique in France have demonstrated the recovery of "cell activity and functional long-range synaptic connections" after up to 6 hours of cardiac arrest. Both slices from the brain's hippocampus (which is particularly sensitive to ischemic damage) and whole brain preparations were restored when reperfused with an oxygenated solution. "Reactivated brain tissue appears indistinguishable from standard tissue prepared immediately after death as far as the behavior of membrane channels and synaptic release machinery are concerned."

Sounds good, huh? Well, not so fast. The preparations were allowed to cool to room temperature naturally, which for something as small as a rat brain can be pretty fast. Slices in the experiments reached 20-24 degrees C in about 25 minutes, much faster than a human brain does after cardiac arrest. Even very small reductions in brain temperature have enormous effects on the degree of ischemic damage. So, while the report does provide evidence for better than expected preservation of neurons after cardiac arrest, it also once again underlines the huge importance of rapidly reducing brain temperature. *Cardiac Arrest in Rodents: Maximal Duration Compatible with a Recovery of Neuronal Activity*, *Proc. Natl. Acad. Sci*., April 1998, p 4748.

Large Decline in AIDS Mortality

According to a report in the *New England Journal of Medicine*, mortality among patients infected with advanced HIV infection has declined from 29.4 per 100 person-years in 1995 to 8.8 per 100 person-years in the second quarter of 1997. Rates of infection with three major opportunistic infections declined even more dramatically, from 21.9 per 100 person-years to 3.7 per person-years. The greatest reduction was most strongly associated with use of the newer anti-retroviral drug combinations, which were even more effective when used with protease inhibitors. AIDS seems to be in retreat, at least among those nations that can afford high tech treatment. *Declining Morbidity and Mortality Among Patients with Advanced Human Immunodeficiency Virus Infection*, *New England Journal of Medicine*, March 26, 1998, p853.

Carbon Nanotube Transistor

Molecular computers, and the increased computational power implied by them, are one of the most important (and potentially lucrative) tools of molecular manufacturing. Researchers at Delft University of Technology in the Netherlands came one step closer to that goal by demonstrating a room-temperature transistor constructed from one single-walled carbon nanotube. While similar devices have been demonstrated at cryogenic temperatures, these are the first to operated at more practical temperatures. Since carbon nanotubes can be manufactured in bulk, this represents a possible technology with which we can bootstrap to true molecular manufacturing. *Room Temperature Transistor Based on a Single Carbon Nanotube*, *Nature*, May 7, 1998, p49.

Engineered Protein Protects from Immune Reaction

A new drug protein discovered by Doug Fearon of Cambridge University and produced by T Cell Sciences of Needham, Massachusetts has significantly improved the recovery of pigs from heart bypass surgery. Called sCR1, it works by blocking a key glycoprotein in the immune reaction called "complement cascade." In heart surgery, complement cascade is believed to be caused by blood circulating through the heart-lung machine. A similar cascade is involved in damage from ischemia and reperfusion. Since cryonics patients are (ideally) placed on heart-lung machines, and all too often suffer extreme ischemic and reperfusion damage, sCR1 may have potential use for our purposes. One caveat: this drug may suppress the immune system's healing ability. Since our patients are going to spend a while in liquid nitrogen first, I somehow don't think this is much of a problem for us. *New Scientist*, April 25, 1998.

What do Blood Vessels and Neurons Have in Common?

A new receptor has been discovered in the blood vessel-lining endothelial cells that control the grow of new blood vessels (angiogenesis). Call neuropilin, this receptor responds to a protein produced by tissues (and tumors) that need a greater blood supply. Rather than simply growing at random, new vessels are carefully steered. The intriguing thing is that this is the *same* receptor used to detect a protein that helps steer axons to their destinations in the nervous system. Growth of nervous system tissue and the blood vessels that feed it are more coordinated than previously thought. The possibility of new cancer drugs based on blocking this angiogenesis system (to stop the growth of tumors) is obvious. But it also raises another question: could this provide another molecular clue to the original structure of a freeze-damaged brain? *Receptor Links Blood Vessels, Axons*, *Science*, March 27, 1998, p2042.

Cryonics Sign-Up Party in Northern California!

A cryonics sign-up party will be held in Sunnyvale, California on **Sunday, September 20, 1998, 2:00-4:00 PM**, with food and socializing afterwards. Food will be provided by the hosts.

- Alcor's Membership Manager, Brian Shock, will be available to answer questions.
- Learn how to fund cryonics with life insurance.
- Sign your cryonics documents in front of witnesses and a notary public (small fee for notary).
- If you fill out an application form ahead of time, then Alcor can prepare your paperwork and have it ready for you to sign at the sign-up party. Phone Alcor at **602-905-1906** for more information.

Address:
Carol Shaw and Ralph Merkle's home
1134 Pimento Ave.
Sunnyvale, CA 94087
Carol and Ralph's phone: 408-730-5224. E-mail: carol@carol.com

Directions: Take Highway 85 to Sunnyvale. Take the Fremont Ave. exit and go east on Fremont Ave. Go a couple of blocks and turn left (north) on Mary at the traffic light. Take the first right on Ticonderoga. Take the first left on Pimento. 1134 Pimento is the yellow house on the right near the end of the street.

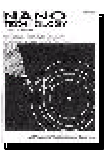
Advertisements

Cryonics *magazine reserves the right to accept or reject ads at our own discretion, and assumes no responsibility for their content or the consequences of answering these advertisements. The rate is $8.00 per line per issue (our lines are considered to be 66 columns wide). Tip-in rates per sheet are $140 (printed one side) or $180 (printed both sides), from camera-ready copy.*

NanoTechnology Magazine

NanoTechnology Magazine is your window into the emerging technology whose awesome power mankind will acquire, for good or evil, very early in the next century. Everything will change radically...the industrial revolution was just a preview. Find out about the millions already spent by government and private labs on the atomic manipulation of matter. Follow monthly discoveries toward the evolution of the technology sure to dominate the 21st. century. Prepare yourself mentally with ***NanoTechnology Magazine***.

1-year subscription: $38.40
(check, M.O., or Credit Card).



NanoTechnology Magazine
4451 Sierra Dr.
Honolulu, HI 96816
(808) 737-0628 fax (808) 739-5145
http://planet-hawaii.com/nanozine

PERIASTRON

Publishing for immortalists since 1990
Now both a newsletter and a book!

***PERIASTRON, the bimonthly newsleter, keeps you up on scientific and technical advances bearing on cryonics. Only $3.00 per issue. Try it for one issue, you'll like it!**

***A GUIDE TO ANTIAGING DRUGS, the book, tells you both the good and bad of each one. And it can be updated as we larn more! Send for free brochure.**

PERIASTRON
80 Q Cabrillo hwy #247, Half Moon Bay, CA 94019

Fund Cryonic Suspension
Affordably wih Life Insurance

Rudi Hoffman
Certified Financial Planner

Alcor member since 1994

Investments, Financial Services, Mutual Funds, Insurance, Annuities, Living Trusts

$120,000 20 Year Level, Renewable Term

Age 35	$16.30 per month
Age 45	$29.26 per month
Age 55	$60.26 per month

Leave message on 800 voice mail for quote.

P.O. Box 290549, Port Orange, FL 32127
E-mail: rudihoffma@aol.com
1-800-749-3773

Venturist Monthly News promotes immortalist philosophy. For free sample write: The Venturists; 15111 N. Hayden Rd., Ste. 160-169, Scottsdale, AZ 85260

CRYONICS INSURANCE SPECIALIST

For over 12 years, Mary Naples has underwritten more insurance policies for cryonics funding than any other insurance agent. If you're looking for fast, dependable, informative service, call Mary today!

Mary E. Naples, CLU, ChFC
2400 Kehoe Avenue
San Mateo, CA 94403
800/645-3338
E-Mail: MNaples24@AOL.com

ORDER FORM

All prices include postage and handling and are in U.S. dollars. Minimum order: $5.00. Overseas orders must be paid with U.S. dollars by Traveler's Cheques or International Money Order, and must include an additional 20% (of total) for shipping. All orders are subject to availability and all prices are subject to change.

Books & Media

- ☐ *Cryonics: Reaching For Tomorrow* ....$ 8.95
- ☐ *Engines of Creation,* by Eric Drexler $10.95
- ☐ *The Prospect of Immortality,* by R. Ettinger $11.00
- ☐ *The 120-Year Diet,* by Roy Walford ....$ 5.95
- ☐ *Chiller,* fiction by Sterling Blake ....$ 5.95
- ☐ *Becoming Immortal,* by Wes DuCharme $20.00
- ☐ *Tech Heaven,* by Linda Nagata ....$ 4.99
- ☐ ***The First Immortal*****,** by James Halperin.............................$24.95
- ☐ **Videotape**: *Immortality on Ice* (Discovery Channel)......$22.00

Cryonics Magazine, 1-year (4 issues) Subscription

- ☐ United States ....$ 15.00
- ☐ Canada/Mexico ....$ 20.00
- ☐ Outside North America ....$ 25.00
- ☐ *Cryonics* back issues on disk/fiche (circle)..............$120.00

The Alcor Phoenix, 1-year (8-issue) Subscription

- ☐ United States ....$ 20.00
- ☐ All other countries ....$ 25.00

Alcor Suspension Membership

- ☐ Alcor Membership Application Package.........................Free
- ☐ Alcor Membership Application Fee $150.00

ARTICLES & REPRINTS

Cryobiology and the Feasibility of Cryonics

- ☐ The Molecular Repair of the Brain, *by Ralph Merkle, Ph.D.* ....$ 3.00
- ☐ Will Cryonics Work? *by Steve Harris, M.D, plus* Why Cryonics Probably Will Work, *by Michael Perry, Ph.D.* ......$ 3.50
- ☐ Freezing of Living Cells, Mechanisms and Implications, *by Peter Mazur, Ph.D.* ....$ 2.50
- ☐ **"Cryobiology and the Feasibility of Cryonics Package"** (all 4 of the above articles)..........................$ 7.50

Nanotechnology

- ☐ There's Plenty of Room at the Bottom, *by Richard P. Feynman, Ph.D.* ....$ 1.50
- ☐ Molecular Technology and Cell Repair Machines, *by K. Eric Drexler, Ph.D.* ....$ 2.00
- ☐ Nanotechnology, *by Brian Wowk* ....$ 2.50
- ☐ Cell Repair Technology, *by Brian Wowk* ....$ 2.50
- ☐ **"Nanotechnology Package"** (all 4 of the above articles)...$ 7.00

Memory, Identity, and the Brain

- ☐ The Terminus of the Self, *by Max More*..$ 3.00
- ☐ A Commented Bibliography on Brain and Memory, *by Thomas Donaldson, Ph.D.* ....$ 2.00
- ☐ Isn't That You Behind Those Foster Grants?, *by David Krieger* ....$ 1.50
- ☐ Neurosuspension: Head First Into the Future, *by Steve Bridge* ....$ 1.00

Cryonic Suspension Reports

- ☐ Her Blue Eyes Will Sparkle, *by Linda Chamberlain* ....$ 2.00
- ☐ A Well-Loved Man, *by Mary Margaret Glennie*...$ 2.00

Alcor Legal History

- ☐ Our Finest Hours: Notes on the Dora Kent Crisis, *by R. Michael Perry, Ph.D.* ....$ 2.50
- ☐ Motion for Award of Attorneys' Fees, *by David Epstein* ....$ 2.50

General

- ☐ Elements of a Cryonics Patient Transport, *by Tanya Jones* ....$ 2.00
- ☐ Frozen Souls: Can a Religious Person Choose Cryonics?, *by Steve Bridge* ....$ 1.50
- ☐ Lovecraft, Scientific Horror, Alienation, and Cryonics, *by Steve Harris, M.D.* ....$ 1.50
- ☐ Cryonics in Popular Culture, *by Steve Neal* ....$ 2.00
- ☐ "Why We Are Cryonicists" and "Alcor: The Origin of Our Name" .... Free
- ☐ Why Cryonics Can Work (brochure) ....$ 0.75
- ☐ Cryonics and Christianity (brochure) ....$ 0.75

☐ **Discount Package (All of the above Articles and Reprints) .... $ 35.00**

The literature above can be ordered by mailing in this form with a check or money order or credit card authorization (Visa/MC), or by telephone (Visa/MC only) by calling Alcor: 1-602-922-9013 or by FAX: 1-602-922-9027.

SUBTOTAL:_____________

+20% if overseas

TOTAL:_____________

NAME____PHONE____

ADDRESS___________________________________CITY____________________STATE______ZIP_____________

VISA/MC# (circle one)____EXP_________

SIGNATURE(credit card numbers only)____

Send your order to:
Alcor Foundation
7895 E. Acoma Dr., #110
Scottsdale, AZ 85260-6916