CRYONICS

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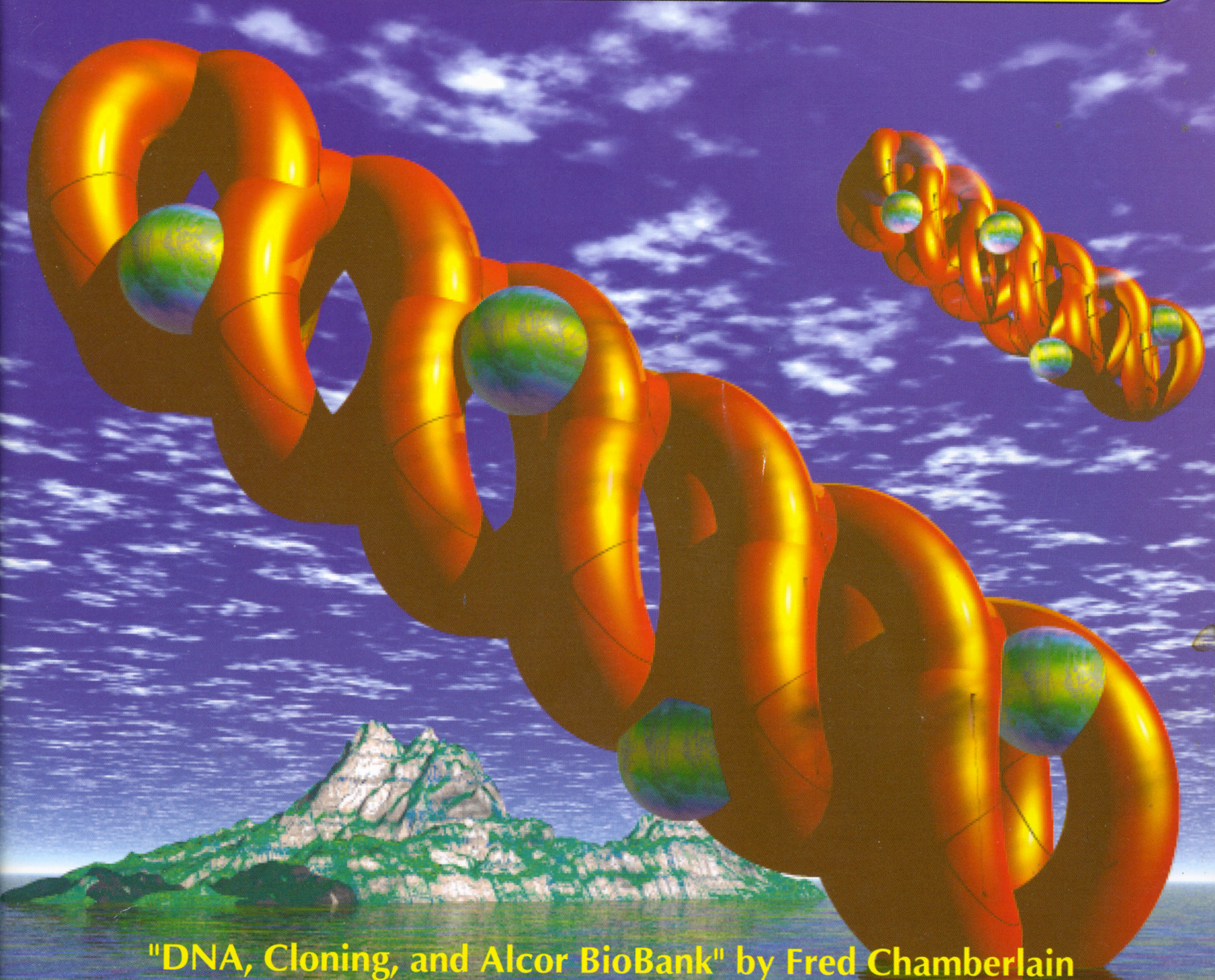

"DNA, Cloning, and Alcor BioBank" by Fred Chamberlain

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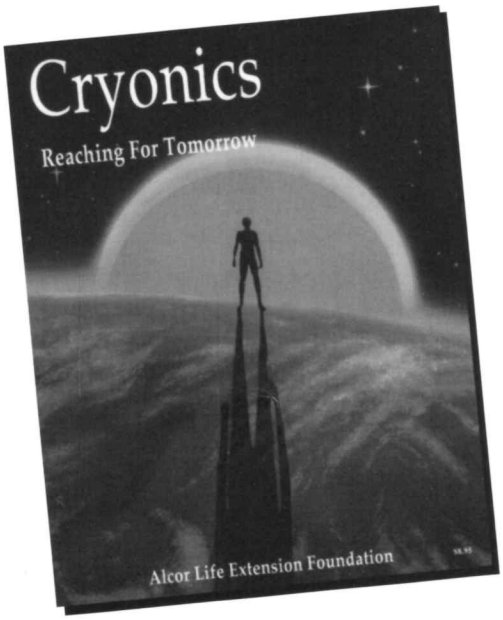
"What *is* cryonics?"

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

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



"How do I find out more?"

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

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

For those considering Alcor Membership. . .

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

Feature Articles

DEPARTMENTS

COLUMNS

ISSUE TO PRESS: September 26, 1997

Shock Treatments

By Brian Shock

Where Are All The Angry Mobs?

Every year I escort dozens of people around Alcor's facility, and at one point or another, in one way or another, almost all of them ask me the same thing: "How much religious opposition do you get around here?"

I'm never sure whether to cringe or chuckle at this Frequently Asked Question. The words conjure up superimposed images of torch-carrying mobs in *Frankenstein* films and placard-carrying mobs in front of abortion clinics on the Evening News. In my experience, though, the Alcor Foundation has *never* received that sort of negative attention from the public*, and certainly not from any specifically religious groups.

You probably already know my standard answer to visitors:

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* True, Alcor's Riverside, California facility was "raided" by coroner's deputies during the Dora Kent case of 1988, but this event was quite secular and almost certainly initiated by the misplaced ambitions of one person.

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Cryonics Magazine, 7895 E. Acoma Dr., Suite 110, Scottsdale, AZ 85260.

About the Cover

CGI Cover Art courtesy of Tim Hubley. *Great work, Tim!*

cryonics is no more opposed to religion than cardiac bypass surgery violates the Ten Commandments. Cryonics offers just one more medical treatment for prolonging human life, not a means of circumventing deities.

This answer never seems to satisfy anyone. That's hardly surprising, when you consider how popular fiction portrays cryonics and religion at odds. This happens in *both* fictional works sold by Alcor. In *Chiller*, by Sterling Blake, employees of a familiar cryonics organization are murdered off one at a time by a religiously motivated psychopath. In Tec*h Heaven*, by Linda Nagata, a quasi-religious organization call the "Knights of the Oppressed Earth" violently opposes the storage and reanimation of cryonics patients. (Nagata's earlier novel, Th*e Bohr Maker*, taking place in a later period than *Tech Heaven*, further demonstrates how Earth and Nature are treated as religious foci in Nagata's milieu.) Clearly, an uninformed public is *not* the only source of this misconception about cryonics and religion.

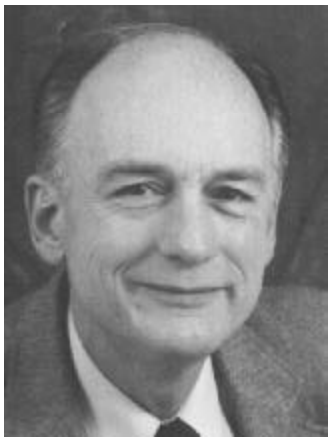
Perhaps my previously mentioned "abortion clinic scenario" has more relevance than anyone would care to admit. (After all, it even occurs to *me*.) As with abortion, cryonics deals with issues of personal freedom and "right to life." Then too, the mob mind could easily make a fuzzy connection between cryonics and fetuses — embryos of 16 cells or less are routinely maintained in frozen storage and later carried to term. Further, a Houston, Texas company, Cryogenic Solutions, actually advertises that it will freeze aborted embryos for possible future reanimation. As ludicrous at it sounds, people may think of a cryonics facility as a "reverse abortion clinic," open to the same controversy.

Perhaps the imagined conflict between cryonics and religion devolves to "moral" concerns, which are often unnecessarily linked with religious groups. Numerous reporters have asked me how cryonics organizations can morally justify selling services that "don't work." Never mind that we offer constant, insistent disclaimers. Never mind that no one can *yet* demonstrate that cryonics will fail. The current practice of cryonics fails to offer certainty (such as the "comforting" certainty of death), and so should require the intercession of spiritual consumer advocates.

Or perhaps religious groups *do* feel a silent animosity toward cryonics, but don't yet consider it a sufficiently large target. Who notices a mere eight hundred scattered zealots in a world of six billion?

Whatever the reason that cryonics has not seen religious opposition, we should take serious note of the simple fact that it hasn't. While lack of opposition doesn't *preclude* the possibility that opposition may someday exist, lack of opposition also doesn't *require* that opposition will someday exist. Even so, I know many cryonicists who skulk around like soldiers in a World War II movie bunker, muttering lines such as, "It's quiet — *too* quiet" . . . as though this indicates a certainty that the enemy must strike at dawn.

I'm annoyed by the almost universal assumption among cryonicists themselves that religious opposition to cryonics *will* eventually occur. Is this some dim pseudo-observation that powerful organizations in the past tended to reject iconoclastic ideas? Is this a cryptic insight of an unconscious mass mind? Or is this simply the instinctive call of the herd, frightening us with stories of wolf packs that devour those who stray?



Notes from the President

By Fred Chamberlain
President/CEO
Alcor Life Extension Foundation

DNA, Cloning, and Alcor BioBank

New developments touch our culture at all levels. DNA, discovered in 1953 by Watson and Crick, has now reached new plateaus of popularity through "Dolly the Sheep." Knee-jerk reactions developed around the globe in opposition to human cloning research. More quietly, the Human Genome Project has been accelerating the growth of knowledge for future developments we cannot yet fully imagine.

Let's look at potential interests in cloning, on the part of both cryonicists and non-cryonicists. They seem to have different roots, but those will converge with time. Alcor, through a project called Alcor BioBank, might help bring those needs together and serve them both.

Recent History

A few decades ago, "genetic engineering" raised such concerns that experimentation with recombinant DNA was faced by a moratorium. As Susan Wright puts it at her web site [1]:

"In the early 1970s leaders of biomedical research quickly moved to contain the emerging ethical and social issues. A partial moratorium on research in 1974 was followed by the famous international conference at Asilomar, California, where scientists addressed the hazards of genetic engineering and agreed to impose controls on their own research. These events were celebrated as acts of scientific responsibility. But they were also pre-emptive strikes, demonstrating that control of genetic engineering was best left in the hands of experts, and defining the problem as one that only experts could address —that of 'containing' possible biohazards. With that definition, genetic engineers were soon back at work under voluntary controls issued by the National Institutes of Health in 1976."

Today, modern textbooks on biology [2] discuss recombinant DNA research as if it were taken for granted from the outset. Now, we have newer, up to date controversies over the possibility of tampering with human reproduction and cloning. Soon, these could be forgotten; maybe anti aging or cryonics is next.

Present Controversies

Aside from the ban on cloning research in humans, genetically altering ourselves and our children is the popular "hotspot." Gregory Stock, speaking at Extro-3 (August 9, 1997 in San Jose CA) on "Reengineering the Human Germ Line", forecast that artificial chromosomes will soon permit us to alter ourselves and our children.

Asked if he thought humans carrying differing artificial chromosomes might find it impossible to reproduce, Dr Stock tried to be diplomatic. In principle, he said, "Making babies is going to evolve like everything else."

What is this leading toward? Will people of the future have children as they now do, or will they make "designer kids"? Must the parents sort through all their own genes, to find the ideal mix? Do artificial chromosomes take center stage? How might clones come into the picture?

Future Issues

Suppose it's forty years from now, and a man with three artificial chromosomes engineered in Switzerland pairs up with a woman with five such chromosomes, of Chinese design? Suppose these artificial chromosomes permeate the germ line (reproductive cells)? Will these people

have normal children?

Maybe not! Perhaps they will be, biologically speaking, "different species"! Could they, to put it bluntly, have "old fashioned children"? If they could, would they then feel impelled to add a mix of custom tailored artificial chromosomes, to avoid "old fashioned genetic defects"? How reliably will the variations and combinations of their own genes match the fine tuning of artificial chromosomes? Is there anything we might have overlooked?

Cloning

Of course, we overlooked cloning. Here, a life history will suggest areas where fine adjustments could help. Known genetic weaknesses in metabolism or bone structure could better be compensated. Many subtle areas of biochemistry or developmental morphology might be optimized, where the genome is known in terms of its end result (phenotype). But why would we want to clone someone?

Cryonicists will be interested from the standpoint of repair. A lot of tissue replacement is likely to be need, especially for neuros. Even whole body cryonicists are likely to get extensive repairs requireing regenerated tissue. In most cases, it could be easier to "regrow" tissue than "rebuild" it with nanotechnology. This regrowing could be an extension of cloning, benefitted by upgrading with artificial chromosomes.

Non-cryoncists will have other reasons. How about those who place a lot of value on family history? They talk for hours about their parents, favorite uncles, and grandparents, and tell you how they, "wish they could have known them, but now it's impossible." And largely they are right.

How "Gone" Are You When You're Gone?

But they are not completely right. Aunt Jenny might have taken you on trips when you were young, or was there when you were sick or in trouble, or helped you to learn and explore when others shut you out or were too busy to listen. You cannot have Aunt Jenny back, but if she were a little girl again, and needed some one to take care of her, might that person be you?

There may come a time when it is easy to add an identical twin of "Aunt Jenny" to your family. Will that "Little Jenny" find out where she came from? You can bet on it. She will be fascinated to know that there once was an earlier Aunt Jenny, who cared for her parent as a little child, and that she is receiving all of the love and attention that earlier "incarnation" of herself gave to others. In like manner, a boy may finds that his mother, who loved her father and could not give him up absolutely when she lost him, has given that beloved "Daddy" a kind of rebirth, although certainly this is nothing like reanimation.

And will this process stop with Aunt Jenny? Or a mother's lost husband? No, gradually, in a future world just around the corner, entire "family trees" may come back to life. Not just one segment, one slice of them, but the whole thing, except of course for those who went into the fires.

How much of anyone's DNA is left, when they die? And what condition is it in? Does it take cryogenic preservation to maintain it in the best condition? Would such a sample be useful in cloning? How can we know these things in time to take the actions which later might be important to us? If we cryonicists have the best suspensions, we just might recover with our memories intact. If not, what are the chances that some family member of ours might find a clonable DNA sample among what we left behind? Pretty Good?

In the past, Alcor offered a "kit" approach for DNA storage, as part of its fund raising program. Perhaps we should refine and extend that into a highly organized, well researched part of our operations. That brings us to Alcor BioBank, a project still under study.

Alcor BioBank

Alcor is presently considering the launch of a subsidiary offering DNA collection kits, with cryogenic storage included or as an option. This would not be a service limited to Alcor Members, but would be available to the general public. The connection with Alcor as a cryonics organization could be part of the promotional result. At the same time, we must avoid undue liabilities.

Until a lot more is known about cloning, we cannot say that samples we store would be usable for cloning. At the same time, in view of the possibility that such samples might be usable for cloning, we would need to assure those who store DNA with us that no use of their DNA would ever be made without their consent. Some might consent to cloning, under well specified conditions. Even considering such a use would raise these people's awareness of life extension and cryonics. And it would raise ours, too.

If we are suspended in any normal way, we cryonicists leave behind

a great storehouse of cells, many presumeably containing intact DNA. But this does not mean that as living humans, our DNA is "safe." Even we might be lost in a plane crash, in an absolute way, and we might choose (in addition to wearing our bracelets) to leave a secure sample where it would be there even if we were not found. Our pets, similarly, could go with us in genome form, even if their "personalities" could not be preserved. DNA samples for cryonicists might make a lot of sense.

DNA is everywhere at this time, in the public consiousness. A "save the tiger" organization has an extensive web page [4]. Legislative action is underway to make sure people's rights in their own DNA are protected [5, 6]. Massive collections of links on DNA are appearing in the World Wide Web [7]. One can get lost in the world wide web, in the world of DNA, and Alcor BioBank is ready to help.

In exploring the Alcor BioBank possibility, a web site has been set up. You may access it at http://www.alcor.org/dna.htm. In the "links" section, dozens of annotated references and outbound DNA sites are provided. If Alcor goes ahead with Alcor BioBank, we'd like this to be the most comprehensive site of its kind on the web. At this part of Alcor's website, we'd weave together all the non-cryonicist ideas concerning DNA with those which pertain to cryonics. Just as in this paper, the two tend to converge, the more you think about them.

Summary

DNA is the master key to our past physical evolution and our present physical selves. We can do much to modify ourselves, without "tampering" with our DNA, but soon such tampering will become commonplace. Everyone will be doing it, and in the process cloning may become a pathway through which many new people will come into being.

This will be accompanied by a new perception of identity in humans. Cryonicists who are suspended in extremely damaged ways or who are lost absolutely in accidents like plane crashes may reemerge, not as themselves, but as identical twins of themselves, who recall and feel strong bonds with their predecessors.

Alcor BioBank would be a logical extension of Alcor's present activities in life extension. Before long, we hope we can tell you that it is a reality. If you think this is a good idea, write and tell us. If you have a suggestion, it's welcome. If you want to know when our kits are ready for distribution, make sure you're on our mailing list. My email address is fred@alcor.org, and I'd like to hear from you.

References:

1. "Splicing Away Regulations Down on the Animal Pharm" by Susan Wright - http://www.all-natural.com/genetic.html

2. "Biology" (3rd Ed.), Campbell, N. A., Benjamin/Cummings 1993.

3. Modern Biotechnology - http://weber.u.washington.edu/~radin/bio.htm

4. Genome Resource Banking Action Plan for the Tiger - http://www.5tigers.org/grb95.htm (Genome Resource Banking involves the organized collection, storage and use of biological materials (usually gametes [sperm, eggs], embryos, tissue and blood).... A diverse group of people interested in tiger conservation has been considering how advances in the freezing of sperm, embryos, tissues and other 'biomaterials' may be useful for managing the world's dwindling tiger populations.")

5. Genetic Privacy And Non-discrimination Act (Hatfield) - http://www.informatik.uni-rostock.de/HUM-MOLGEN/documents/texts/0012.html ("February 18, 1996 - Abstract - A Bill to Protect Genetic Privacy introduced (but not yet acted upon) in The US Senate...")

6. Genetic Privacy And The Law - http://dserve.swmed.edu/V1N2/GenePriv.html ("Today there is increased awareness and concern about genetic discrimination and genetic privacy as the public learns more about genetics...")

7. MedWeb: Genetics and molecular biology - HREF="http://www.gen.emory.edu/medweb/medweb.gen.html (This is a *massive* collection of links.)

Book Excerpt

By Charles Platt

Life Unlimited

Chapter 3: Life Suspended

"The act of freezing a dead body and storing it indefinitely on the chance that some future generation may restore it to life is an act of faith, not science."
—Policy statement from the Society of Cryobiology.[6]

Ice Damage

Since cells live more slowly when we lower their temperature slightly, will their processes stop completely if we lower their temperature much more? Suppose we take some human cells, such as brain cells, and make them *really* cold. Can we keep them for years or even decades and then revive them by warming them again?

Perhaps this sounds too simplistic, an insult to the profound mystery and complexity of life. Indeed, the chemical processes that seethe restlessly inside every cell are so complex, many of them still aren't properly understood. Yet we don't need to understand them in order to control them in some very basic ways.

The first man who tried to do this was a Jesuit priest named Basile Luyet. This strange, solitary man grew up in a French valley that was so cut off from the outside world, its people spoke a dialect that few outsiders could understand. Later he learned English, studied biology, moved to the United States in the 1930s, and eventually established a small laboratory in Madison, Wisconsin. After saying mass at 6 AM each day he would spend the rest of his time puzzling over the nature of life as it was revealed to him through his microscope.[5]

For years Luyet experimented freezing and thawing plants, tissues, organs, and insects. He saw very clearly that life processes are slowed dramatically by low temperatures—which is no surprise, since no matter how complex the processes are, they all depend on chemical reactions, and a well-known equation tells us exactly how reactions are affected when the temperature falls. This equation has been a standard tool of chemistry since it was originally derived back in 1889 by a Nobel-prize-winning Swedish scientist named Svante August Arrhenius.[1]

Consider the case of just one chemical in human cells, an enzyme called catalase. Like a party animal, catalase is highly energetic and loves to interact. If we cool it below normal body temperature, it loses some of its zest and becomes sluggish—exactly as predicted by the Arrhenius equation. Near the freezing point of water, catalase is slowed to one-fifth its normal speed. If it gets really cold, it can barely move at all; at -200 degrees Celsius a catalase reaction that usually takes 1 second will take literally millions of years. But if we warm it again, it "wakes up" and becomes just as active as before.[3]

Since catalase actually happens to be the most reactive of all cell chemicals, in theory we really *can* preserve cells by freezing them, and we *can* revive them by rewarming them.

In practice, however, there's a snag.

As the temperature falls, water starts seeping out of cells and forms little particles of ice among them. Gradually the particles grow bigger, stealing more space, muscling in on the cells, exerting relentless pres-

Charles Platt, editor of *CryoCare Report*, is a regular correspondent for *Wired Magazine* and the author of countless books of fiction and nonfiction alike, including *The Silicon Man*.

sure, eventually squeezing the cells to a fraction of their normal size.[4] If we raise the temperature and melt the ice, chemical reactions will resume—but the cells will be so badly damaged, they may not function anymore.

Basile Luyet wrestled with this problem of ice damage for years, as it killed almost all the specimens that he froze and rewarmed. Still, there were some exceptions. When he tried freezing embryonic frog hearts, he was astonished to see that they resumed beating after he thawed them. This impressed him so much, he made a home movie of it. He also found that if he soaked vinegar eels in ethylene glycol (antifreeze) he could take them all the way down to the temperature of liquid nitrogen, and after he warmed them, they started wriggling again.[5]

No one else was conducting experiments like these. Basile Luyet was that rarity in science, an eccentric-mystic who nevertheless did rigorous work and became a true pioneer. The only way he could report on his research was by starting his own publication, which he titled *Biodynamics*. Single-handedly he created a field of science that had never existed before.[5]

His journal had a small circulation, his ideas were wrapped in philosophical speculation, and there was no practical use for his work—but in England, a remarkable woman named Audrey Smith sensed some possibilities. Women were rare in science in those days, and they faced a quiet but pernicious wall of prejudice. Still, Smith had a tough, assertive personality and some political connections. Even though Britain was virtually bankrupt after World War II, she somehow managed to get funding for a research group specializing in low-temperature biology, and they set up their operation in grim, bare rooms at the National Institute for Medical Research, near London.

Sir Alan Parkes, a biologist, was chosen to head the team. A young man named Christopher Polge was added to it, and they started work.

In 1948 the British scientists made their first discovery: they could reduce freezing damage if they soaked cells in glycerol, a slippery colorless liquid not so different from the ethylene glycol that Basile Luyet had used. In simple terms glycerol replaces water in and among the cells, so that less ice forms, and the cells aren't crushed into such tiny spaces.

Actually the British scientists didn't discover glycerol, they *re*discovered it, because a French biologist named Jean Rostand had stumbled on its protective properties two years earlier at L'Academie Francaise.[5] Either way, glycerol was the first known "cryoprotectant" (cryo being derived from the Greek word Kryos, meaning "cold").

Smith and her coworkers soaked red blood cells in glycerol, froze them, rewarmed them—and the cells revived. This may sound trivial, but the life processes in blood cells are not so different from life processes in other human cells, including brain cells. In fact Sir Alan Parkes felt that this work was so important, it was opening up an entirely new field of science that should have its own name. He called it *cryobiology*, which didn't please Audrey Smith, who disliked the idea of adding another piece of jargon to the English language. Still, Parkes insisted, and the name stuck.[5]

The British scientists decided to try something tougher for their next effort: freezing bull semen. They soaked it in glycerol, froze it, thawed it, and looked at it under a microscope, and the thawed semen wriggled just as busily as semen that had never been frozen.

But was it still alive in the fullest sense? The scientists used the semen to fertilize cows by artificial insemination. Months later, the cows gave birth; and months after that, the calves themselves were fertile. The chain of life, linking one generation with the next, had been interrupted—and restored.

Today, frozen bull semen is bought and sold routinely in the cattle industry. Human semen is also frozen on a routine basis—for example, if a man plans to have a vasectomy but wants retain the option of fathering children, just in case.

Even tiny human embryos, containing fewer than 100 cells, can be frozen, stored, rewarmed, and implanted in a woman's womb with a 50 percent survival rate.[9] The first child to grow from a frozen embryo was Zoe Elizabeth Leyland, born in Australia in March, 1984 from a woman whose blocked fallopian tubes prevented her from conceiving normally. There have been thousands of similar births since then, and glycerol is still the cryoprotectant that makes this possible.[2]

The Fascinating Question

After doing so well with blood cells and semen, the British cryobiologists became more ambitious. As Sir Alan Parkes put it, "Inevitably, we were drawn to a still more fascinating question: Could a whole animal survive freezing?"

With typical British understatement, Parkes made the work sound

like idle speculation, pure research with no practical applications. In reality, his team was heading into highly sensitive territory. They weren't just blurring the line between life and death for a matter of a few minutes; they were seeking to switch life off and on like a light bulb, and if they managed to do this using whole animals, the procedure should also work on people.

Parkes never said anything publicly about the long-term implications, presumably because he wanted to avoid backlash. But in one of the papers published by Audrey Smith and her co-workers, they suggested ways to warm an animal after it had been frozen, and near the end they speculated about ways to scale up the equipment—so that it could be used on a human being.

Before this could happen, though, the team faced two major problems. First, if you inject glycerol into a living animal, it interferes with blood chemistry, causes embolisms, and the animal dies. Second, while glycerol can protect individual cells, it can't do enough to safeguard the structure linking cells—such as the vast web of neurons in the brain. Some ice still forms, which pushes things around on the microscopic level. This doesn't matter when cells are free to move independently, as in the case of red blood cells or even very young fetal cells. But the links between neurons are incredibly delicate and easily broken. Also, tiny capillaries can be punctured or torn, so that if blood resumes flowing, it will leak from millions of minuscule wounds.

Could a different chemical be used as a cryoprotectant? Audrey Smith couldn't find one that a living animal would tolerate, so she decided finally to tackle the challenge without using any cryoprotectant at all. This wasn't quite as primitive as it sounds, because she could control ice formation to some extent by adjusting the rates of cooling and rewarming. If all the factors were optimized, conceivably the animals would survive.

She picked golden hamsters as her test subjects, because they hibernate naturally and are well equipped to withstand the cold. By monitoring the heat flow, Smith was able to prove that the animals' brains contained sixty percent ice. And yet, when she warmed them, many of the hamsters did survive. Once again, the general principle was affirmed: the symphony of life *can* resume after cell processes have been slowed by low temperature, even if the temperature is below freezing.

That was the good news. In fact, it was better than anyone had expected. But there was bad news as well: The survivors didn't live very long. Their capillaries were damaged, probably their brains were damaged too, and their gastric systems were eroded by stomach acid. One by one, they died.

Paradoxically, Audrey Smith was a classic British animal lover. She owned a dog named Katie, which she took with her everywhere—even to scientific conferences. She wrote a book which she dedicated to Katie, and when Katie died, Audrey managed to find another dog that looked exactly like her.

How could an animal lover subject so many small, helpless creatures to such an unpleasant death? Perhaps she felt it was justified because her goal was to banish death completely—not just for animals, but for people. Animal rights activists may still feel that Audrey Smith had no business sacrificing scores of hamsters in pursuit of a grandiose, impossible dream. On the other hand, what she really wanted was for the hamsters to live.

She worked for several years, with relentless determination. In the end, though, she had to admit defeat. She gave a final report with her co-workers in the *Proceedings of the Royal Society* in July, 1956. Summing up, she said that in order to freeze an animal successfully, she needed to replace at least ten percent of its water with some kind of antifreeze. But that was impossible, using any cryoprotectant she could think of.

In *Scientific American*, Sir Alan Parkes echoed this pessimistic message. He wrote, "The biologist is not yet in sight of achieving suspended animation of a warm-blooded animal at a temperature likely to result in a stable state."

Was this the end of the road? It sounded like it. And yet, Parkes wasn't saying, "It can't be done." In his cautious British style he was saying something rather different: "It can't be done *yet*."

Brain Waves

At Kobe University School of Medicine in Japan, a scientist named Isamu Suda extended the British research in a direction that was radical, unexpected, and bizarre. His reasoning seemed to go like this: It's extremely difficult to cryoprotect, freeze, and revive a whole animal. Therefore, why not work on just one organ—such as the brain, which can be kept alive by nourishing its cells with an external supply of blood?[10][7]

Suda gave a cat a general anesthetic, slowly reduced the tempera-

ture, and circulated a blood substitute to protect the cells from damage. Then he removed the cat's brain and perfused it with a solution of 15 percent glycerol, so that the cryoprotectant reached every cell. Finally he froze the brain at a temperature slightly below zero degrees Fahrenheit.[7]

Forty days later, he warmed the brain and flowed diluted blood through it. Here was an isolated brain amid a tangle of lab equipment; a brain that had been in a freezer for more than a month. By anyone's standards, this brain seemed incontrovertibly *dead*. Yet when Suda took a standard electroencephalogram (EEG), he picked up a signal—and the trace looked very like a reference signal that he had recorded while the whole animal was still alive.[7]

True, the brain had been damaged by freezing, and the signal didn't last long. But still the cryoprotectant had preserved the cells well enough that they still functioned when they were warmed and resupplied with fuel.

Suda repeated his gruesome experiment many times. He stored some cat brains for seven months, and they still produced brainwaves when they were revived, though the traces weren't so clearly defined.

In 1966, Suda's results were published in *Nature*, one of the most prestigious scientific journals in the world. But he didn't stop there. He kept some brains frozen for *seven years*. When he finally thawed them, even they still showed some activity. He wrote another paper and reported "well synchronized discharges" of cells in the cerebellar culmen, and "rhythmic but continuing uniform wavelets."[8]

Suda's work was a true breakthrough, yet it received very little publicity. No one repeated his experiment to verify it, no one tried adjusting the variables to get better results, and today, few people even remember that it took place. In fact, if you describe it to scientists outside of cryobiology, you may have a hard time convincing them that it ever happened.

There are good reasons for this. Suda's work was unconventional, to say the least. Pumping blood through defrosted cat brains and sticking electrodes into them to search for signs of life—it was like something out of a freak show. You could get into trouble if a stunt like that was picked up by tabloid journalists or animal-rights activists. It could damage your reputation. You might even lose your funding. Cryobiology had started as a wide-open frontier, full of opportunities for risk-takers who wanted to touch and control the basic processes of life; but by the mid-1960s this radical spirit had been swept away by a tide of caution. Cryobiologists didn't just abandon the path that Suda opened up, they stopped freezing mammals under any circumstances. In fact, virtually no work of this kind has been done since the 1960s.

Several factors caused this retreat, but one eclipsed all the others. In the words of Robert W. Prehoda, an expert in trend analysis and forecasting who published a book titled *Suspended Animation* in 1969: "Serious scientists engaged in reduced metabolism research have been confronted by the unexpected emergence of a pseudo-scientific cult which is presenting a completely distorted picture of the prospects for suspended animation to the general public."[5]

"Cult" was a loaded word; "movement" would have been fairer. Either way, there was no doubt where it originated. In 1964 a physics teacher named Robert Ettinger published a book titled *The Prospect of Immortality,* which changed everything.

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Report

By Linda Chamberlain
CryoTransport Manager
Alcor Life Extension Foundation

Alcor CryoTransport Standby Services

For years Alcor has made repeated attempts to inform members that Standby services and their costs cannot be included in CryoTransport (cryonic suspension) insurance funding. There are two primary reasons: (1) a Standby is an open-ended process that could go on for many days without any way to know the duration in advance, and (2) if the member survives a Standby (such as during surgery), the member's insurance will not cover it.

The purpose of this article is to discuss what a Standby is, why every member should consider having Standby services, what a typical Standby (if there is one) might cost, and how to provide Standby funding easily and conveniently without financial sacrifice.

What Is Standby and Why Is It Advantageous?

To understand the many phases and complications of a Standby, one must understand what a CryoTransport Team is trying to accomplish. CryoTransport describes the entire process of attempting to transport our members to a future time and place where medical science can heal and recover them, returning them to a state where they can continue with their lives. CryoTransport can be broken down into three major areas: (1) Standby and Remote Transport to Alcor, (2) Cryoprotective Perfusion, and (3) Cooldown and Long Term Care.

Standby and Remote Transport, which include patient acquisition and stabilization, are time-critical. The greater the delay, the greater the physiological damage caused by diminished or halted blood flow to the tissues (ischemia). The eventual amount of freezing damage is also affected by the duration of ischemia. For example, if ischemic damage results in a leaky capillary bed, the perfusion of cryoprotective chemicals into the tissues will be compromised.

Every minute counts. As a result, if Alcor is not notified of a member's need for assistance until after the pronouncement of legal death, a devastating delay could result (especially if the member does not live in Arizona , which includes the majority of Alcor members). Even if the next available flight is not many hours away — as will often be the case when a member goes into cardio-pulmonary arrest in the wee hours of the morning — just calling to find out airline schedules takes time.

There are two major instances in which Alcor would provide a Standby. The first is when a member has scheduled surgery or some other risky medical procedure. The other most likely scenario is when a member nears death as the consequence of a terminal illness. Since logistics and duration (and therefore, cost) of Standby are very clear cut in the first instance, preparations for it are also much easier. However, while terminal illness may be more difficult in terms of planning, some form of Standby is vitally important in such situations.

The Logistics Trip and Advance Preparation

The coordination of a Standby and Transport requires an intensive effort to anticipate potential problems and try to eliminate them. If at all possible, Alcor personnel (usually Alcor's CryoTransport Manager) should make a "logistics trip" to the Standby area to accomplish this goal and contact key people in advance. Preparation of these influential players greatly helps to lessen their possible distrust of the individuals and situations involved, as well as improving the likelihood that they will cooperate in a timely, well coordinated manner.

In this article I am assuming that

the member's family already supports his or her desire to be frozen. Without that cooperation, a Standby or transport may not even be attempted. Assuming cooperation with family members, the next three most important people (or organizations) that Alcor must coordinate with are (1) the coroner, (2) the patient's physician and hospital, and (3) the contract mortician. (See opposite page for major contact points with each.)

Contact with the coroner must come first. If the coroner is hostile and will not cooperate, other plans must be made (for example, finding a way to move the member/patient to another county or state). If the coroner is cooperative, the next contact is the personal physician (who can bring hospital cooperation along with him). The third step is then to contact a local mortician for assistance with transfer paperwork, arrangement of transport from the hospital, and an appropriate facility for the surgery and wash-out procedures.

Whenever possible, Alcor's CryoTransport Manager or an on-site CryoTransport Technician should meet with these individuals in the presence of the member (or the member's family, if the member's health dictates) for whom the Standby is being arranged. Experience has shown that the coroner, physician, and mortician are all usually at greater ease in these coordination meetings if they know that the member/patient and the family agree with the proposed plans. Such meetings can be handled by teleconference, but are usually more successful if done in person.

Typical Standby Costs

Even if the logistics trip was successful and all apparent obstacles have been eliminated, unexpected problems lurk in the shadows of every Standby. For example, although Standbys necessitated by surgery have a fairly well defined length and cost, medical complications could arise when least suspected. If the member does not recover well, the Standby could last significantly beyond original projections.

When Standby is performed for a terminal member, determining Standby length is even more difficult. The CryoTransport Manager and member must carefully balance expense versus need. If the CryoTransport Team enters the field too early, the costs of Standby may become unnecessarily high. If the Team is not deployed soon enough, the member could go into cardio-pulmonary arrest before the Team arrives.

Both financial and medical considerations need to be considered. Each case is different, and so expenses cannot be completely determined in advance. For this reason, the member for whom a Standby is being performed must place a deposit with Alcor ahead of time. After the Standby is performed, Alcor will provide an accounting, and refund unused funding per the member's wishes (cash refund, or, in the event the member is suspended, donation of excess funds for research, etc.).

Although setting a single, prearranged fee would be impractical, it is possible to give a typical Standby cost-range based on a breakdown of various elements.

Standby Cost Breakdown

Logistics Trip (1 person, 2 day minimum):	
Travel and Lodging expenses	varies (Estimate $500)
Alcor staff member (1)	$400/day
Local Alcor trained assistant	$100/day
Total 2-day logistics trip estimate:	$1000
Standby Trip (2 persons, 2 day minimum):	
Travel and Lodging expenses	varies (Estimate $1000)
Cargo (medical equip & supplies)	varies (Estimate $300)
Two Alcor staff members ($400/day ea)	varies (Estimate $800)
2 Local trained assistants ($100/day ea)	varies (Estimate $200)
Total 2-day Standby estimate:	$2300
Total Minimum Logistics (2 days) and Minimum Standby Logistics (2 days) estimate:	$3300

Standby Contact Questions

For Morticians:

1. Does the mortician understand Alcor's goals?

2. What is his or her response time in an emergency? To determine this, add the paging and response time to the round trip driving time. If this is greater than 10 minutes, is the mortician willing to stand by at the hospital? How much will that cost? Does the member/patient understand the importance of cutting this time? Does the member authorize the added expense?

3. Is the mortuary Transport vehicle a van or a stationwagon? Will the portable ice bath and heart-lung resuscitation equipment fit into the mortician's pick-up vehicle? Is there room to perform cardiopulmonary support in it? If not, arrangements need to made to rent or borrow a vehicle that will accommodate this need.

4. Will Alcor receive priority over the mortician's other customers?

5. Will an embalmer assist with the surgery prior to a blood wash-out? Additional charges?

6. Can the equipment be set up in advance? Additional charges?

7. Can additional equipment be stored at the mortuary? Additional charges?

8. What does the mortician need to interface with the coroner and hospital?

9. How quickly can the death certificate, transfer permits, cremation authorization, etc. be obtained?

10. What else will be required for him or her to get our patient shipped promptly? How much can be done in advance?

For Coroners:

1. Communication of our goal: we are attempting to minimize the biological deterioration associated with the dying process. This requires quick action because cellular damage begins at (or, in some cases, even before) cardiopulmonary arrest. To minimize biological deterioration we need to start our procedures with absolute minimum delay. This means that we need to have our patient pronounced and then released from the hospital *as quickly as possible* after cardiopulmonary arrest.

2. Will she or he cooperate with that?

3. What circumstances would require autopsy? In those cases, can the autopsy be limited to the trunk (i.e. can the brain be spared)?

4. What does the coroner need to effect an immediate release of our patient from the hospital?

4-a. Does the coroner need a phone conference with the physician? If so, make sure that the physician and the coroner speak to each other in advance. Both of them should understand exactly what each other needs, and should know how to contact each other immediately (phone numbers, pagers, etc.). By arranging communication between the coroner and physician in advance, less confusion and fewer obstacles are likely to appear at the last moment.

4-b. Does the coroner need any paperwork completed? Can we get a blank form and fill it out in advance? How can we get this paperwork signed by the physician or hospital and delivered to the coroner in the most efficient way (fax, courier, etc.)?

For Physicians/Hospitals:

1. As with the coroner, does the physician understand our goals?

2. Will she or he cooperate with us and assist in gaining hospital cooperation?

3. Can the patient be pronounced promptly? What arrangements are necessary to make this happen?

4. Do the physician and hospital recognize Alcor's authority to accept the patient as an anatomical donation?

5. What is his/her fax number so we can fax the "General Information for Hospital Personnel"?

6. How far are the physican and hospital willing to go in cooperating with us? Non-interferrence only? Medications and IV line only? CPR?

7. Are large quantities of ice available at the hospital and mortuary?

8. Can Alcor personnel wait nearby (eg. in the floor lounge)?

9. Can Alcor equipment be stored nearby (eg. in an empty room)?

Before Alcor personnel can plan for the logistics trip, we must have a deposit of $5000. After Standby is terminated, the member or the member's next of kin will receive an accounting. In case of overages, the member can choose from several options as to how Alcor might disburse this money (cash refund, donation to research, etc.). If the Standby becomes lengthy, the member must make arrangements to cover this as well.

Covering the Unexpected

An unexpected need for Standby usually poses the greatest problems. What if you suddenly fall ill with appendicitis, are rushed to the emergency room, and have no way to make Standby pre-arrangements? Even though Alcor could not carry out a logistics trip in advance (possibly compromising any Standby), some members would still prefer to call us and ask for the deployment of a CryoTransport Team.

This last-minute scenario would require a slightly different type of accounting. Without the advance logistics portion, actual Standby would become far more difficult, forcing the CryoTransport Team to account for every possible complication. Such a Standby would probably require the participation of more Alcor staff members, and possibly local assistants as well (if available). Every situational difference will change the billing to one degree or another.

A Simple Way To Provide Standby Funding

Some Alcor members have chosen a very simple and inexpensive way to provide funding for unexpected situations. A member need only provide a credit card that Alcor is authorized to draw against in such an emergency. Since you want to have your full credit limit available at all times, this credit card should have no other purpose but Standby funding.

As you can see, Standby provisions handled in this fashion do not need to represent a cost unless you actually use the service. Further, because Alcor can confirm that sufficient funds are available on extremely short notice, the dedicated credit card account allows us to accommodate emergency requests for Standby services without being hampered by funding questions. And, unlike setting aside specific funds that you might prefer to invest elsewhere, you will not lose any interest or potential appreciation of assets.

Conclusion

Arranging for your Standby is the single most important thing you can do to improve your chances of a good CryoTransport, but you must make these arrangements well in advance. Don't be caught by an unexpected emergency — provide for your Standby now, so that Alcor's CryoTransport Team can be there when you need us.

If you have any questions on this subject, please give me a call or email me at linda@alcor.org.

Interview

By Russell Cheney

Unbinding Prometheus

A Conversation with the Most Likely Candidate for Scientific Leader of the Prometheus Project

Editor's Note:

The following is an exclusive interview with the scientist who is widely regarded as first choice to head the Prometheus Project's research team [26]. Anonymity is maintained out of respect for this scientist's current position. While the editorial policy of *Cryonics* usually precludes the publication of anonymous interviews, in this particular case we believe that the strength of the subject matter outweighs this consideration.

Cryonics presents this article *solely* as a point of information. *Cryonics Magazine* and the Alcor Life Extension Foundation neither endorse nor criticize the Prometheus Project.

Russell Cheney (RC): Why is the Prometheus Project exciting to you?

Answer (A): Well, the answer to that is clear. The Prometheus Project offers the prospect of very radical changes in the way we regard medicine and the way medical care is carried out. The Prometheus Project essentially offers the possibility, effectively, of curing any disease that does not involve direct damage to the brain, in the sense that if the brain could be cryopreserved for long periods of time, sooner or later all diseases will be curable, and patients would then be allowed to reach the cures that will be developed in the future.

The Prometheus Project is a two-step project. The first step is a proof of principle involving cryopreservation of the brain. The second step is the perfected cryopreservation of the whole body. In other words, the attainment of true suspended animation.

And certainly it's not very controversial to think that *if* suspended animation can truly be achieved, then of course, all medical advances that will be developed in the future would be available to anyone that needs them today.

And I think that is such a sweeping shift in our concept of what is possible that, of course, it would be very attractive to make that become a reality. It would certainly be a revolutionary departure in human history, if we could achieve that goal.

RC: Before we ask you about specific research plans, is there any background information that would be helpful for our understanding of the future potential of the Prometheus Project?

A: Sure. Let's consider several aspects of background behind the Prometheus Project. One of the backdrops to this whole Project is prior research achievements in the area of organ cryopreservation. Of course, if we're going to be inducing suspended animation in the human, we need to be able to preserve the individual organs that comprise the human. And although there has been interesting work done in the area of whole-body freezing by Audrey Smith [20], and by people like Ken Storey, who studies frozen frogs [21, 13], those experiments in a way fall short of strong proof that

Russell Cheney (pictured above; no, that's *not* the interviewee) is an Alcor suspension member, a certified Alcor CryoTransport Technician and regular correspondent for *Cryonics*.

we can attain suspended animation because the storage temperatures for both of those whole-body experiments were much too high for long-term storage.

In the field of organ cryopreservation, though, there have been some whole organs that have been successfully cryopreserved at temperatures that would allow long-term preservation. One of them is the canine intestine which has been shown by a number of groups to survive freezing in liquid nitrogen, and to support normal function after transplantation [11]. The canine spleen has also been frozen to fairly low temperatures, thawed, and at least in one case seemed to escape some of the long-term degenerative diseases that tended to plague that model [1]. But the bottom line is that, in at least one case, it's been shown that the canine spleen can survive deep freezing and thawing and still function after transplantation.

RC: Any successes in organ systems in addition to the intestine and spleen?

A: John Farrant's cryopreservation of guinea pig uteri back in 1965 is worth mentioning [9]. He used a very innovative approach which avoided freezing entirely. And this is one of the precursor approaches that led to the current efforts to cryopreserve organs by vitrification. He could have actually vitrified the uteri at the time, but he did not understand that. He didn't understand the physics well enough to realize that if he'd only cooled the uteri another 50 degrees or so he would have converted them into a glassy state and probably could have preserved them for years.

That just was not known at the time. But he did the hard part: he was able to introduce about 55% dimethyl sulfoxide into the uteri and wash out the DMSO after warming them back from about dry-ice temperature, and have the uteri contract normally in response to histamine stimulation.

That's a substantial achievement in cryobiology.

I might also mention that, using an extension of that technique, Gabriel Rapatz, a few years later was able to cool adult frog hearts down to dry ice temperature, warm them up, and get good, vigorous beating of the frog hearts after warming [17].

There have also been a number of sporadic reports of partial or complete successes in the area of kidney freezing [10]. The problem with these experiments is that they seem to fly in the face of what we now know mechanically to be going on in the case of kidney freezing.

And, unfortunately, as you know, recent claims for successful rat heart cryopreservation have not been substantiated to date [2].

At the same time, using completely different methods, Fahy has been working on organ vitrification for several years, and that seems to be nearing a critical point [7].

So you could say that part of the background for considering the Prometheus Project is that there has been a lot of success, or results that are pointing directly toward the possibility of success, in other organ systems [16, 25].

RC: But as to the brain itself . . .?

A: One of the things to keep in mind is that the brain is an organ like any other organ, and if it's possible for certain organs to be cryopreserved, then it may well be possible for the brain as an organ to be cryopreserved too, which is the first step of the Prometheus Project.

With respect to the brain per se, there's been a tremendous amount of prior work done on cryopreserving brain tissue. And generally speaking, what has been observed is that brain tissue survives biochemically in spite of very severe freezing. And despite freezing being done in ways which are not exactly as protective as they could have been.

So we think that biochemically the brain is fairly hardy, but for whole brains, very limited work has been done. It's known that you can perfuse rabbit brains with glycerol with good permeation of the glycerol. It's also known that rat brains resist permeation with most cryoprotective agents. So one issue is whether we'll be able to get cryoprotectants to penetrate the brain adequately.

"The brain is an organ like any other organ, and if it's possible for certain organs to be cryopreserved, then it may well be possible for the brain as an organ to be cryopreserved too."

There's also been work, of course, on the cat brain by Isamu Suda and his colleagues at Kobe University in Japan [22]. They showed that it was possible to obtain a normal electroencephalogram after freezing the isolated cat brain

to minus 20 degrees Celsius and holding it there for five days, and then thawing it and reperfusing it with warm cat blood. What they did was actually to electrically compare the same brain before and after freezing to see if the wave pattern was similar. And what they found was a very good degree of complementarity between the pre-frozen and the post-thawed brain. Which is quite a stunning accomplishment.

They did not use enough glycerol to protect at very low temperatures, however, and what they found was, if they froze to minus 60, they could get some recovery of the electroencephalogram, but it was much diminished. If they froze to minus 90 they got no EEG, suggesting that long-range neural connections were broken. But they did get nice recovery of individual brain cells, as demonstrated by applying microelectrodes to cells within the brain and recording the electrical discharges.

RC: Does other significant research background in this field exist?

A: It's known that living tissues can survive an incredible amount of distortion by ice. This has been one of the paradoxes in the field and one of the reasons it's taken so long for people to decide that we have to go to such extents as vitrification in order to cryopreserve organs. Human limbs severely frozen by accident in the winter in Alaska can sometimes be largely saved by slitting them open to allow edema fluid to escape and pressure to be relieved from the tissues so the blood can reflow back to the blood vessels.

Prior to those observations, it was thought that the limbs were just irreversibly damaged; when you thawed them out, blood went into them for a little while, but then the limbs turned blue and that was the end of it. But the problem is that the blood vessels are leaky. If you allow the leaked fluid to weep out of the limb so you don't build up tissue pressure, you can actually preserve the limb.

And there are similar experiments on frostbite where people have taken animal limbs and immersed them in very low temperature baths and frozen them to unreasonably low temperatures, such as minus 20 degrees or below, and thawed them out and retained most of the structure of the limb.

And this is without any cryoprotective agents being present. And yet what we find when it comes to the three most popular organs - the heart, liver and kidney - is that they tend to have very sensitive vascular beds. Presumably the same would be true of the brain. If you freeze out too much ice in those systems, you can't recover the whole organ because of the blood vessel damage.

Nevertheless, some of these experiments allow us to devise goals that we can pursue. In other words, it's known in certain cases how much ice can form without destroying the capillary bed, and from phase diagram information it's possible to calculate how much cryoprotectant you would need to prevent formation of that amount of ice. Then you can design experiments that would allow you to introduce at least that amount of cryoprotectant to protect the vascular bed.

For example, in the case of the brain, the golden hamster has been frozen to the extent of about 63% of its brain water being converted into ice. And yet when you thaw the hamster out, the hamster seems to behave normally afterwards [20]. You can actually freeze out even more ice than this in the brain, and have the hamsters breathe afterwards, which is still impressive, even though they don't recover. And it seems that the damage to the brain was probably not the limiting factor in those experiments.

So arguing on that basis, it would seem that you don't need to prevent too much ice from forming in the brain in order to protect it. On the other hand, there were a lot of experiments done back in the '80s indicating that in fact the brain is mechanically damaged by ice, and we really do have to contain the amount of ice and reduce it to a minimal level if we're going to get long range structure preserved in the brain.

RC: Based on what you're saying I'm envisioning a cryonic suspension protocol here which might involve addressing different organs separately. Is that conceivable?

A: Sure, that's a real possibility. Unfortunately, cryobiology, particularly organ cryobiology, is a shoestring operation, and always has been, and so we don't have a great deal of information about the differing requirements of different organs for cryoprotectants. But it's been long apparent that one potential approach would be to have several different cannulas going to several different organ systems within a given body so as to optimally protect each individual system.

That's entirely feasible. It would be awkward. It would be a lot more convenient if one agent, or one mixture of agents, could be found that would protect everything. But if

that cannot be done, then there's certainly the prospect that you raised of individually protecting the individual organs all within the body. It's not unreasonable at all.

RC: In terms of what you think might be appropriate background for us, the reader of this interview, were there any other items that you felt could be mentioned at this point?

A: I suppose I could amplify a bit on some unpublished findings that cryonicists came up with in the 1980s and early 1990s [3]. One of the findings was that if you actually look at brains in the frozen state to see what the ice patterns look like with ordinary freezing techniques, looking at things at the light level, the damage looks quite severe and quite fearsome.

If you re-examine the same brains using the electron microscope, there is still some damage that is observed in the frozen state, but far less than you would assume just by looking at the picture on the light microscope level. So it's a little bit of a paradox that there does seem to be injury, and you can see the injury in fact when you thaw the brain out. You see rips and tears in the tissue that correspond to the large ice cavities that are formed and are visible in the light microscope.

If we're shooting for a perfected method, we have to preserve the structure.

So I'd say that one of the primary findings that came out of the work that was done in the '80s and early '90s is that current cryopreservation methods for brain cause a tremendous amount of structural damage to the brain. They do permit some structural preservation, of course, but the level of injury that we see is sufficiently severe that I don't think we can really be content with the status quo. We have to do better than what we've seen so far.

RC: Have there been additional significant findings more recently?

A: There has been some very recent work that Mike Darwin did, on canine brains, in which he loaded the brain with about 7-molar glycerol, froze to minus 90 for a couple of years, thawed out the animal, reperfused the brain with fixative, and processed the brain in a number of different electron microscope facilities [4]. In at least one of those facilities, the structure that came back was quite breathtaking in many areas. The synaptic structure was normal, the synaptic vesicles both pre- and post-synaptically were normal. You could see the normal postsynaptic densities. You could see clean interstitial space in the brain. And you could see this sort of structure over large areas of the brain.

"We must have a more reliable and more complete preservation technology at our disposal."

Unfortunately you also saw, within the same brain, sizable areas that seemed to be ripped or macerated, perhaps by ice. And you also saw partial dissolution of what seemed to be small populations of glial cells. In other words, you would see cell nuclei with no cell bodies surrounding them.

RC: For cryonics, how critical is that finding?

A: Fortunately those are probably not neurons and are probably not critical; they're probably not informational in nature. The informational structures seemed to be present. But, nevertheless, this is a defect in the results. I think the positive outcome is that at least much of the neuropil, which is the fine weave of the brain, or what you might say is the "cross-talk area" between brain cells, seemed to remain intact. And that's probably where we live, as individuals, in all those electrical connections, where all the traffic takes place.

On the other hand, there were those seemingly macerated areas of neuropil. Furthermore, samples from the same or similar dog brains sent to most other electron microscope facilities have shown terrible results. I mean unbelievably bad results. So we have a problem of reproducibilty here. But even under the best conditions there's still sufficient damage that although we can hope that some of the synapses have survived, we also have to be very concerned that some of them may have been destroyed.

So there's substantial evidence that gives you pause, to put it mildly. And I think that as long as the present situation continues to exist, nobody can be very thrilled about being frozen today. So we must have a more reliable and more complete preservation technology at our disposal.

RC: Could you share with us your thoughts on what approach might most effectively be taken in a serious, well-funded research program leading to effective brain

cryopreservation?

A: I would envision a two-pronged approach being initiated early on, in any kind of serious research program in this area. There are really a couple of issues that need to be addressed, and should be faced upfront.

One of the issues is whether you can get cryoprotective agents into the brain or not, without causing massive damage from dehydration. In other words, the brain has all the usual permeability problems of other organs, but in addition to that, it has a permeability barrier known as the "blood-brain barrier". And these barriers make it difficult for molecules to pass from the blood vessels into the brain tissue.

This blood-brain barrier has been developed by evolution to protect the environment of the brain cells, because you have a very sensitive system which can't be allowed to be disturbed. Unfortunately, what this means for the cryobiology of the brain is that we have to be very lucky and find agents that can penetrate through this blood-brain barrier without causing damage. Or we have to be able to open the blood-brain barrier, at least temporarily, to allow these agents to get through.

RC: You mentioned a second issue?

A: At the same time that we concern ourselves with structural preservation and penetration, we have to be concerned about the second issue: the cellular toxicity of any agent that might be used. Classically, cryonics hasn't had to worry too much about cellular viability, and ultrastructural preservation was the goal. And I think ultrastructure still has to be preserved if you want to perfect the process, but you must do more than that. You must also preserve the biochemistry of the brain.

I told you that the biochemistry can survive severe freezing and thawing. Unfortunately, the structure of the brain can not. And as you add cryoprotective agents to protect the structure, then you can only increase the threat of damage to the biochemical aspects of the brain. So that balance has got to be met, and in order to do that you need feedback on cellular viability, as you go through the initial series of experiments.

I think one excellent model that could be exploited, in this regard, is the hippocampal brain-slice model. The hippocampus is the part of the brain that reads in and reads out memories, and a tremendous amount is known about the neurophysiology of the hippocampus. And it's possible that if agents are found that penetrate the brain adequately, they ought to be screened against the hippocampus for the ability of the hippocampus to recover normal functions after exposure to the cryoprotectants.

In addition, if agents are found to be particularly attractive, based on cellular viability with the hippocampal brain-slice model, then it may also justify extraordinary techniques to make sure that those agents can be delivered into the brain, including opening up the blood-brain barrier, or lavaging the brain through the ventricular system, or whatever other techniques people can come up with.

RC: Opening up the blood-brain barrier?

A: There has been work, by Rapoport many years ago, indicating that it is possible to open up the blood-brain barrier in the monkey, temporarily, to allow drug molecules to enter the brain [18]. And monkeys subjected to this procedure recovered with no neurological deficit. The barrier opening just involved an osmotic pulse of about 1500 milliosmolal or so, flushed through the cerebral vascular bed. And apparently that osmotically opened up temporary gaps in the capillary wall which allowed small molecules to cross the barrier and get into the brain.

This technique has not really been explored in brain cryopreservation research to date. It's remained a possibility for many years, and it can still be exploited.

So to summarize the answer to your question, I think the initial approach ought to be a two-pronged approach in which cryoprotective agents are screened for their ability to get into the brain and to do so without causing damage to cellular viability. And that process can be optimized and improved upon in many ways until satisfactory results are obtained.

Presumably one wants to get in as much cryoprotectant as one possibly can, and possibly even at the expense of a certain amount of biochemical injury, provided it's likely that injury can be reversed given several days of healing after rewarming.

RC: From a research perspective, how would the two-pronged approach be viewed?

A: You could say the first prong is the whole brain, and the second prong is brain slices. Because the whole brain has to be perfused. The brain slice does not have to be per-

GLOSSARY

Anastomoses: Connections between blood vessels.

Freeze Substitution: A method for preserving the structure of a frozen system in which the system is fixed while frozen and ice is then dissolved prior to warming the system.

Cryoprotective Agent: A chemical compound or a mixture of such compounds designed to both minimize freezing damage and have minimal side effects on the tissues to be preserved; a cryoprotectant.

Dimethyl sulfoxide: DMSO; A traditional cryoprotectant that permeates well through cell membranes.

Glial Cells: Nonexcitable cells of neural tissue that support, protect and insulate the neurons.

Glycerol: Currently the most widely-used cryoprotectant for cryonics, $C_3H_8O_3$.

In situ: In its usual place, usually within the living organism.

In vitro: Literally "in glass," meaning in laboratory apparatus, as opposed to within a living organism.

Model: An experimental system that has features resembling those of ultimate interest to the investigator, but that is simple enough to be amenable to study.

Morphology: Biological structure.

Perfusate: A liquid (or gas) that is perfused.

Perfuse: To pass liquid (or gas) through blood vessels.

Prometheus Project:

First ten years:

1) Discover how to fully recover both brain and mind from a state in which it could remain for decades without deterioration.

2) Demonstrate that mental facilities have been fully recovered in a manner that will convince scientists, the media and the public.

Subsequent years:

1) Attend to imperfections.

2) Extend the research to the remainder of the body to permit the achievement of reversible whole-body suspended animation. (This accomplishment would replace cryonics with a perfected method properly termed suspended animation.)

Preparation: A specific type of model system.

Thermal Treatment: The time - temperature process used on an object.

Vitrification: A process wherein a solution, at sufficiently low temperature, becomes so viscous that it solidifies without the formation of ice. A vitrification solution is an aqueous cryoprotectant solution that does not freeze when cooled at moderate rates to very low temperatures.

fused. The brain slice can be immersed in the cryoprotectant, and the agent can be added and removed by diffusion. So the blood-brain barrier basically does not exist in the brain slice model. But in the whole brain, the blood-brain barrier may be the primary determinant of whether a given agent is practical to use.

So if you just do hippocampal slice experiments, you may discover wonderful cryoprotectants that are useless because they can't get into the brain. Or if you do brain perfusion experiments, you may find things that get in nicely but are useless because they are lethal to the brain cells. So you need to look at both sides of the coin.

RC: The hippocampus is an especially desirable model because . . .?

A: It's especially desirable because it controls memory, there's a great deal known about it, and also it's a great example of a neural circuit that includes both cell bodies and an intensive amount of neuropil (in other words, axons and dendrites that are in communication with each other). One can apply stimuli in various areas of the hippocampus and pick up resulting signals elsewhere in the hippocampus to make sure the connectivity is retained.

And I think the connectivity is one of the absolutely key areas for successful brain cryopreservation. It's like making sure your transcontinental telephone system operates properly: that if you pick up the phone in California and dial me in New York, you don't reach New Zealand or Florida instead.

RC: And after the successful completion of the two prongs, do you envision a sequence of research to follow?

A: Yes. Because even after you've done what I described, you have only experimented with cryoprotective agents; you have still not experimented with freezing and thawing or with vitrification and rewarming. So that now must be looked at as a separate issue. To what temperature can the brain be cooled without injury, what is the optimal cooling rate, what is the optimal warming rate, and are there things you have to go through other than the standard ones, in order to get a good result? There are many variations that must be examined. The goal of that kind of research would be to find out what the brain needs.

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You can evaluate the results in a couple of different ways. We really haven't discussed end points other than cellular viability and morphology, so far. But now we come to an issue which will have to be looked at if anyone is going to be persuaded the Prometheus Project has succeeded: the assay for whole brain viability.

There are all kinds of indirect assays that can be done, such as brain metabolic parameters, oxygen consumption, glucose consumption, all kinds of things like that. Evaluation of electrical activity can be very sophisticated and exquisite if done by an expert, and a tremendous amount can be learned that way. But what we would really like to know is if the brain can wake up after that sort of experience.

RC: Recover full consciousness.

A: Yes. And this involves the need to reperfuse the cryopreserved brain with blood. Isamu Suda did this with his isolated brain model, and he was able to obtain electrical activity [22].

But as I said, electrical activity may not be persuasive to everybody. So what else can we do? Also, if you have an isolated brain model, you don't have the ability to have the brain express itself in any way other than electrical activity. Presumably this could include the electrical activity associated with consciousness, but it would not include consciousness itself.

One proposal has been to revive some of the brain transplantation methodologies that have been proposed in the past. There are a couple of versions of them. One was published by Robert White, in which you take the brain that's basically within the isolated skull with the vascular segments intact, and transplant that into the neck, or other area, of a second animal [23].

That allows you to record EEG over several days, if not longer. And

that means that the true cellular viability of the brain would be established, by failure of the brain to disintegrate over time. And you could also measure the blood flow going into and out of the brain to verify that it's relatively normal.

That would be good evidence that the brain remained alive, but it wouldn't necessarily be good evidence that the brain was functional. And so it would be desirable, even though that particular model is fairly simple and doable, to go after a more ambitious model, such as Robert White [24], Demikhov [5] and Sano [19] have looked at here and in Russia and Japan, in which the whole head is transplanted.

White has done this both on dogs and on monkeys, and the Russians and the Japanese have done this on the dog upper body, in which you use the arch of the aorta in the donor as a point of connection in the recipient. This involves basically transplanting the two upper limbs along with the head and the upper body. But what it gives you is a preparation which can express consciousness and purposeful behavior to the nth degree, and which is stable for several days, and even for several weeks, after transplantation.

This is more of a surgical tour-de-force, but with sufficient funding the Prometheus Project ought to be able to attract surgeons who can do this kind of transplant procedure. If so, we would then have a preparation which could be at least perfused with cryoprotectants, and possibly even frozen and thawed to various levels, and then transplanted and evaluated for consciousness and behavior.

That is the *sine qua non* of an end point for brain cryopreservation, conscious behavior.

RC: Are there any anticipated major issues with this approach?

A: There is a problem which attends this, and that is the necessity of cryopreserving more than just the brain. If you're preserving the sense organs along with the brain and you're more able to preserve the brain than the sense organs, then you're going to find that you cannot do this preparation.

If your eyes are damaged, if your ears are damaged, if your facial muscles are all in rigor mortis, because they didn't survive freezing and thawing, then you're not going to be able to have a very successful outcome with such a whole-head transplant model. But that is just another challenge to be met along the way; the Prometheus Project must ultimately include being able to preserve those superficial structures. After all, those are on the way to whole-body suspended animation, which is the ultimate goal. But they would introduce potential problems in the short run.

On the other hand, it's entirely possible that those simple structures will be a lot easier to cryopreserve than the brain itself, since they are simpler and, in many ways, hardier. And so it's possible the problem of being selectively unable to preserve them will actually not arise. But I think the biggest concern is that, in the eye, and probably in the semicircular canals in the ear, you have fluid inclusions which are not perfusable, and this means that the water in the middle of the eyeball will tend to freeze because you won't be able to introduce cryoprotectants into it. The eyeball will tend to shrink also, because of withdrawal of fluid by the osmotic pressure of the cryoprotectants. So you can easily imagine ocular damage and ear damage caused by this unstirred-pool effect.

Possibly that's something that can be addressed using fairly simple approaches, if it comes right down to it. It's hard to say exactly what those approaches would be at this point, but they could be addressed when the time came.

So to answer your question, after we qualify various agents by screening them for cellular viability and for the ability to access cells within the intact brain, then we can step up the level of rigor to looking at whole-brain viability and, if possible, whole-brain function, depending upon what the experimental limitations turn out to be.

RC: You didn't say so explicitly that I recall, but going back a step here to Robert White's work with the dogs and the monkeys, there was an implication that his work was successful?

A: It ***was*** successful.

RC: That's just astonishing!

A: Yes, it is astonishing. You could transplant these monkey heads [24], or dog upper bodies [5, 19], and the heads would track you with their eyes, and they would bite you if you put your finger into their mouths. They were perfectly intact neurologically, there is no question about it. And so we know that is possible.

What we don't know is how much damage we can do by adding and subtracting cryoprotectants and still have such a preparation recover, and how long it would take for such a preparation to recover.

For example, about a third of

the transplanted human kidneys don't function initially. You have to put the patient on dialysis for maybe a week or two before the kidney sufficiently recovers to support the patient without dialysis.

That's OK because we have dialysis machines, so there's no real problem with the time delay. But if you're dealing with a head-transplant model, and the lifetime of that model is only a week because you get into trouble with infections, or who knows what else the limitations might turn out to be, and it takes two weeks for the brain to recover from the insult that you induced, then you're in a bit of trouble.

Incidentally, there is another way station that can be used. If part of the problem for the brain or for the superficial structures has to do with vascular breakdown, it's possible to perfuse the head preparation on an artificial circuit in vitro, so that you could prevent some of those vascular problems from being limiting, and therefore get results that otherwise could not be obtained. And you could quantitate things like blood flow a little more easily, perhaps. But that's just one variation along the pathway that we discussed.

RC: So it sounds like what you're saying is that you would envision an approach that would, by design, manage to harvest relevant prior research?

A: Well, let me put it this way, which is a little bit more precise. I've given you a lot of information about how the research would proceed, but I haven't said anything about what the actual agents or agent would be. And so I'm leaving that completely open. And if the Visser agent turns out to be the best agent, then that's terrific, we'll use that. If Fahy's agents turn out to be the best, that's terrific, we'll use that. If some completely other, novel agent comes along that's discovered in the course of the Prometheus Project, or that somebody else comes up with in some other laboratory in the world, or that some other group comes up with outside of the Prometheus Project but within one of the cryonics organizations, then fine, let's use that.

I think the goal here is to succeed, and I wouldn't want to prejudice the Project in any way. I think that it's important to keep an open mind at all levels on how this is going to happen, and be guided by the experimental results.

The brain is largely uncharted territory. There have been a number of brain tissue slab experiments that have been conducted in which the slabs were immersed in various cryoprotectants, including ethylene glycol, DMSO, various concentrations of glycerol, propylene glycol, methanol, mixtures of methanol and glycerol, and other mixtures as well, including Fahy's cryoprotectants, then either freeze substituted and looked at for structure in the presence of ice, or just fixed after exposure to the cryoprotectant and looked at for structural preservation after exposure. And I would have to say that after all of that research, glycerol still seems to be unbeaten by any other agent. There are agents that are competitive with glycerol, but not anything that's distinctly superior to glycerol at this point.

However, I think that those results largely should be repeated in a model that's more appropriate than a brain slab. There are problems in the brain-slab model with getting the cryoprotectant in and out by diffusion because of the thickness of the slab.

RC: In your opinion, what do you think would be required to convince the general public and press and science community of the complete success of the first part of the Prometheus Project?

A: It's possible the head-transplant model would not be sufficient to convince everyone that brain cryopreservation had been successfully done. This would be particularly true if it turned out that the brain required two weeks to recover and the lifetime of the preparation was only about two weeks. By the time the brain had a chance to do something to prove that it was intact functionally, you couldn't maintain it any longer.

There could be an answer that would be quite impressive to everyone. Although it would be difficult technically, it is apparently feasible, at least to a degree. And that would be to selectively freeze the brain *in situ*, in the intact organism. This would probably be most achievable using a monkey model, rather than a dog model, because there are so many anastomoses between the cerebral circulation and the superficial circulation of a dog, making it extraordinarily difficult to isolate the brain circulation.

To non-selectively freeze the brain in situ could be difficult or not so difficult depending on how tolerant the superficial tissue is to freezing. We already discussed the problems of freezing eyes, ears, and muscle in the face. If those structures turn out to be fairly resistant to freezing injury, then that would be a potentially useful approach. You place the attached head in a freezing

bath, freeze and thaw it, and then let the whole animal recover and behave.

If the superficial tissues do not tolerate cryopreservation, it may be possible to demonstrate successful brain cryopreservation by selectively freezing the brain without freezing those superficial structures. It remains to be seen exactly how far down in temperature we can get the brain without freezing the superficial structures. Calculations have been done indicating that we can get the brain down to reasonably low temperatures. From the point of view of cryobiology, if we can get the brain down to minus 60 to minus 80 degrees C, for example, it's good evidence that the brain could be cryopreserved indefinitely by cooling to lower temperatures, since not a great deal of extra injury would normally occur during cooling below those temperatures.

And yet if we could cool the brain by, for example, gas or fluorocarbon perfusion, down to those temperatures while keeping the superficial structures -- the eyes, the ears, and so forth -- above the freezing point, or at least above their lethal freezing temperatures, then one could reverse the process by using warm gas or warm fluorocarbon, to thaw the brain within the skull, wash out the cryoprotectant, release the vascular clamps to allow the blood to reperfuse through the brain, and allow the animal to recover.

The animal may require intensive care for a couple of weeks, but with adequate funding that could be provided. After which the animal might not only be able to demonstrate that it survived this experience, but also show it recognized people, it could behave normally, it could follow you around the room appropriately, or swing from a tree, or heel, or whatever might be appropriate for the animal that's chosen.

If it turned out to be a monkey, of course, it would be all the more impressive because the monkey obviously is as close as you can get to a human. But a dog would be incredibly impressive as well, due to the high intelligence of a dog.

So this would be a way that you could obtain survival of the entire animal after having its brain selectively frozen. To the extent that this can be done, I think it would convince anybody that the brain can be successfully cryopreserved. We don't have to achieve this level of accomplishment in order to convince probably the vast majority of people, but if we could do this, I think we could convince just about everybody.

RC: Are you comfortable that the ten-year time-frame and the $1,000,000 a year funding objectives for the first part of the Prometheus Project would be sufficient to meet the scientific goals?

A: Yes, I think that the answer is affirmative in both cases.

I think the time frame is appropriate because there is a great deal of prior knowledge out there that is relevant to this problem, both in terms of brain tissue freezing, whole-brain perfusion, brain-slab freezing, and cryopreservation of hearts and kidneys and intestines and spleens et cetera. So a lot is known in the field, and during the ten years of the first phase of the Prometheus Project, that information is not going to stop accruing.

So all information from outside sources all over the planet will feed into the Prometheus Project, during the Project itself, in addition to the findings that would otherwise arise. I think that many things going on in cryobiology laboratories are potentially helpful to this Project. And so I think that the time scale is a reasonable one.

I don't think we should be too sanguine about the ease with which this goal can be accomplished; there are certainly plenty of problems. So I think looking at a time horizon less than ten years is probably not intelligent. But I think that ten years provides a reasonable hope that the goal can be attained.

As far as the funding level is concerned, I've done rough calculations of what it would cost to do a project like this adequately, and I do think that $1,000,000 a year turns out to be about the right number.

RC: Would you have any concerns, in terms of the financing, that the

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funding might not be required at an even rate. In other words, maybe in the beginning there would be some additional funding requirements, for instance, to obtain a lab and suitable equipment?

A: The Project will have a lot of up-front structural costs the first year, but the most costly models will be implemented only later, so it will tend to balance out. I see the Project phasing in new required equipment and technology as it evolves, which essentially costs roughly what the last wave of new equipment and new technology cost. So I think that generally speaking a million a year is reasonable as to what ought to be provided.

And it's true that from year to year there may be ebbs and flows in the exact requirement involved, but if you average about $1,000,000 a year you'll probably get where you want to go. And if there's more money than expenses in a given year, the surplus needs to be retained in savings, to avoid a shortfall in a later year.

It's hard to see that it would be possible to spend too much money on the Project. It's not likely $1,000,000 will be an excessive amount in a given year. There is just too much to do.

RC: In the longer term, is it possible that one mechanism for accelerated funding might be research progress itself?

A: You have a point. The more results are produced, the more credible the concept will become. The closer it gets to the goal, the more excitement the Project will generate, and so it's quite possible the funding could actually accelerate as the research itself is accelerating toward the goal.

RC: Did you wish to say anything about the makeup of the team that you envision would be appropriate for Prometheus success?

A: I could say a little about that. The Prometheus Project could benefit from having talent in a number of different areas. Certainly having a neurophysiologist involved in the Project would help a great deal. Having a cryobiologist or two would help a great deal. There needs to be adequate technical support; I don't think you can overestimate the importance of people just doing routine tasks. There will be a lot of data to be processed and people will have to be brought in to do that kind of analysis.

A lot of surgical expertise will be required, so you're going to have to bring in people who can do head-transplant experiments. You're going to have to be able to bring in people who can do brain slice work earlier than that.

But certainly surgical expertise is going to be needed. Preferably a neurosurgeon, somebody like Robert White, would be ideal for this kind of project, somebody who both understands the neurobiology involved *and* can do the surgery. I think the Project will be unlikely to obtain somebody like Robert White, excepting Robert White himself being wooed into Prometheus, unless the funding is greatly increased over $1,000,000 a year, as we were just discussing.

I also think there should be somebody around who can do engineering work, who can make new kinds of equipment as required, and repair old equipment as it gets broken. Because Prometheus is going to involve a constant series of inventions and innovations, and the Project has to have the flexibility needed to be able to go in any direction that's required.

There may be a need for somebody to be involved on a full-time basis just to do the electron microscopy. It would be wonderful to have somebody who could process micrographs, both light and electron micrographs, on an almost full-time basis. One of the problems of a project like this, particularly one that involves morphology as an important end point, is the sheer volume of data that has to be assimilated by the workers and the project; that could be a limiting factor in the rate of progress, unless you have specialists who are willing to take on that task to the exclusion of a lot of other work.

The other kind of expertise that would be valuable would involve computer equipment automation techniques and talent, so at least some of the aspects of the data tracking could be automated to make the volume of data tracking manageable by the team.

A number of these tasks can be pursued on a part-time basis, or can be contracted out to external organizations. You don't necessarily have to have given individuals for each and every one of these functions. But these are all functions that would be valuable to the Project, and the number of individuals brought in and assigned to these different functions will be directly dependent on how much money is available.

The more tasks that can be done in-house the better. But if a lot of it has to be done outside, then that's probably feasible as well.

RC: Some cryobiologists have expressed a certain reticence toward cryonics research. What effect do you think that might have on staffing a research team?

A: Yes, the question you're really asking is, "How likely is it that cryobiologists could be enlisted to participate in the Prometheus Project?"

I think that is a very difficult nut to crack. I do think that there are a few cryobiologists who might be able to participate in a project like that, but the vast majority of them would not be able to participate.

I think that there are cryobiologists who do have relevant talents that could be brought into the Project, and I think that one of the important tasks early in the Prometheus Project would be to attempt to recruit these cryobiologists. For some who can't be recruited directly, confidential consulting agreements and business arrangements might at least allow them to act as advisors.

There are cryobiologists in Russia who are available. Whether these individuals are able to really do what has to be done on this Project is an open question. Certainly there is no shortage of cryobiologists from Russia, but I think we need to have a Western cryobiologist running the show if we can manage it.

RC: You mean as a project manager?

A: As a project manager.

RC: Do you believe that, because of the Project's extensive funding and time-frame, that it might very well put many cryobiologists in a position where they would feel more comfortable about having a continuity of a career, if they choose to participate?

A: I think so. I think there may be a couple of cryobiologists who would be on the fence about a project like this, would realize that departing from academia and going into this field of research might make them unemployable in the future, but who might think, "If we actually have ten years to pull this off, an adequate amount of funding to get good results, and if we have the ability to publish results that are obtained along the way, in good journals like the neurobiological journals, then there may be the opportunity of sustaining one's career, in some way, after the Project is completed."

And again, I think that if there is hope of recruiting cryobiologists, the ten-year time-horizon would be a major factor in successfully recruiting these people. Because it is potentially a one-way street; it's a tremendous risk for any cryobiologist to go into, just because of the controversial nature of the whole concept.

On the other hand, one redeeming feature about this research is that it is not cryonics. It's a scientific research project devoted, in the first ten years, to cryopreserving a single organ. As such, it's no different from other research projects to preserve organs.

But I believe Robert Ettinger once said that cryobiologists are like firemen who only want to put out small fires, and that analogy pertains here. This is the banking of a single organ, and so on that basis should be perfectly respectable. And nobody is asking anybody to have their brain frozen in the interim. Yet because of the profound nature of this particular organ, cryobiologists and others are going to be uncomfortable about it.

RC: Is it possible that some talented cryobiologists might be positively motivated by the extraordinary potential of Prometheus?

A: Yes. In fact, I know of at least one credentialed cryobiologist who would definitely be interested. But we also need to recognize that science is a universal, non-exclusive enterprise by its nature. Bright young Ph.D.s who are not cryobiologists by training could be recruited and trained as cryobiologists. In other words, if we can't hire cryobiologists, we may be able to make some new ones. If they can publish their work, then they're cryobiologists.

RC: What role do you envision for volunteers on the research team?

A: Volunteers could be of enormous benefit. In a project of this kind, there is virtually no limit to the amount of man (and woman) power that can be usefully applied. Volunteers would provide more cost effectiveness.

RC: What do you see as the impact of recent biomedical research on the Prometheus Project potential?

A: There are two new developments that are clearly relevant.

The first development, alas, is an unfortunate one, and that is the trouble Olga Visser had in reproducing her results. This new information about how difficult the Visser method is to reproduce, even using

an extremely simple and forgiving test model, should remind us all that we are dealing with difficult questions that may require more than one new idea to answer. In my opinion, it is not scientifically plausible that the Visser method is going to give cryonicists everything they want. I believe many people will now agree with this conclusion. This underscores the need for the whole community to get in the same boat and start rowing together. That waterfall ahead keeps getting closer every day, and jumping out of the boat and swimming to shore doesn't look particularly feasible.

The second development, fortunately, is positive. The first successful cloning of an adult mammal by Ian Wilmut, a cryobiologist, suddenly brings body-replacement opportunities into view. One can imagine transplanting a formerly successful cryopreserved head and spinal column into an anencephalic clone. Peripheral nerves regenerate, so the dorsal and ventral roots might be coaxed into establishing reasonable connections with the cloned replacement body. Hookups of the vagus and other nerves may also be manageable. A transplant team with sufficient daring and determination might well be able to accomplish such a "body transplant" operation using surgical acumen and equipment that largely already exists and has been demonstrated.

Societal and ethical concerns would need to be resolved before this approach could be utilized. But this approach would then allow a successful central nervous system cryopreservation technique to be the rough equivalent of whole-body suspended-animation. In other words, the payoff of part one of the Promethius Project could be much greater than anticipated.

RC: From where we stand today, what is needed to unleash Prometheus, as far as you're concerned?

A: Well, I think it could happen in a number of ways. There could be some dramatic breakthrough, maybe Olga Visser preserves a pig heart, or something like that, and suddenly everybody feels that this whole realm really is possible and needs to be supported.

Or maybe Paul Wakfer comes up with another way of structuring the organization such that suddenly everybody feels the payoff is so much greater than they perceived it before that they just have to participate.

There could be a variety of ways it could happen. But I think it absolutely imperative that it happen. I think there is much to be done, and our limited time is passing rapidly. What we have now is inadequate. And the concerned groups and individuals can not accomplish as much alone as they can together.

The lack of a perfected technique results in such a high price to pay that we need to find every possible way of overcoming that limitation.

RC: Let's presume that, for some reason or another, the $1,000,000 funding objective was not met. In your opinion, could there still be a Prometheus?

A: There could be. It would be more risky, and it would produce results more slowly, and it might be more difficult to recruit the talent into it that would be desirable for the Project. But as far as I'm concerned, some sort of research program, focused, systematic, well-managed, and well-funded to the extent that it can be done, is necessary. And some project is better than no project.

I think Paul Wakfer would tell you that anything less than about $900,000 is not likely to be useful, and to a certain extent he's right, but to a certain extent *any* money that's spent on brain cryopreservation has the potential of discovering new information that could help everybody.

RC: If, through some mechanism that we don't envision at the moment, funding were ten times greater, or a hundred times greater, would that affect the rate of the research results?

A: Yes, I don't think there's any question about it, because a lot of the research will be very systematic in nature, and the speed with which you can progress through the variables depends on the resources you have at your disposal: the manpower, the number of machines you have to do simultaneous perfusions, and factors of that nature.

So, yes, it could be sped up by having more resources.

More resources would also attract more credibility on the part of outside scientists, who could be drawn in as collaborators and so forth, which would allow conventional laboratories to take on some of the work load. That of course would accelerate the results and bring in new dimensions that otherwise might not be integrated.

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TechNews

By Stephen J. Van Sickle

Column #1

So much is happening so rapidly in technologies that bear on cryonics, it is impossible to follow even a fraction of it. This new column is my very humble attempt to fill you in on what I think is interesting and important. I make no claim to completeness or even relevance; these are just some items that caught my eye over the last few weeks. Unfortunately, I don't see everything. This is where you, my readers, enter the picture. Be my extra eyes, e-mail me information about the latest breakthroughs, point me in the right direction, and I promise this will be much more interesting reading than if you had to rely solely on my meager resources. If you want credit, you've got it; if you're revealing deep, dark corporate secrets, I'll defend your anonymity. It's all up to you, though, how interesting and exciting I can make this column. Feel free to e-mail me at sjvan@csd.uwm.edu (if you put TechNews in the subject line I'll get to it faster) or postal mail me at Alcor's address.

Cloning Update

By now, almost everyone has heard the news about "Dolly," a clone from the udder cells of an adult sheep at the Roslin Institute of Edinburgh, Scotland. What you may have missed is the July 24th announcement about the birth of five lambs cloned from fetal cells. These lambs are special because they contain extra genes inserted before they were cloned. One of the lambs, named "Polly," carries a human gene. This is significant, since it points the way to efficient reproduction of animals that produce human hormones and proteins of therapeutic value. Possible examples include clotting factors, human growth hormone, and treatments for cystic fibrosis. (Science 277, pg. 631, Aug. 1997).

Molecular Nanotechnology

Dr. Eric Drexler has recently released his design for a new fine-motion controller consisting of only 2,596 atoms. Previous rough designs were estimated at over 3 million atoms. The current design is based on a Stewart platform (similar to those used for flight simulators) with eight struts, allowing the positioning of atoms and molecules within a fraction of an atomic diameter in six degrees of freedom. See http://www.imm.org/Parts/Part2.html for pictures, details, and a file of the complete design.

Molecular nanotech designs may be getting simpler, but we still have to face the question of how to make them. One approach is to use fullerenes (the famous "buckyballs") and their derivatives as building blocks. The NASA Ames Research Center Computational Chemistry Branch is investigating this by designing components based on fullerenes, including gears and computer components. (http://science.nas.nasa.gov/Groups/Nanotechnology/). Professor Richard Smalley, Nobel prize winning discoverer of buckyballs, is also investigating the use of carbon nanotubes as probe tips for scanning probe microscopes (Hongjie Dai, Jason H. Hafner, Andrew G. Rinzler, Daniel T. Colbert, and Richard E. Smalley, "Nanotubes as Nanoprobes in Scanning Probe Microscopy," Nature 384, 147-151 (1996)).

Finally, abstracts of the papers to be presented at the Fifth Foresight Conference on Molecular Nanotechnology are now available on the World Wide Web (http://www.foresight.org/Conferences/MNT05/Abstracts/index.html). Papers of interest to cryonicists include "Cryopreservation of Large Biological Systems," "Ultimate Theoretical Models of Nanocomputers," and "Intermediate and Long Term Objectives in Nanotechnology."

Buckyballs on the Brain

Spheres of sixty carbon atoms aren't just for machines, anymore.

Researchers have reported that malonic acid derivatives of buckminster fullerene (a water soluble form of C60) have powerful neuroprotective effects, particularly against the glutamate receptor-mediated excitotoxicity that occurs during stroke, cardiac arrest, and brain trauma. Is there nothing these versatile molcules can't do? (Laura L. Dugan, et al. "Carboxyfullerenes as neuroprotective agents." Proc. Natl. Acad. Sci. USA, Vol. 94, pp. 9434-9439, Aug 1997)

"Re-educating" Organs

Rejection is the Number One problem in organ transplants. Most candidates for organ transplants die waiting for a suitable organ, transplants often fail even with a "match," and even successful transplantees have to rely on dangerous anti-rejection drugs for the rest of their lives. Capt. David Harlan and Lt. Cmdr. Allan Kirk at the Naval Medical Research Institute in Bethesda, Maryland have succeeded in the laboratory with a new technique that may change all that. They do not yet understand how their technique works, but they say the data suggests the immune system is "re-educated" to leave the transplanted organ alone. To quote from the press release: "As part of their research, the team transplanted very mismatched kidneys into non-human primates and treated them with the novel therapy for 28 days after the operation. No other therapy, including the use of anti-rejection drugs, was administered. Six months later, the primates are robust and suffering no significant side effects. The short course of the therapy appears to be long-lasting, precluding the use of daily medication to prevent organ rejection." It appears that the technique may also be useful in xenotransplantation (transplanting organs from non-human animals). Details were published in Allan D. Kirk, et al. "CTLA4-Ig and anti-CD40 ligand prevent renal allograft rejection in primates." In Proc. Natl. Sci., USA, Vol. 94, pp. 8789-8794, August, 1997, the full text of which is available on the Web at http://www.pnas.org/cgi/content/full/94/16/8789.

Artificial Chromosomes

Scientists at Case Western Reserve University School of Medicine in Cleveland, Ohio have succeeded in assembling strands of human DNA into artificial chromosomes. Current experimental gene therapies, relying on viruses to add genes to existing chromosomes, may cause mutations, alter function in unpredictable ways, and often disappear as the cell divides and the new genes fail to replicate. Artificial chromosomes, the creation of which is not yet fully understood, appear to bypass these problems, and have survived for as much as 6 months in cells replicating in culture. Harrington, J.J., et al. "Formation of de novo centromeres and construction of first-generation artificial chromosomes." Nature Genetics 15(April):345.

Alcor Member Wins Award

Dr. Ralph Merkle, Alcor member and computational nanotechnologist at Xerox, was awarded on March 2, 1997 The Association for Computing's (ACM) "Paris Kanellakis Theory and Practice Award" for his contributions to the development of public key encryption. The Award was given to Dr. Merkle and five others for "the conception and first effective realization of public-key cryptography. The idea of a public-key cryptosystem was a major conceptual breakthrough that continues to stimulate research to this day. Without it today's rapid growth of electronic commerce would have been impossible." Dr. Merkle shared the award with Leonard Adleman, University of Southern California; Whitfield Diffie, Sun Microsystems; Martin Hellman, Stanford University; Ronald Rivest, MIT; and Adi Shamir, The Weizmann Institute of Science.

Revolution to Orbit

You may not have to take that risky low-temperature trip to the future to fulfill your space travel dreams. Rotary Rocket Company (a Redwood Shores, California startup) has released the latest redesign of its Roton single-stage-to-orbit spacecraft. This extremely original design uses a proprietary rocket engine that "rotates about the Roton's longitudinal axis, generating the centrifugal force necessary for pumping the propellants at high pressure to the engine's banks of multiple combustion chambers." Rapid turnaround and low operating cost promise to radically reduce the price of space travel.

Preliminary financing has been secured. Engine tests have begun at a site in the Mojave Desert, and propellant tank tests are being conducted at Burt Rutan's Scaled Composites, Inc. It is rumored that major investors include famed techno-thriller author Tom Clancy.

For the Record

by R. Michael Perry, Ph.D.

Musical Creativity in Cryonics

Cryonics may be important to many of us, yet it's only a means to an end. We work hard for a longer, healthier life, but what we *do* with that life is important as well. The things we accomplish on *this* side of the freezer will have a bearing, we think, on what we accomplish on the *other* side, when there'll be more opportunities and less time pressure.

Cryonicists are noted for being a diverse (and often divisive) lot, but one of their oft-recurring features is above-average *creativity.* Over and over I've seen cryonicists fascinated with one particular creative endeavor: *music*. Efforts in this field range from the rankly amateurish to the nearly professional, but for the most part have gone unrecognized. I hope to change that.

The following musical cryonicists either have suspension membership with a cryonics organization or are now in suspension. All of these individuals have consented to public mention of their cryonics arrangements. To those musical cryonicists I may have missed in this article, I apologize.

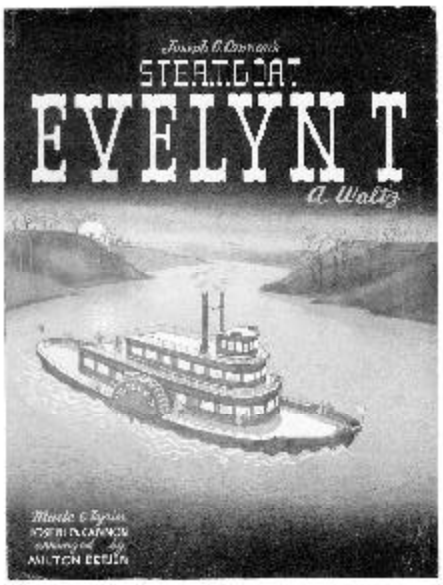
Joe Cannon

Some years ago I learned (from Mike Darwin) that Joe, a long-time cryonicist whose involvement goes back to the '60s, wrote "a couple of waltzes." When I wrote to Joe, he obligingly sent me the printed scores. The story that goes with them is an interesting one.

During World War II, Joe had imagined one day setting up a little tourist attraction: a steamboat cruise over some of the small, interconnected lakes around Appleton, Wisconsin where he lived. Being very ambitious and enterprising, he would do everything himself, from arranging for the boats to composing music that would be played onboard while the customers were enjoying their ride.

And compose Joe did, notwithstanding his meager background for it. Unable to write out a score, he whistled two waltzes into a tape recorder. Milton Detjen, a friend with more formal musical savvy, listened to the tape and wrote down the notes, adding harmony and getting things to sound, on the piano, as Joe imagined they should. The music was completed and printed in two large, showy flyers with the copyright date 1943. The waltzes, around 2 or 3 minutes each, are named "Claudius G" and "Evelyn T," after Joe's parents.

They were the only music Joe Cannon ever composed. . . and they were also as much progress as he ever made on his cruise project. Nevertheless, the music remains, and I've had pleasant moments listening to it. (I use music software on my PC to make up for a lack of playing ability.) As you might expect, it isn't "great" music, but it does have a soothing quality that I imagine would have been just right for its intended purpose, a leisurely cruise



aboard a paddle-boat steamer.

Joe was suspended by Alcor last February, aged 82, to join his wife Terri, who entered suspension 12 years earlier. There were problems with Joe's suspension, and his final state of preservation was far less than what we currently consider optimal.

Someday we hope to have Joe and Terri back with us. We may have difficulty in accomplishing this, but we do have some extra information to aid in the task. Terri, it turns out, was a prolific diarist. Joe, meanwhile, left us his book, *Recollections of an Average Man* [excerpted in *Cryonics*, 3rd Qtr '97 — *ed*], his music, and several videotape interviews. These data may get good use in sharpening our reconstructions of Joe and Terri Cannon, another reason for cryonicists to exercise their creativity and leave some permanent, decipherable record of it.

Robert Ettinger

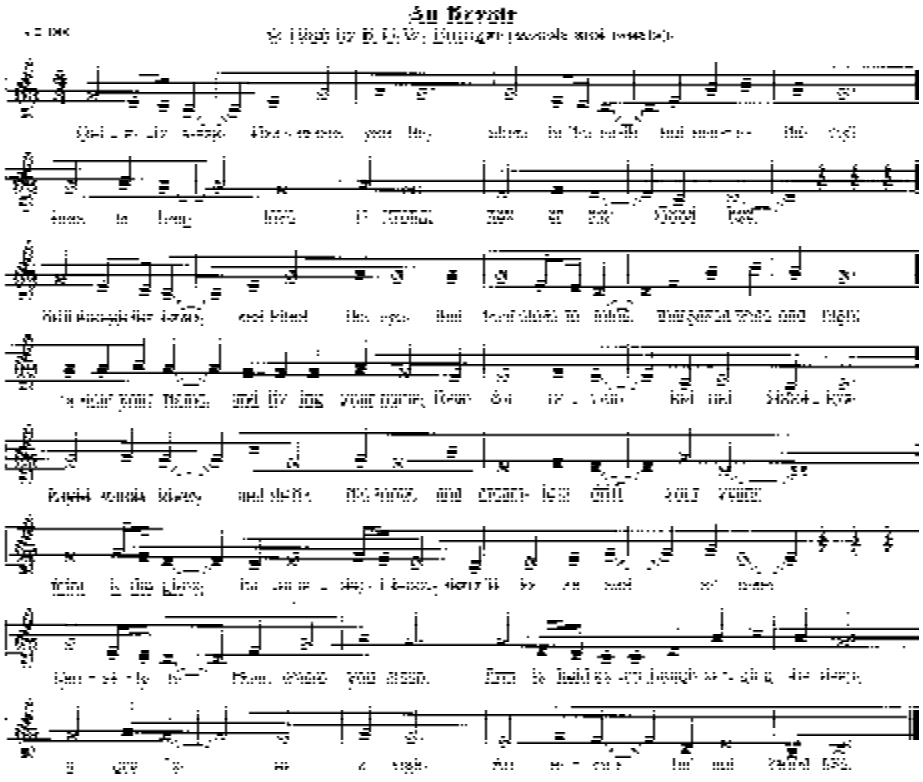
The "father of cryonics" himself is among those cryonicists who have composed music. Indeed, it's possible his composition, "Au Revoir," copyright 1966, is the first song about cryonics. (This was only two years after the publication of Bob's famous book, *The Prospect of Immortality*, that first gained a wide audience for cryonics.)

In the song we hear "au revoir but not goodbye." There's an important connotational difference between the two expressions that we usually think of as having the same meaning. "*Au revoir*," in French, means literally, "to the seeing again," or more colloquially, "till we meet again," whereas the English "goodbye," which happens to derive from "God be with you," carries no such thought of future encounters. In this way, one might say that the French are ahead of us, cryonically speaking. One wishes, however, that they would take "au revoir" more seriously — cryonics is essentially illegal in France.

Recently I asked Bob Ettinger about his involvement in music. He

Robert Ettinger

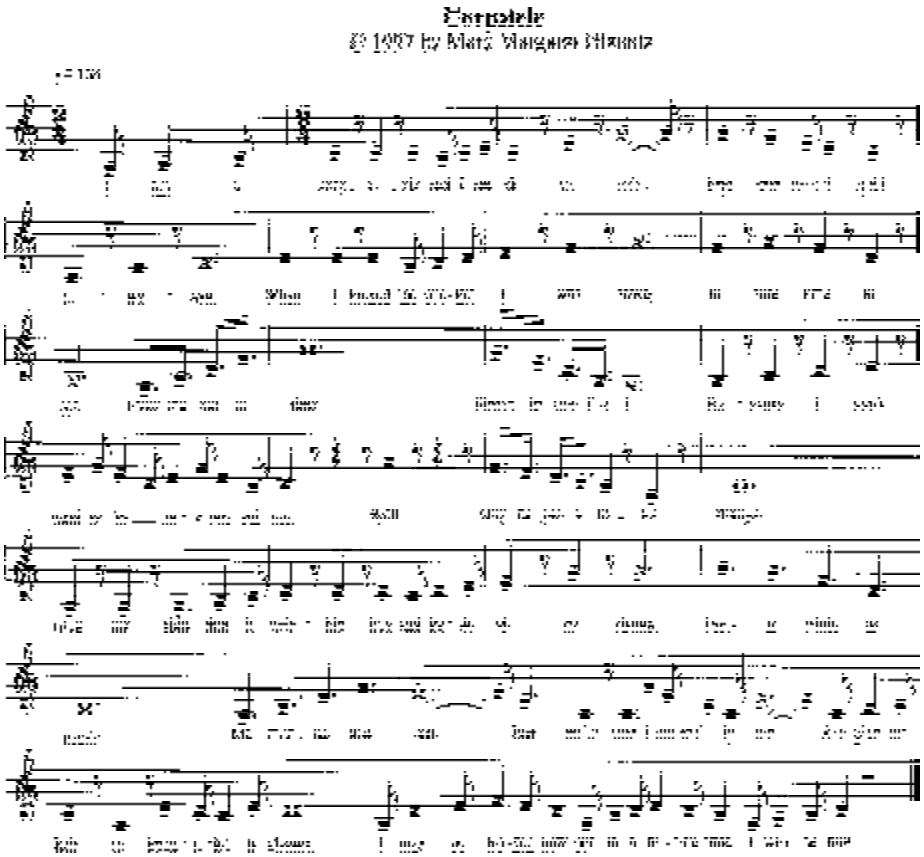
considers himself an amateur, rather like Joe Cannon; Bob has worked out a few tunes and written them down. But I also asked him whether musical talent "runs in his family," and got an interesting response. His mother's family, it turns out, were Russian Jews who emigrated near the turn of the century. He says they could all play some instrument, most



commonly the piano. An uncle, Herman Chaloff, was a composer and arranger who worked many years as a pianist for the show "Oklahoma," then got a musical doctorate and taught at a western university. A great-uncle, Eugene (Yevgeniy) Plotnikov, was a 'cellist and prominent conductor. In younger days Plotnikov "played fiddle to the Czar," most likely at the Bolshoi Theater in Moscow, where he was employed. After the Russian Revolution he emigrated to the West and wound up conducting the New York Symphony Orchestra!

Mary Margaret Glennie

Mary Margaret is a well-known cryonicist and libertarian promoter who lives in Ft. Collins, Colorado. Her husband, Jim Glennie, was suspended by Alcor in 1992. Mary Margaret has also had a long and varied career in music, starting with junior high in her home town of Minot, North Dakota. After high school she studied Music Theory and Composition at the University of North Dakota. In the '60s she hitch-hiked, played the guitar, and sang folk



songs. In the '70s she had the female lead in "Stop the World. I Want to Get Off."

Mary Margaret plays several musical instruments, including the French horn, piano, and soprano recorder. Among her compositions are several hundred lyric songs and a work in progress for string quartet. Two of her songs, both written within the past year, are about cryonics. While trying to reduce the time-consuming task of transferring her compositions to paper, she developed a copyrighted staff paper that is now used in several university music departments. Dissatisfied with the available teaching methods, she developed her own curriculum for her piano students.

Mary Margaret Glennie's two "cryonics songs" were both composed for the 1997 Alcor Cryonics Technology Festival. "For Awhile" is a thoughtful piece about waiting for someone (such as a spouse) who has been suspended. "Corpsicle" is in a lighter vein, a lively ditty that ends optimistically with, "I may be frozen now, but in a future time I will be hot." During the Festival, some of us made an effort at singing these songs, but clearly we needed more practice. Perhaps this is one more reason to have more such gatherings!

Jim Yount

Jim is the president of American Cryonics Society and a longtime activist in the movement. It surprised me when, in response to my request on CryoNet asking for contributions to this article, he said he'd been composing and arranging songs "for some years," something I hadn't heard before. Many of his songs have a country and western form, but with a science fiction theme. He says, "I don't read or write musical notation, so it is a matter of singing into

a tape recorder (often before I forget the tune). More rarely I also do parody."

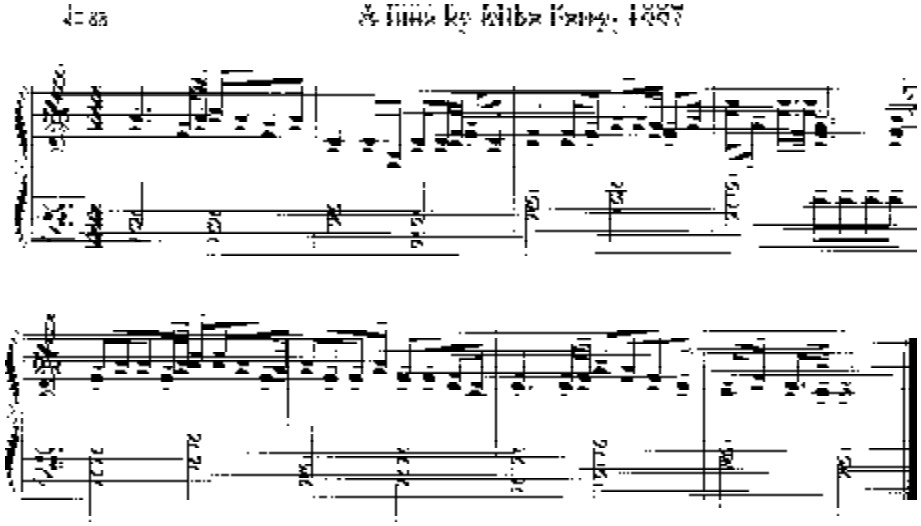
One of Jim's recent compositions with a humorous twist is "Little Ol' Public Domain Me." He says (in all seriousness, despite the funny overtones), "I have been intending, for some time, to declare myself public domain. That is, I want my genetic/biological material to be available to anyone, for any purpose. That doesn't mean that anyone who wants can show up at my house and cut off a slice of Jim. However, if they somehow get a piece, they can use it as they want without paying 'royalties' to the original. The statement of public-domaindom, must be clear, explicitly precise, and legal. Such a statement must also not interfere with my intentions for cryonic suspension. I have not yet worked out the wording of the declaration; though such is my intention."

Jim also notes that some other well-known cryonicists of his acquaintance are involved in music. Two (both now suspended) are Dick Marsh and Jerry White. Dick used to compose parodies (new words to familar tunes), and Jerry, while apparently not a composer, loved to sing and would sometimes perform at AIDS concerts.

Jim suggests the possibility that cryonicists may want to create their own CD. Certainly this is a thought, though judging by what I've heard, the types of music would be unusually varied. Achieving "unity" *might be hard*. (Now where have we heard *this* before?)

Mike Perry

Like many of the others, I'm not a trained musician. I don't play an instrument and cannot "hear" a tune from a printed score. I never thought of myself as much inclined to music when growing up, did not perform in a band, and did not try out for any other musical activities. I had some strong dislikes about music — but some strong likes too, as it turned out. In college I heard a lot more classical and older music than I'd heard before, and took a special liking to some of the older styles, such as baroque. Meanwhile, I would sometimes mentally "hear" fragments of original tunes, which I began to string together into longer sequences. At one point a college professor of mine pointed out that



in a certain composition — the opening of "Sleepers Awake" from J.S. Bach's Cantata #140 — there was an unexpected amount of material before a repetition occurred. This gave me an "awakening" of sorts right then and there: it seemed logical that music would be better off, if well done, *without repetitions at all*. So that's the way I tried to shape my compositions from then on, avoiding the major-length repetitions of thematic material you usually find in music. (I think this has changed now, with some of the more recent styles, but it's certainly true of much of the older music.)

That decision probably killed any possibilities that I might compose a significant amount of music before the Singularity*; even with technological augmentation to the human brain, I suspect that writing music will remain difficult. However, I have been able, over the years, to assemble a small number of compositions with reasonable standards of non-repetition. Some of these pieces are several minutes in length, and I hope someday to assemble a CD worth of good-sounding, highly tuneful, non-repetitious music.

As with several others mentioned in this article, computer technology has been a great help to me in getting music to a performable state and actually hearing a composition played. Before the modern PC, I would construct a composition slowly, memorizing it as I went along and sometimes whistling into a tape recorder as a memory aid. This generally took years; I didn't have anybody handy to reduce the whistled notes to a finished product.

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* For the uninitiated, the "Singularity" is basically the time when technology to make us more than human becomes available.

Composition is still a slow process for me, but the end result is better. The computer, suitably programmed and with suitable peripherals, has talents I lack (though I still get to tell it what to do!). I can enter notes into a score electronically and play them back to find out if this is the sound I have in mind. Best of all, I can try endless experiments with top-notes and chords, choices of instruments, etc, and make refinements to further improve the sound. There is a whole orchestra at my fingertips, and computers' sound quality has improved steadily over the years with quite affordable upgrades.

Ralph Whelan

Ralph has been involved in cryonics for several years, serving as Alcor's Membership Administrator, Alcor's Vice President, an Alcor Director, and editor of *Cryonics Magazine*. Music is one of his long-term interests. While Ralph was growing up, he fell under the influence of music his father listened to at home. This included modern elements such as progressive jazz and jazz fusion. In high school Ralph took up the saxophone, and meanwhile developed an interest in "deconstructing the songs, and figuring out the way they were put together." His interest in performing music soon gave way to composing it, which he started doing about age sixteen. Even so, over the next few years he joined a couple of rock bands and earned money playing at weddings.

At eighteen — "on a lark" — Ralph eschewed college in favor of joining the U.S. Army, and "went in as a musician." He wound up in Germany. During this hitch overseas, he took up the piano and studied his favorite jazz fusion artists such as David Benoit and Jim Bajor, trying to figure out how their songs were written. Through correspondence, Ralph struck up a friendship with Bajor, who among other things "found cryonics fascinating" (not enough, however, for him to make the effort and sign up).

In 1992, after leaving the Army and starting to work for Alcor, Ralph obtained the necessary equipment for musical composition via computer. "I started being able to mix tunes for the first time," Ralph says, "having actual complicated drum lines and bass lines with different sounds and feels and timbres. ... That's when my interest really started to grow in composition. I started writing a lot of stuff, probably for about a ... two year period, '92 to '94, when I was twenty-five to twenty-seven, probably enough to fill a CD, but only half the tunes on the CD would bear any semblance of being finished."

His compositions "always move in the direction of ... the fusion of jazz and rock" — jazz fusion or fusion jazz, depending on whom you ask. Ralph explains, however, that the term has "really warped a lot over the last twenty years," becoming less well-defined as new styles of music have evolved. "Anything that's easy to listen to, and cannot be classified in any other way, it's labeled easy listening. And if it's got a little more of a beat to it, you're probably going to call it jazz fusion, no matter what it is."

As for Ralph himself though: "Most of my favorite stuff has strong jazz components to it, even though it really makes use of modern technology ... having digital effects and things that you wouldn't normally attribute to a jazz ensemble sound."

Derek Strong

Derek was introduced to cryonics by Ralph Whelan when they both were in Germany and played in an Army band. Over the years, their close association has continued. Derek has been quite active in Alcor, at one time or another acting as Membership Administrator (in which he succeeded Ralph), an advisor to the Board of Directors, and editor of the *Alcor Phoenix*. At present he (along with Ralph) is in

"civilian life" doing computer work for a living.

Derek remembers singing in preschool, and that his mother encouraged him in this activity. A few years later he started playing in his school band, choosing the trombone because he liked the glissando: "It was really circus-like, which entertained my fifth-grade brain." As it turned out, he was good at this instrument, and he kept getting better. "By my ninth grade year I was the best musician in the band, and they were up through twelfth grade."

But Derek's talents were not limited to performing. "Along there I started finding out that I could compose ... I could listen to things and figure them out easily, like on my horn. And, like sixth or seventh grade, my brain started ... actually trying to manipulate the music, rather than just ... mimicking it or trying to produce it."

Musical talent was a stepping-stone for Derek's plans after high school. "I went into the Army for bucks and travel," he explains. As a musician it was easy to get a tour of Europe, which he did from 1987-90, visiting Germany, Spain and Holland. Afterward he used the GI bill to continue his education. He especially remembers playing a joint concert with a Russian military band in Berlin (around 1989, when the wall was coming down) and how music served as a bridge between the two vastly different groups.

Derek has an interesting comparison of his talents to Ralph's. (Like Ralph, he is interested in fusion jazz and his compositions tend to follow those lines.) When he has music "in his head," he has no trouble writing it down. Ralph doesn't have this ability (nor do many of the rest of us, myself included!) but Derek credits Ralph with greater creative ability. Like Ralph and others among us, Derek has profited by computer technology, and uses it in creating his compositions.

Bart Kosko

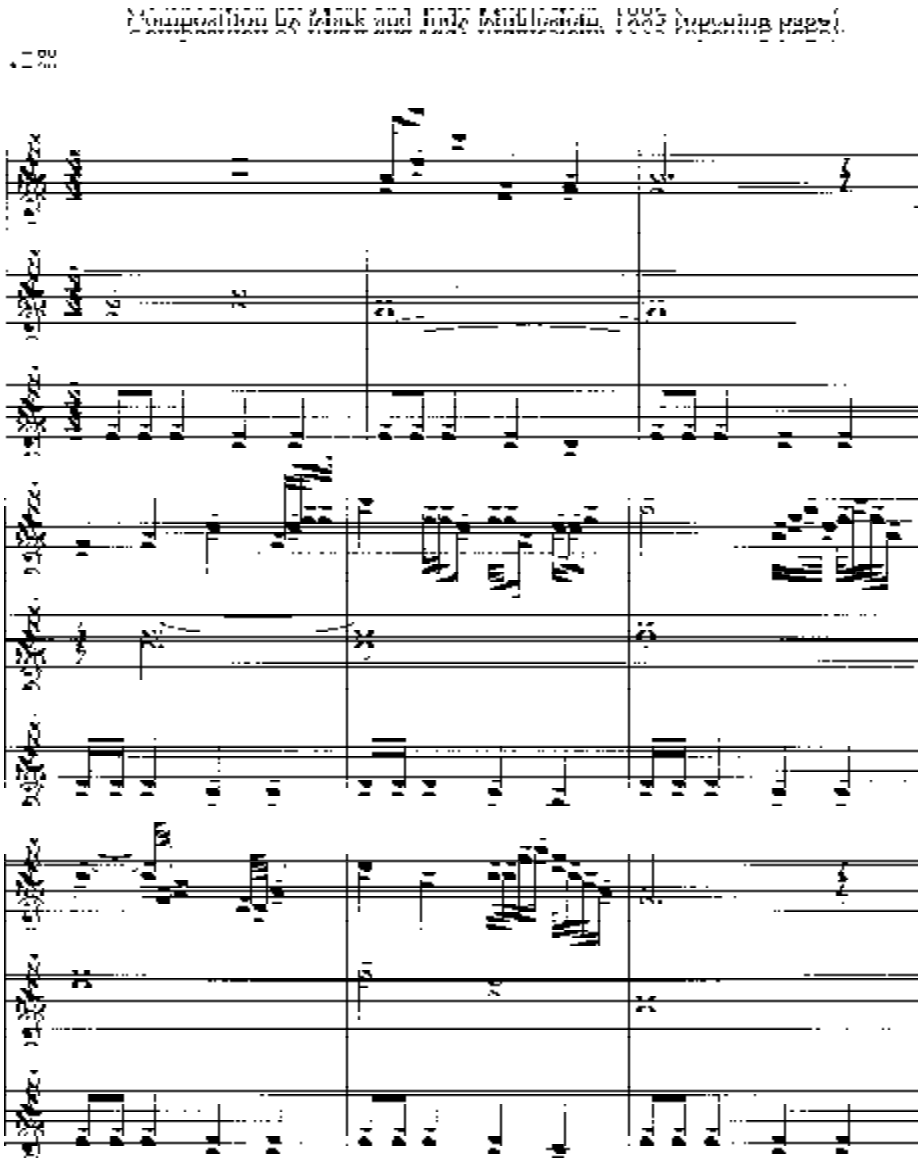
Born in 1960, Bart is a multi-talented cryonicist who has distinguished himself in several rather varied fields. He is an internationally recognized authority in the highly intellectual discipline of fuzzy logic. That's his profession, and it is impressive enough — but he has other interests too. He holds degrees in philosophy, mathematics, and economics, as well as a Ph.D. in electrical engineering. He is a prolific science fiction writer. He holds a black belt in karate. And of course, he's written music, including three symphonies.

Bart had a tough childhood. His house burned when he was 10, and three months later his father died in a car accident. The family was finanically strapped, and soon split up. Bart experimented with drugs, but after a bad LSD trip at age 14 he renounced both chemicals and rock music. Bart took up the mandolin, the violin, and the piano, and began classical music studies at a local college. Comparing a printed score with the actual sounds of a composition aroused his interest in symbolic representation of information.

At 17 he won a young composers' contest for his "Second String Quartet in A Major." That, plus an orchestral suite, earned him a full musical scholarship and allowed him to "pole vault out of Kansas," where he lived, to the University of Southern California (USC). However, at USC he became dissatisfied with the emphasis on atonal music and eventually gravitated to mathematical subjects: math itself, computer science, economics, and the philosophy of science.

"Both science and art map experience to symbols," he says. "Science symbols *reveal* the structure of the world. Art symbols *add* structure to the world. Music is the sound of math." But according to his interview in the *IEEE Spectrum* (Feb. 1996), he has mostly stopped composing. "The hardest thing to do is to write a new tune. It's harder than coming up with a scientific conjecture or a logical proof. I now keep only musical notebooks."

But this seems unlikely to last forever, if all goes as it should. Bart has made cryonics arrangements (with Alcor, it turns out), and looks forward to a more-than-human future. "Biology is not destiny. It was never more than a tendency. It was just nature's first quick and dirty way to compute with meat." Bart's hopes center on computational hardware that will not only replace our fragile brain tissue but greatly improve our powers.



Mark and Judy Muhlestein

These two (formerly of Tucson, now relocated to Northern California) have been very active in Alcor over the past several years. They also have a large family between them, and have used this to advantage in TV interviews. Signing up your children as well as yourself is indeed a most noble way to say "I care."

In music, they are both confessedly the rankest of amateurs, with no great knowledge or scoring talent. (Judy has said that her early musical training was "limited to turning on the radio.") But with the help of the computer, they have done some intricate and sometimes beautiful composing, and had fun in the process — always a great motive!

Final Thoughts

While there are probably no "Mozarts" on this list, we see that musical creativity is no stranger to cryonics. In general, we cryonicists like to use our minds creatively, and our current creative abilities — limited though they may be — have provided us with a glimpse of wonderful things to come. The prospect of grasping these possibilities and fulfilling our creative potential provides many of us with a powerful motivation for reaching the future!

Acknowledgments and Sources:

Most of the above is based on personal interviews with the people reported, and I thank all these people for their willingness and generosity in furnishing information, as well as permission to reprint copyrighted material. Bart Kosko sent me an interview published in the "profile" column of the IEEE *Spectrum*, Feb. 1996, pp. 58-62. Bob Ettinger's song is from the Sep. 1970 *Outlook*, and his photo is from *Cryonics Reports*, May, 1967. I also thank Mikhail Soloviev in St. Petersburg, Russia, for researching Ettinger's relative Eugene Plotnikov and translating and sending the information he found in the *Musical Encyclopedia* (*Musykalnaya Entsiklopedia*), Moscow, (ed. Yu.V.Keldysh), vol. 4, 1978.

The Donaldson Perspective **by Thomas Donaldson, Ph.D.**

Suspended Animation → Cryonics

Not long ago Paul Wakfer decided to distance the Prometheus Project from cryonics, if only a little bit, by emphasizing its aim of "suspended animation." In doing so, he may be making a very smart move, which will in the end lead to many more cryonicists than any plan for direct recruitment.

I say this because, in practical terms, advocacy of any form of suspended animation must lead logically to advocacy of cryonics. My own conversion to cryonics, back in the early 1970's, began not with Ettinger's *Prospect of Immortality* but with a suggestion from Herman Kahn's book *The Year 2000* that by 2000, suspended animation would be available "as a form of forward time travel." Certainly, once I started looking I quickly found Ettinger's book, but that's not how my interest began.

Here is the reasoning which led me to cryonics, and may still lead many others. First of all, many science fiction books and films use suspended animation. Almost always, the intrepid spaceman/woman awakens from their suspended animation fully competent, ready to fight off whatever villainous alien presents itself. As a practical matter, however, the earliest forms of suspended animation will very likely require a long period of recovery before the suspendee becomes fully competent again.

So then: exactly what use would such a form of suspended animation have? We all know: *it might be used to transport patients sick with some currently incurable disease to a time at which doctors knew how to cure their disease and make them whole again.* Many NON-cryonicists would probably agree with such a use. Yet this statement raises many questions that reflexive advocates may not have asked.

1. Suppose we were to put patients into suspended animation for a future cure. Just how long should they remain waiting in that condition? If a cure does not come in 10 years, do we keep them suspended for another 10? After what length of time should we remove them from suspension?

Any standard decision to remove someone from suspension, say, after 20 years (or even after 100), raises the risk of depositing a sick, confused patient into a future world he does not understand, with no relatives and no help of any kind. I don't know how any **GOVERNMENT** might answer this question, but the kindest answer is quite simple. Anyone put into suspended animation should remain there INDEFINITELY until a cure for his condition is found.

2. Suppose that we accept indefinite suspended animation for patients who choose it as a means to seek out a cure for their disease. Just what, then, is to be considered a *disease*?

All those who believe that our present notions of disease and health will remain constant into the indefinite future may now go to the back of the class. Even a small amount of reading in the history of medicine

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NON FICTION REVIEW

The Cerebral Code:

Thinking a Thought in the Mosaics of the Mind
by William H. Calvin, MIT Press 1996

(The whole book can be found at
http://weber.u.washington.edu/~wcalvin/bk9.html.)

Reviewed by H. Keith Henson

Why would a book about the way brains are organized be of great interest to cryonicists? The point of cryonics is to get from where the breakdown of our bodies will no longer support our brains to a future able to reconstruct and restart them. The difficulty is that we don't know much detail about how brains work, or exactly how and where our memories and personalities are coded into the structure of our brains. Calvin's new book goes a long way toward offering a model of how minds are implemented in the top millimeters of the cerebral cortex.

William Calvin is well known for provocative theories — theories which are slowly becoming accepted. One of his previous ones was that our large brains evolved to coordinate ever more accurate throwing, as humans came to occupy a "projectile hunter" niche. Later, these temporal sequencer brain mechanisms (evolved to coordinate throwing) might have come to be used for speaking.

Just as I write down sentences and edit them through several cycles for grammar and style, the mental process which goes on in the seconds to milliseconds before we speak seems to be doing the same thing — starting from jumbled memory noise not unlike the confusion we are sometimes aware of in dreams. This pre-speaking mental activity can be seen as a Darwinian process with style and grammar rules being used to select from variations. This process, though not the actual mechanism, was described in one of Calvin's earlier books, *Ascent of Mind.*

What Calvin has done in *Cerebral Code* is to propose a way the brain substrate of the cerebral cortex might support a Darwinian process. He starts with the nerve bundles of the cortex and their interconnections. The bundles are about 0.03 mm in diameter and contain about a hundred cells. The bundles cross-excite, not their neighbors, but other bundles about 0.5 mm away. (They tend to *inhibit* closer neighbors.)

So, when a pair of bundles 0.5 mm apart start firing in a synchronous temporal pattern, besides cross-exciting each other, they both excite the bundles at a radius of 0.5 mm from where each one intersects. The additional entrained bundles further excite ones on the 60 degree (hexagonal) pattern, resulting in spreading of the firing pattern. Calvin makes the case that these spatio-temporal firing patterns encode our thoughts, and that spatial propensity to fire encodes memories.

Calvin sees errors, boundaries, long distance inter-brain connections and competition for area as the environment of a full scale Darwinian selection process. When "enough" of the cortex is "singing the same tune," we speak a completed sentence or move in some coordinated way. Calvin's proposals on how brains work might be wrong, (he doesn't claim certainty) but his work has no obvious holes from the gross level of what we know about brains.

I won't tell you that this is an easy book to absorb. In some ways it reminded me of Marvin Minsky's *Society of Mind*. But then you wouldn't expect ease from a serious effort to bridge the gap between brain and mind. While it was writ-

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FICTION REVIEW

How Others See Immortality:

Welcome Chaos by Kate Wilhelm, 1985
Eternity by Mack Reynolds and Dean Ing, 1983
To Live Forever by Jack Vance, 1956

Reviewed by Thomas Donaldson, Ph.D.

From time to time, science fiction authors decide to bring some form of immortality into the picture. The three novels above all have some form of immortality as basic to their plots, and they all deal with it differently, though with some common features.

In Kate Wilhelm's novel, *Welcome Chaos*, a scientist named Saul Frankl discovers an immortality treatment during Nazi times. The treatment infects those who take it, so that any contact with blood from someone treated spreads the infection. This initial version of Frankl's treatment immunizes people not only against aging but against all diseases and many kinds of physical injury (including radiation damage). However, the treatment has two big problems: those who take it become sterile, and worst of all, when someone first receives this treatment he becomes very ill. Fifty percent of those who receive it die. Frankl and his assistant flee to Switzerland. The thought of overpopulation strongly influences them, but they also have nightmarish notions of what might happen if Hitler or ANY government learns of this treatment. And so, they decide to keep it secret.

As time passes, other scientists come close to discovering the same secret. Frankl and his assistant tell these scientists just what will happen, and get them to join in the silence. Gradually a cabal of immortal, indestructible scientists develops, carefully guarding against discovery of their treatment. The immediate story involves two events: in Russia (this book was written during the Cold War) the treatment is discovered separately; in the US, the FBI has tracked some of these immortal scientists and followed them about, suspecting unknown crimes. As part of this, a writer named Lyle Taney is also inducted into the group. Eventually the Russian scientists who have found the same drug contact this group; most of them are held secretly by their government. The Russians also explain their solution to the problem of sterility (yoga exercises!).

The scientists decide to distribute their treatment in little packages explaining the risk, listing the benefits, and pointing out that contact with blood of someone made immortal and indestructible also transfers these treatments to the contactee. This program causes much social disruption on both sides of the Iron Curtain, but the world is saved from nuclear war. The title comes from code words the group uses for signaling delivery of their immortality treatment packages.

The second novel, *Eternity*, by Mack Reynolds and Dean Ing, presents a different situation. A group of naturally unaging people exist unknown to present science. The oldest of these remembers Cro-Magnon times. They hide this trait from others because they (justifiably) fear persecution. One of them, Alex Germain, until then quite alone, finds a group of the others in Mexico.

At the same time, a group of "bad guys" have not only discovered the existence of immortals, but have also found some way to bring immortality to any mortal. However, rather than distribute this artificial immortality freely, they want to keep it for themselves and eliminate those naturally immortal as rivals. (These people aren't clearly affiliated with

any government.) Although the bad guys kill a few natural immortals, they move slowly enough for the natural group to disperse over the Earth and disappear. Alex finds the first real love of his life in one of these immortals, who was formerly Nefertiti. Reynolds and Ing frame sections of this book with quotations from various people who have raised the issue of immortality, Saul Kent among them.

The novel by Jack Vance, *To Live Forever*, differs from the other two in one major way: unlike the others, it happens thousands of years from now, after a Dark Age brought on by the discovery of immortality and the overpopulation that results. The only city-state remaining technologically advanced is *Clarges*, where the "problem" of immortality is solved by setting up different ranks, into which everyone may enroll: Brood, Wedge, Third, Verge, and Amaranth. Each rank adds more years to a citizen's life, until finally a few reach Amaranth and virtual immortality. To reach a higher rank, one must accomplish something of advantage to society, in science, art, or other kinds of achievement. This is called *striving*, and its result is *slope*. If you do not achieve Amaranth in a given time, however, you are visited by the Assassins, who take you out and kill you. Those who don't enroll in this system grow old and die naturally; they are called *glarks*, a contraction of Gay Larks. Only one activity offers guaranteed slope: exploration of space.

In the context of the story we learn a good deal about this society and its contradictions (which in exaggerated form mirror those of our own society; the plot of the story requires those present to respond not as we would but with the beliefs and feelings of Clarges). Assassins also provide the police force, under the guide of the "Actuarian," which uses a vast computer to assess how many enrolled citizens must die each day. To murder is the vilest of sins. Murderers are labeled as "monsters." The pornography of Clarges deals with death, not with sex.

Amaranths preserve themselves from destruction of their bodies by maintaining, in carefully protected places, five unconscious copies of themselves. By visiting these copies periodically, they ensure that the copies' memories will match their own. If an Amaranth encounters destruction, his copy replaces him. Except for glarks, everyone thinks constantly of how they can increase their slope and achieve a higher class. Stress from these thoughts leads to a special kind of mental breakdown in which the victim becomes catatonic, with occasional bouts of homicidal mania. Some citizens of Clarges, unconsciously feeling the contradictions behind their society, meet at night as "Whitherers"; they have no answer, but merely a question: whither?

Gavin Waylock, just after reaching Amaranth level, causes the "death" of another Amaranth by accident. (Naturally the Amaranth he killed returns to life in the form of a copy.) Waylock runs away, fakes his own death, and takes on another identity to hide from the Assassins. He supports himself by working in Carneval, a place with many games and diversions to which citizens of Clarges go to forget their strivings, if only for a few hours. Waylock plans to remain hiding in Carneval until the legal system declares him officially dead, after which he will enroll as Brood and try once more to reach Amaranth. Just before that time, however, he takes up briefly with another Amaranth, a woman who suspects his identity. Waylock must kill this Amaranth, too. As with his first murder victim, she revives but does not clearly remember her time with him (this information is not preserved in her copy, which remembers only up to the last session with her).

Still, the resurrected Amaranth woman has suspicions. When Waylock re-enrolls as Brood, she pursues him constantly, blocking all his attempts to strive legally. In order to save himself, Waylock brings down the entire society, awakening the stored copies of all Amaranth, forcing the Assassins to kill more citizens to make room. The Actuarian and the Assassins are mobbed and destroyed. The same mob then searches for Waylock as the man who has brought down their world. The book ends with Waylock's speech to the mob, just before he goes off to space for new worlds: *everyone* should have immortality, so long as they make a place for themselves, in space or elsewhere. Vance makes quite plain one major point of his story: "the events [mobs storming the Actuarian, killing Assassins] ... represented a culmination to the Industrial Revolution, to the defeat of disease in the 20th Century, ... to the reach of Clarges itself..."

All three of these books tell us something about attitudes toward immortality, which in each case both powerfully attracts and powerfully repels. In *Welcome Chaos*, immortality brings chaos, social disruption, and a 50% risk of death. In *Eternity*, immortality serves as the ultimate elitism; even the discovery of artifi-

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NON FICTION REVIEW

Design for Dying

by Timothy Leary with R.U. Sirius, Harper*Edge* 1997

Reviewed by Brian Shock

Let's dispense with the basics. First, I can sum up the message of *Design for Dying* in one sentence: "Don't let the Establishment dictate how you die." What else would you expect from a man who never let the Establishment dictate *anything* he did?

Next, drawing on a protracted string of hints in *Design for Dying*, I can tell you why Timothy Leary decided to forego cryonic suspension: Cryonics had become one more form of Establishment for him. Remember Leary's public statement that he didn't wish to reawaken from suspension in fifty years and find himself surrounded by white-coated men with clipboards? This type of image — the humorless, impersonal, mass-production, dictatorial medical/religious/legal Establishment — recurs again and again in *Design.* In the end, I believe that Timothy Leary was offering CryoCare and BioPreservation a compliment long desired by the cryonics community — they were too well formed, too acceptable, too *mainstream*.

In refusing cryonic suspension, Timothy Leary was acting far more consistently than if he had allowed anyone to freeze him.

Now, let's talk about the contents of *Design*, and why I feel you should or should not read it.

If you're looking for scientific information, forget it. Leary used pseudo-scientific jargon as both sledgehammer and whoopie cushion; his "Leary Eight-Circuit, Twenty-four-Stage Theory" of mutation and evolution is high silliness. He probably would have admitted as much, if doing so served his momentary purpose.

If you're looking for biography, you will find only tantalizing bits and pieces. In particular I was intrigued by his chapter on "Psychology," in which he suggests (apparently from personal experience as a psychologist) that post-World War II psychotherapy owes its form and direction to the OSS and CIA.

If you're looking for insight, a judicious search just might reveal some. In his chapter "One Last Taboo for the Road," he offers a very colloquial outline of what might be "Terror Management Theory," as defined by Sheldon Solomon, Jeff Greenberg and Tom Pyszczynski (espoused on CryoNet by Tim Freeman, *et al*).

If you seek a way to convey the idea of cryonics to your New Age friends, you may have hit the jackpot. *Design* begins with New Age techno-mysticism, seamlessly leads up to cryonics and nanotechnology, treats both with relatively deadpan factuality, and never for a moment repudiates their usefulness.

And if you wish to know the impact that Timothy Leary had on those around him, this is definitely your book. The last 60 pages contain nothing but loving anecdotes from Leary's friends and acquaintances. The very *fact* of *Design* is a testament to the lives that Leary touched.

Timothy Leary was an iconoclast in a rapidly evolving age when moss-covered idols needed razing and green ideas needed to emerge. If we as cryonicists extract anything from his last work, I hope it teaches us to maintain our sense of humor in the times ahead, when social and scientific "(r)evolution" may occur faster than ever before.

Alcor Third Annual Cryonics Conference

April 3 - April 5, 1998 Scottsdale/Phoenix, Arizona

Featuring...

From **Alcor**: Gregory Benford (tbc), Fred & Linda Chamberlain, Bart Kosko (tbc), Ralph Merkle, Marvin Minsky (tbc), Michael Cloud

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Lodging: $99/night/single or double room. Fifty rooms are being held through March 4, 1998. For additional information, contact the Chamber of Commerce in Scottsdale at (602) 945-8481 or in Phoenix at (602) 254-5521.

Cost: Full package includes all speakers and materials, Saturday awards luncheon and Saturday fund-raising banquet.

Early Bird "Thank You For Getting Us Started" Special Rate...received by December 1, 1997...**$97**

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Please make check payable to **Alcor Foundation**. Your check is your receipt

Please pick up your tickets at the conference. *Thank You!*

Watch for future program developments as Alcor's Third Annual Cryonics Conference approaches.

PROGRAM

Friday, April 3, 1998

7:00-8:00 pm	registration, reception	
8:00-10:00 pm	welcome: Merkle Mode Desert Contest	
	Gregory Benford (tbc)	"Cryonics in Science Fiction"

Saturday, April 4, 1998

9:00-9:30 am	Introduction	
9:30-10:30 am	Fred & Linda Chamberlain	"Alcor Research Update"
10:30-11:00 am	break	
11:00-12:00	Ralph Merkle	"Nanotechnology Update and Molecular Repair of the Brain"
12:00-12:15	break	
12:15-1:30 pm	awards luncheon	
1:30-2:30 pm	Marvin Minsky (tbc)	
2:30-3:00 pm	break	
3:00-4:00 pm	panel	"What's in It for Me?"
4:00-4:30 pm	break	
4:30-5:30	Michael Cloud	"How to Make the Idea of Cryonics Infectious"
5:30-700 pm	break	
7:00-7:30 pm	reception with no host bar	
7:30-11:00 pm	banquet and fund raiser	
	Bart Kosko (tbc)	

Sunday, April 5, 1998

8:45-9:30 am	Bus to Alcor Facility	
9:30-11:15 am	Alcor Tour and Sign-up Party	
11:15-11:45 am	Bus returns to Conference Site	
11:45 am-1:15 pm	lunch break	
1:15-2:15 pm	Paul Segall and Hal Sternberg	
2:15-2:45 pm	break	
2:45-3:15 pm	Dave Pizer	"A Retirement Community and Safe Storage"
3:15-3:30 pm	break	
3:30-4:30 pm	Robert Ettinger	
4:30-5:00 pm	wrap-up	

The Donaldson Perspective, Continued from page 39

shows that over time our civilization has changed its ideas of what constitutes a "disease." Indefinite-term suspended animation will inevitably modify these ideas further. People might seek suspended animation — or have it forced on them — even though today's medicine would not consider their condition a true illness.

If we look around us, we can see the boundaries between disease and health moving constantly. Is addiction to tobacco a disease? Not long ago many would have claimed such addiction did not exist. What about those who molest children or commit violent crimes? With a better understanding of how our brains work, we can see how physical conditions can turn some normal people into homicidal maniacs. For that matter, we now see a gradual movement of medical opinion to the notion that OLD AGE is a disease.

2A. Is death itself a "disease"?

In this case, many would unthinkingly answer NO. Yet as our notion of "disease" has changed over time, so too has our notion of "death." When it became clear to medicine that at least some people might be revived after both heartbeat and breathing had stopped, the old tests for death lost their absolute validity. Committees of physicians had to create a new definition for death, but soon this one too became riddled with questions. Under the best available treatment, some "dead" patients have been revived even though their "deaths" lasted minutes past the accepted limit (and these were patients who were NOT at low temperatures and had NOT taken barbiturates).

Instead of a simple end to life, death begins to sound more like a *potentially* correctable condition. Since new treatments emerge every day, who could then say that a treatment might not arrive for a particular form of death?

3. Shall we apply suspended animation to patients almost regardless of how much damage they have sustained? Even if our methods for suspended animation are faulty and cause damage themselves, *should we apply these methods to most of those now considered "dead"?*

Given that we've accepted indefinite-term suspended animation, and *given* that we've accepted the notions of DISEASE and DEATH will continue to change with time, it is irrational not to answer YES to all these questions. Those people who agree are cryonicists, even if they may not yet know it.

Henson Non-Fiction Review, Continued from page 40

ten mainly for neuroscientists, there is a serious effort to include enough background for an educated layman to understand what is going on. It also helps that a lot of the book uses analogy — which Minsky says is the primary way we extend knowledge. In any case, you can sample it, or even read the whole book on the Web. I read it off the screen, and ordered a copy before I was half way through.

Donaldson Fiction Review, Continued from page 42

cial immortality leads one group (the baddies) to try restricting it to themselves. In *To Live Forever*, the city-state Clarges shows both the attraction and the repulsion. The Assassins of Clarges kill to prevent overpopulation, and yet murder by anyone else is a monstrous sin. Gavin Waylock "kills" two Amaranths, who promptly revive. The caste system of Clarges itself follows the idea of immortality for only a select few.

Why must immortality be so restricted? It's not just a problem of overpopulation.

One reason may be that much of our society depends implicitly on aging and death. If these were abolished for everyone, many things must change. The functioning of major offices in our current society depends on the death or retirement of those holding them; an immortal society would have to find other solutions for the lifetime tenure of college professors, Supreme Court justices, and the like. Historical poetry and literature, which assume so many things about relations between old and young, would have little interest for immortals. Even the idea of authority based on age would founder in a society where ancients and youths appear identically young. (Imagine a 25-year-old Pope!)

As cryonicists, we should face this problem directly: if suspended, we will probably awaken in a society with NO organization based on age. We will have to judge people by other criteria.

If you had the pleasure of attending Extro 3 (August 9-10, San Jose, CA), you may have heard Eric Drexler's speech on "Conservatism" at the banquet on Saturday night. For those of you who didn't, Dr. Drexler offered some simple yet cogent reasoning: Since medical science continues to advance, a "conservative" thinker does *not* assume that any current medical condition will remain permanently incurable. When faced with death from aging or illness, such an individual would "conserve" himself in the best manner available, until technology offered suitable treatments. [Please forgive the clumsy paraphrasing, Eric. --ed.] So compelling did Dr. Drexler find this reasoning, he announced publicly that he had made this type of conservative arrangement for himself.

But then most of you probably already guessed that Eric Drexler, author of *Engines of Creation*, was an Alcor suspension member.

The next day of Extro 3, after a panel featuring Artificial Intelligence theorist Marvin Minsky, Dr. Drexler again made a speech: "I have long wondered how I would explain the absence of the head of my dissertation committee to people in the future. Now, I won't have to do so." He then presented Dr. Minsky with a new Alcor bracelet and necktag set, officially initiating him as an Alcor suspension member.

If other brilliant minds like Drexler and Minsky choose cryonics, shouldn't *you*?
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Alcor's Emergency Response capability includes equipment and trained technicians in Arizona, New York, Indiana, Northern California, Southern California, and England, and a cool-down and perfusion facility in Florida. Alcor's Arizona facility includes a full-time staff with employees present 24 hours a day.

Meetings

Board of Directors Meetings

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

ALCOR
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(602) 922-9013

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

Bay Area

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

Boston

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

District of Columbia

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

England

There is an Alcor chapter in England, with a full suspension and laboratory facility south of London. Its members are working to build a solid emergency response, transport, and suspension capability. *Meetings are held on the first Sunday of the month* at the Alcor UK facility, and may include classes and tours. The meeting commences at 11:00 A.M., and ends late afternoon.
The addres of the facility is:

Alcor UK
18 Potts Marsh Estates
Westham
East Sussex
Tel: 01323-460257

Directions: From Victoria Station, catch a train for Pevensey Westham railway station. When you arrive at Pevensey Westham turn left as you leave the station and the road crosses the railway track. Carry on down the road for a couple of hundred yards and Alcor UK is on the trading estate on your right.

If you're coming to an AUK meeting you should phone ahead since meetings are sometimes rescheduled. Call Garret Smyth on 0181 789 1045 or Garret@theoffice.net or Mike Price on 0181 845 0203 or Alan Sinclair on 01273 612 071. Note: the email address listed above for Gattet is different from the previous erroneous listing.

Florida

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

Los Angeles Area

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

Indiana

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

San Diego

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

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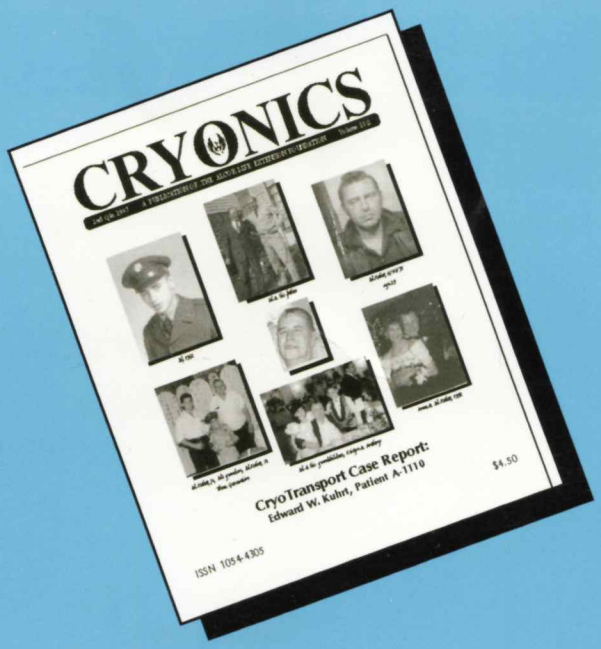

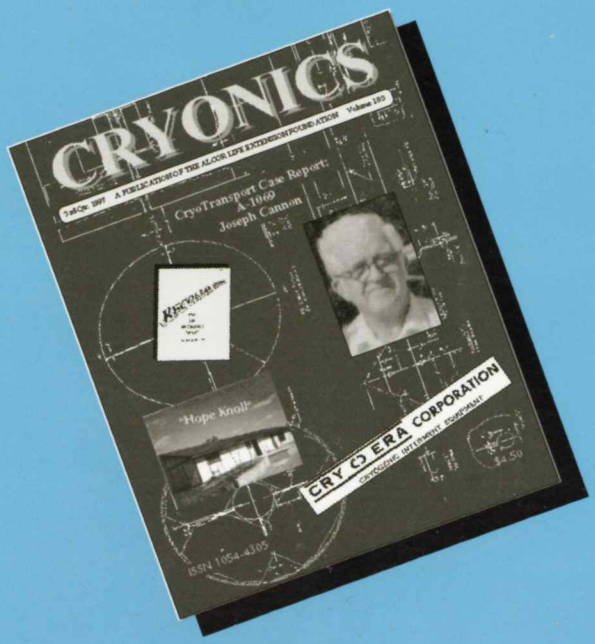

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