Cryonics

Volume 13(6) • June, 1992
ISSN 1054-4305 • $3.50

cor's 20th Anniversary

by Fred Chamberlain

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Cover: Fred and Linda Chamberlain with a prototype perfusion machine a few weeks before it was exhibited at the 1971 (4th) Cryonics Conference in San Francisco.

Cryonics

Volume 13(6)
June, 1992
Issue 143, ISSN 1054-4305

Cryonics is the magazine of the Alcor Life Extension Foundation, Inc.

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Contributing Editor: Hugh Hixon
Production Editors: Eric Geislinger and Jane Talisman

Published monthly. Individual subscriptions: $35 per year in the U.S.; $40 per year in Canada and Mexico; $45 per year all others. Back issues are $3.50 each in the U.S., Canada, and Mexico; $4.50 each all others.

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Issue to press: May 15, 1992.

Up Front by Ralph Whelan

Impending Contract With Mike Darwin

The May 3 Alcor Board of Directors meeting saw discussion of a proposed contract between Alcor and Mike Darwin. This contract would contain provisions for a substantial amount of training for Alcor staff and volunteers, perhaps as much as 90 days per year. It would also include provisions for Mike to participate in suspensions and remote standbys during the term of the contract. The contract is still under negotiation.

Renegade Cryonicists On Wheels

We received a request for information a couple of weeks ago that came from an odd source. Apparently, the requestee had been driving up the 405 freeway in Los Angeles when he saw a "burgundy minivan" with an Alcor bumper sticker. Of course, the Alcor bumper sticker lists our Riverside location, so the potential immortalist checked with information and found our number.

We're not sure which L.A.-area Alcor member drives a burgundy minivan, but whoever you are, you should feel proud. Your simple act of buying and affixing that sticker may well have saved a life, and indeed the lives of all who stand to be cryo-infected through this new vector.

So don't be coy, folks. One dollar buys you an Alcor bumper sticker, one of the most inexpensive opportunities to expose hundreds or even thousands of innocent motorists to this century's most imperative meme, and perhaps even subject them to immortality. The more the merrier.

Easy, Inexpensive, and *Essential*

Signing up as an Alcor Suspension Member is easy. This has not always been the case, and if you're used to hearing horror stories about the pounds of paperwork and byzantine instructions, you may not be aware that times have changed, and so has the sign-up process. We now have but two important and straightforward requirements:

1) Put your signature on four documents, in triplicate, and have two people witness this action. *All* of the preparation of these documents is now done by Alcor's tireless Membership Administrator (Me!), based on information that applicants provide on their Application For Cryonic Suspension, an 11-page *informational* (not legal!) document.

2) Take out a life insurance policy on yourself for at least the amount of the suspension mode you've chosen, and make Alcor the Irrevocable Beneficiary. *Don't* be put off by the word "Irrevocable." We will guarantee in writing that you will retain absolute control over the policy, including the right to change the beneficiary. (But only after notifying us first.)

Signing up as an Alcor Suspension Member is inexpensive. The application fee is now only $100 (certain limitations apply), and Emergency Response Dues are $288 a year — or $25 a month. Full time students and additional family members in one household pay only *half* of that. Your only other expense will be the cost of your insurance policy.

Signing up as an Alcor Suspension Member is *essential*. At this point in time, there is only one lifeboat willing to take you on when the rest of the world is telling you it's time to sink. That boat is called cryonic suspension, and it *will* be there for you, *but only if you ask for it!* We offer it to everybody, with yearly dues that only cover one third of our operating costs, because it really *is* the last boat out, and we will come to need it every bit as badly as you.

Don't miss it.

Business Meeting Report

In addition to progress toward a contract with Mike Darwin, covered above, other significant items that saw discussion/action at the May 3 Board of Directors meeting were:

• The proposed move to Arizona: as alluded to in my article, "To Move or Not To Move," in last month's issue, the primary building that we were looking at in Scottsdale, AZ will not be available at the original low price that we were considering. So, while we are still considering pursuing it at the somewhat higher price, we may also pursue a somewhat smaller and less expensive building in the same business park. I will report further on this as details become available.

• The Patient Care Trust Fund (PCTF) Advisory Committee, consisting of Eric Klien, Bob Krueger, and Courtney Smith, submitted their recommendations for reinvestment of PCTF funds. The board adopted their proposals en toto. Details of the investment strategy are available to those interested.

• The Board approved a new dues collection program for U.K. members, whereby those who choose to can send their dues to an Alcor U.K. representative, who will forward the appropriate sum to Alcor proper. This will simplify matters for U.K. members, who previously were required to translate pounds into U.S. dollars before sending their dues.

Financial Statement Omission

The 1991 Financial Statement that was printed in the April, 1992 issue of *Cryonics* contained an omission. The interest that the Patient Care Trust Fund earned during the year was lumped in with other Patient Care Trust Fund revenue, rather than shown as a separate item as it should have. The amount of that interest was $36,400.

Good News From New York

The May, 1992 issue of *Alcor New York News* contained an exciting report on recent memory durability experiments performed by Alcor Suspension member Gerry Arthus. Quoting from the newsletter,

Gerry placed a small number of worms (Caenorhabditis elegans) in a cryoprotective solution and froze them to -80 degrees Celsius for two hours. After he revived the worms, the ones that survived the experience still "remembered" their former environmental preferences. So far as we know, this is the world's first experiment designed to verify that memory is chemically encoded and will survive the freezing process.

For more detail about the experiment, and information on how you can receive *Alcor New York News*, call Brenda Peters at (212) 353-8665.

Letters to the Editor

Editor of Cryonics,

Alcor Indiana is now in full swing. If you live in Indiana or the neighboring states of Illinois, Kentucky, Ohio, or Michigan, this is especially for you.

Alcor has five members here in Indianapolis and we have all come together to form Alcor Indiana. I am Alcor's Midwest Coordinator and President of the local group. Other members are Angalee Shepherd, Richard Shock, Robert Schwarz, and Margaret Schwarz. Bob Schwarz and myself have had Alcor's transport training and we have a full local rescue kit. As a group, we have recently borrowed $5,000 to purchase one of the new Michigan Instruments Heart-Lung Resuscitators to upgrade our rescue capability.

We have just published the third issue of our bi-monthly newsletter, which includes some personal cryonics history, a discussion about giving cryonics talks, and other interesting articles. Richard Shock is our editor, and I provide an article each month. Other contributors are welcome. We are targeting this publication at a more beginning level than *Cryonics* Magazine, which sometimes can get quite technical.

At this time, Alcor Indiana Newsletter is free, although we may have to charge for postage and printing sometime in the future. Small donations are welcome, of course. We also supply the Newsletter free via Kevin Q. Brown's CryoNet. If you have a computer and a modem and you are on a service like Compuserve or Portal that has an Internet link, send Kevin an e-mail message at >INTERNET:kqb@whscad1.att.com. Electronic mail is the most exciting exchange of information on cryonics around. If you're not on-line with CryoNet, you're missing a lot.

Alcor Indiana will be meeting in Indianapolis the second Sunday of each month at 2:00 p.m. beginning in July. We are especially trying to attract visitors to the Sunday, June 14th meeting, which will be at 1:00 p.m. to give us more time. Call Steve Bridge at (317) 359-7260 or Richard Shock at (317) 872-3066 (day) or 769-4252 (evening) if you would like to attend. Or write Steve Bridge at 1208 Charleston E. Dr., Indianapolis IN 46219; e-mail 72320.1642@compuserve.com. We'll decide on a place when we see how large a crowd we are going to have.

If you want to receive the newsletter, write to Richard Shock at 670 South St. Rd. 421 N., Zionsville IN 46077.

There is no reason to be alone out there. Find the closest cryonicists to you and get together. We need all of the friends we can get — if you think you're going to freeze yourself, you've got the wrong idea.

Steve Bridge
Alcor Indiana

Dear Editor,

With regards to the article, "The $tuff That Dreams Are Made Of," in the May, 1992 issue of *Cryonics*, there is one small error and another substantive correction.

The small error is that the *Cryonics* issue in which I made the original financial proposal was September 1991, not December.

Second and more importantly, after having made two $5000.00 loans which became donations to Alcor, I have now found what I consider a better use for my money. It will be used to finance the restarting of cryonics research under the terms of a joint effort with Mike Darwin. I have therefore regretfully decided to terminate my offer of low interest loans.

When I made the offer, I knew that the money I had would not go far and I hoped that the idea might induce others to also consider this kind of matching donation. I am still hopeful that others may be inspired to follow my lead, but *I* must put my money where my heart is.

Paul Wakfer

Letter to the Editor:

Thank you, Ralph, for your appraisal of the points for and against moving, as moving is now conceived ("To Move Or Not To Move," May, 1992). I would like to comment on your comments, using the same points you made:

• "Arizona is seismically *much safer* . . . ." Not necessarily. The evidence presented to the Board was based on a history of seismic activity, not the placement of tectonic plates, and the expectation of future activity. There is virtually no place in the United States where seismic activity is not expected to occur. The current Alcor facility is located between faults, and on solid rock. At least two earthquakes have shaken the facility since Alcor moved there, and have done little or no damage (both were in the 5-6 range). No matter where Alcor moves, earthquake precautions must be taken, and will be no less expensive in money and time no matter where they are taken. I would be very much against a move to Phoenix or anywhere else without earthquake precautions being planned and taken. I hope that such precautions are going to be in place soon on the bigfoot dewars in Riverside, move or no move. Riverside has the advantage that public planners are prepared for earthquakes, and the public is used to them; elsewhere where people *feel* safe (but are really not), there is no planning, people are more likely to panic if an earthquake occurs, and buildings are not built to earthquake-resistant standards as they are in California.

• "Our present facility . . . is *too small* . . ." I do not mean to criticize when I say that I do not think the present facility is well organized. The space has been occupied in much the same way that a city often grows — without thought to best use of space, and then the upheaval caused by rethinking space becomes obnoxious. Of course it couldn't be worse than moving altogether. Nevertheless, to accept your premise, and that of the next two points ("Our present facility is difficult to look at" and "The local zoning commissions will not give us a zoning variance."), I will put forward an alternative to moving out of state.

The zoning variance, as I understand it, would be required only if Alcor were to move its operating room and, particularly, its storage facility. Why not separate the medical research and cryogenic industrial facility from the office? No variance is needed for some desks, telephones, computers and file cabinets. No one could possibly object if Alcor moved its *offices* elsewhere. This suggestion also answers the "difficult to look at" point. If the office is in a nice building, everything can be pretty. If people want to tour the "back end," as computer people say, the actual working facility, they will: (a) have had their first impression of a pleasant office, and (b) be warned that the working part of the facility consists of an operating room (which is never pretty, but must only be orderly and clean), other medical research areas, and a cryogenic engineering industrial facility. That is the truth of the

matter, and people cannot expect an industrial facility to be in other than an industrial neighborhood, and they cannot expect it to be anything other than orderly and clean — not pretty. The office and engineering staff are clearly separate in current Alcor operation, and such a move would be less expensive and less disruptive than a complete, long-distance move.

It is my understanding that the ambulance bay is needed for patient care, especially if dewars are to be properly secured against earthquakes. This means moving the ambulance. My suggestion on this point would be to store the ambulance in a 24-hour-access, high-security (mean-dog) storage facility, and detail someone from the research and storage address to drive it out and use a checklist on it once a week. (Alcor might even get some "mileage" out of allowing it to be used — with supervision — by whatever local community college teaches EMT skills. They need to practice putting gurneys in and out of an ambulance, driving an ambulance around their school parking lot, etc., three or four times a year. They might even pay money or allow staff to take courses for free in exchange. They might even store it free and allow urgent access through the campus police.)

• "The California State Health Department" case. The discussion of moving is the first time in a year or so I've heard anyone take this case very seriously. The CSHD could win, but it seems unlikely. It is a risk, granted, but a very small one.

• "The cost of living and operating in California is . . . higher . . . , and . . . moving . . . would be analogous to receiving a raise . . . ." You haven't heard people complain about Workman's Compensation Insurance until you've seen someone from Michigan get down on his knees and kiss the California soil. Given the fact that Alcor cannot get insurance, perhaps the fact that this is necessary is actually a good thing, since it's the only way we can be insured at all. Maybe we ought to make anyone touring the facility wear a hard hat. As to the cost of living, I have my doubts. I suspect the absolute necessity for air conditioning — buildings and cars — wipes out the difference. I've never lived in Phoenix, which is 10 degrees hotter than Tucson year round, but after living in Tucson I am familiar with living in a place where the monsoon rains make transportation dangerous and even sometimes impossible around twice a year, where a simple walk in summer is extremely dangerous (never go anywhere without water!), and where you must shake out your shoes before putting them on to avoid poisonous insects. A trip to get groceries in summer must be undertaken with an ice chest on board (or the air conditioning full blast), or the milk will be spoiled before you reach home. Add that to the cost of living. Given building maintenance costs, including air conditioning, insect control, humidification (during most of the year when humidity goes into the minus numbers) and flood control, I think it would be cheaper and easier to raise staff salaries.

• "A move anywhere . . . will be *very* expensive . . . ," but much less if only the office is moved, and that not too far. I certainly grant your point otherwise. This point still says nothing about the difference in building maintenance.

• "Might we be moving from the frying pan . . . ?" Perhaps. Government is even more corrupt in Arizona, and more religiously oriented given the large Mormon population. Corrupt governments have the advantage that knowing the right people can be helpful, but the disadvantage that they can be unpredictable, especially with changes in personnel.

• "How will this affect our ability to service members?" During the move the answer is "extremely adversely." After that, my main problem with Arizona is that there is no cooperating doctor in Arizona who can act as medical director and prescribe the necessary medications for stabilization/suspension, or infection control. Out-of-state doctors cannot prescribe nor treat. In Arizona there will be in fact *no* medically trained members who are likely to act as either volunteers or consultants.

• "The climate . . . ." I've already commented on that. I will add that the Arizona thunderstorm activity causes frequent blackouts and brownouts in Tucson. If that is true in Phoenix, power generation would be an absolute necessity, and so would lightning control. And if anyone has pollen allergies, better bring a mask and lots of medicine along.

• "The Phoenix metro . . . is smaller . . . ." Yes, and the whole community less diversified. Arizona's economy is geared to tourism and retirement. Scottsdale is the Beverly Hills of Arizona, or perhaps a dry Miami Beach. It could be miles to the nearest hardware store.

My main problem with a complete move to a building the size being contemplated is one of priorities. Even if money is raised to buy the building, will the expenses of moving be covered? Even if the expenses of moving are covered, will the expenses of ongoing building maintenance be covered? Given current money conditions, wouldn't it be better to meet the priorities of patient-care equipment, earthquake security where we are, raising staff salaries, and addressing other issues rather than stirring up the massive upheaval of moving to another state? I have no doubt that moving will be necessary eventually, but I do not think this is a good time. If the Health Department case ends favorably or equivocally, as I think is likely, and if current economic conditions in California continue, wouldn't we be better off to wait and see? Property prices are dropping, the zoning variance will eventually become available, and regulatory issues may change as California government becomes aware that it must do something to attract back the business it's losing. I urge the Board to consider these thoughts, especially if we run into a snag and the current moving fever subsides.

— Arel Lucas

Carlos Responds:

• *Yes, there are quakes everywhere, and we should be prepared. But the vast difference in their frequency and severity in Arizona undeniably lessens our risks.*

• *Our offices are not part of the Alcor tour. Prospective members and media are only interested in patient storage and medical facilities. No matter how it is dressed up, the "warehouse next to an auto body shop" makes people worry about our long-term stability. Further, no one has expressed the slightest interest in donating money for office space.*

• *Our staff has looked at what we spend our money on (mostly rent), and while none of us is thrilled about living in Phoenix, our cost of living would be significantly less.*

• *Finding a local medical director is important; good point.*

• *The nearest hardware store is, in fact,*

closer than the one here in Riverside. So is the nearest Price Club.

• No one here is looking forward to a move; it would certainly be more comfortable (in the near term) to stay put. As for California bureaucrats becoming more reasonable, that's hard to imagine, let alone rely on.

Dear Editor:

I am saddened and dismayed to hear of the departure of Mike Darwin in the January issue of *Cryonics*.

Although I have not signed up, I have always maintained an open mind about cryonics and its possibilities. If I ever do sign up, it will be because of what I learned from Mike Darwin.

I happened to speak to Mike during the final stages of my father's terminal illness. Father's doctor was evasive and frustrating, and wouldn't even admit that father was dying.

Mike listened to me, and talked to me about my father's impending death. He was sympathetic, but also the first person to be straight with me about the process of dying. His honesty made me better able to cope with what lay ahead, and for that, I will be forever grateful.

Mike is a believable and witty spokesman for the advancement of the public's acceptance of cryonics. I hope that this wonderfully creative and talented man has not abandoned his efforts on behalf of cryonics, and will be heard from again in the near future.

Sincerely,
Elleda Wilson

For the Record

Gerald Feinberg, Scientific Cryonics Advocate

Michael Perry

When the cryonics movement got off the ground with the formation of the Life Extension Society and the publication of *The Prospect of Immortality*, a major problem was scientific credibility. Few reputable scientists would go on record saying anything one way or the other on the controversial topic of freezing the dead for later reanimation, but some who did were decidedly negative. Much of the opposition came from cryobiologists who were considered by many scientific outsiders to be the best experts on whether cryonics was likely to work. For example, Armand Karow, a respected cryobiologist, had this to say in 1966:

"The probability or chance of reversing damage done today during the freezing of large tissue masses — even when cryoprotective agents are used is extremely slight. The best methods available do not sufficiently prevent damage to allow for recovery. The severity of this damage can only be fully appreciated by someone who has studied thoroughly the subjects of statistics, thermodynamics, and protein chemistry as well as cryobiology. The layman must simply take the scientist's word that this is true, just as he must take the word of the doctor that such-and-such a pill will help cure the patient rather than kill. ..."[1]

(Although this statement was made over a quarter-century ago, it still is a fair summary of what most cryobiologists, though not all of them, think about cryonics. It should also be noted that Karow, though pessimistic about the workability of cryonics, did lend his advice, as we see here, and in fact made lengthy contributions to cryonics periodicals in the 1960s.)

When we look for the scientific voices that spoke up *in favor* of cryonics, we find, as one oddity that will come as no surprise by now, that they were usually not cryobiologists. However, this does not mean their particular expertise was less relevant to the main problem of cryonics — the feasibility of the *eventual* resuscitation of frozen humans, which will require technology as yet undeveloped. One of the scientific optimists who was not afraid to lend public support to cryonics was the physicist Gerald Feinberg.

Feinberg received a Ph.D. from Columbia University in 1957, and soon after joined the physics faculty at the same university. His main interests were elementary particles and quantum field theory. One of his profoundly original contributions was a theory of particles that travel faster than light. These "tachyons" have not yet been detected but have not been ruled out either, and Feinberg's work inspired much additional interest and effort in certain reaches of theoretical physics. However, his interests were far from confined to the purely theoretical. Ev Cooper had this to say in 1968:

"Professor Feinberg is a thinker who is interested in what is important to man in the long run as well as the present. He is interested in stimulating discussion on the short and long range values of man — especially the latter. ... Not only is Feinberg interested in possibly exceeding the present limits of space or speed, ... but also whether life can be extended."[2]

Many of Feinberg's thoughts on the future of man (including the possibility of radical life extension through aging control) are contained in his books such as *The Prometheus Project* (Doubleday, 1969), *Consequences of Growth* (Seabury,

1977), and *Solid Clues: Quantum Physics, Molecular Biology and the Future of Science* (Simon and Schuster, 1985). However, in some instances he addresses the main issues of cryonics more directly. Thus in the April 1965 issue of *Freeze-Wait-Reanimate* he writes:

"One important problem connected with the freeze-reanimate idea concerns the question of whether memory will persist in a body cooled to liquid air temperatures or below. I don't think anyone can answer this offhand, but obviously the answer is crucial to the success of the idea. If memory is basically a punch card system, as has been suggested, then the answer is probably affirmative. If however, the memories involve circulating electric or chemical currents in the brain cells, then the outlook isn't so good. Some fairly simple experiments should help to settle this ..."[3]

This article also considers the (alleged) problem of overpopulation if people are frozen and reanimated (not a serious additional burden, according to Feinberg's calculations) and the possibility of eventually storing frozen people in space.

Probably Feinberg's greatest contribution to cryonics was the masterful and thoughtful article, "Physics and Life Prolongation," that appeared, not in some small-circulation cryonics periodical, but in the mainstream scientific publication *Physics Today* (reprinted later in this issue). It is not a whitewash of the difficulties inherent in the idea, nor on the other hand, is it particularly original thinking about cryonics. (The main arguments had in fact been well covered by Ettinger in *The Prospect of Immortality*.) But it does have something to offer: a major scientist speaking his mind about cryonics, and allowing for due scientific caution, favorably. Among the points made are that (1) there is nothing about the cryonics premise — that the frozen dead can eventually be resuscitated — that violates known physics, (2) as history has shown, when some proposed goal doesn't violate the accepted laws of nature it is often eventually reached (and even when it does, because "accepted laws" can change and do) and (3) the cryonics option should be available to at least some of those who want it. (Other possibilities such as the eventual elimination of diseases and aging are also presented favorably, as in Feinberg's other writings.)

Here the optimistic physicist proves a match for the pessimistic cryobiologist, Karow, above. (In fact the *Physics Today* article is dated only a month later than the issue of *Freeze-Wait-Reanimate* that featured Karow's remarks; Feinberg and Karow did not publicly debate, however.) Feinberg was no "layman," and certainly must have been well-grounded in such relevant subjects as statistics and thermodynamics, as well as being able to bridge the gaps between his specialty and the particular concerns of cryobiology. Cryonics is not cryobiology, in the conventional sense, and if you think about it, the physicist may be just as much (or more) of an expert to pronounce on its validity as the cryobiologist. Feinberg then, seems as well qualified scientifically as Karow to speak on cryonics, yet he is fundamentally an optimist. The difference seems to reduce to the two contrary propositions: (1) What we aren't close to being able to do today should not become a serious preoccupation today, and (2) What we don't know we *can't* do today, if worthwhile enough, *should* become a serious preoccupation today. Cryonics of course is "worthwhile enough" since its

chances, though unknown, don't seem hopelessly remote, and if it succeeds, lives will be saved and extended. The significance of this seems lost on most of the scientific fraternity (and the general public as well). Probably it can only be properly appreciated by those of us who want very much to extend our own lives: that is why we are in cryonics.

One question Feinberg addresses in the *Physics Today* article is the one he raises in the earlier quote about whether memory would survive freezing to low temperature. Although the question isn't answered in full (and indeed, the answer isn't known yet) strong evidence is cited that long-term memory is encoded structurally rather than in a "volatile" form such as circulating electric fields. As Feinberg points out, mammals were cooled to near-freezing temperature and experienced clinical death, yet were then revived and retained earlier training. Since the memories survived clinical death, it seems a reasonable bet that they would also survive the deeper cooling needed for long-term preservation.

Feinberg was on the Advisory Council of the Life Extension Society,[4] and later, (along with Armand Karow and other cryobiologists, it turned out) a Scientific Advisory Council of the Cryonics Societies of America (which in turn was a short-lived confederation formed in the late 1960s).[5] Despite the support and favorable leaning toward cryonics, however, his story has a tragic conclusion. Only a few days ago, as I write this, Gerald Feinberg, aged 58, died of cancer. He was not frozen. It appears that he didn't lack the means to make the arrangements, nor the time. Somehow, he was just not interested enough. Friends or acquaintances I've talked to could give little in the way of definite reasons for the lack of interest, but I get the impression that, when all was said and done, the interest he did show was mainly academic after all. Another factor may have been hostility from colleagues and family members. Apparently he was well criticized for the *Physics Today* article on the prolongation of life, though not for something really scientifically daring, like the tachyon theory. In the absence of further information I'll close now, with the painful wish that somehow, persons who think at all favorably on cryonics will not ignore the benefits it can have for *them*.

How Many Are We?

Alcor has 315 Suspension Members, 449 Associate Members (includes 160 people in the process of becoming Suspension Members), and 21 members in suspension. These numbers are broken down by country below.

Country	Members	Applicants	Subscribers
Argentina	0	1	1
Australia	13	1	4
Austria	0	1	1
Brazil	0	0	1
Canada	11	4	21
France	0	0	3
Germany	1	1	2
Holland	0	1	0
Italy	0	2	2
Japan	1	1	0
Lichtenstein	0	0	1
Mexico	0	0	1
Norway	0	0	2
Portugal	0	0	1
Spain	6	2	0
Sri Lanka	0	0	1
Turkey	0	0	2
U.K.	11	5	6
U.S.A.	272	141	260

References:

1. *Freeze-Wait-Reanimate* **28** 4 (Oct. 1966).

2. *Freeze-Wait-Reanimate* **43** 5 (Feb. 1968).

3. *Freeze-Wait-Reanimate* **11** 7 (Apr. 1965).

4. *Freeze-Wait-Reanimate* **13** 2 (Jun. 1965).

5. *Cryonics Reports* **3** 167 (Sep. 1968).

Several individuals assisted with recollections or in other ways, including Gregory Benford, Peter Gouras, Curtis Henderson and Mark Plus.

New methods for freezing and storing at low temperatures might lead to many new potentialities for the human race, the most exciting of which would be the opportunity for dying individuals to avail themselves of future medical progress. Successful experiments have already been done with cells and lower animals, but many problems remain.

PHYSICS AND LIFE PROLONGATION

by Gerald Feinberg

SCIENCE AND TECHNOLOGY in the 20th century have made real many dreams of men in earlier ages. Among these are transmutation of elements and manned space flight. Another dream of many men in different places and times, that of elimination of aging and death, remains unfulfilled by us. Scientists who work on this problem do not know how to solve it or even whether it can be solved at all.[1] I cannot answer these questions here, and I believe that physics is somewhat peripheral to their solution. Instead what I shall do is to present a somewhat novel way of looking at the matter, based on an optimistic estimate of future scientific progress. In addition, I shall discuss how some results of low-temperature biology (cryobiology) open the possibility to those living of taking advantage of this progress before the problems of aging and death are solved. This possibility depends on development of reliable methods of freezing, storing at low temperatures and reviving humans.

Developing such methods would lead to many new potentialities for the human race. The most exciting of these seems to be that of being able to take advantage of future medical progress. The methods will probably involve coöperation among biology, medicine and physical science. This can be seen from a brief list of some key unsolved problems in this area: (a) developing more efficient methods of heat transfer for cooling and thawing, (b) better understanding of the mechanism of damage in freezing cells, (c) discovery of more effective protective agents against freeze damage and (d) study of possible harmful effects of long-term storage on animals.

These problems may not be easy to solve, but in view of the immense consequences of their successful solution, we should undertake a strong effort to solve them. I shall try to indicate the important role that physics has in this effort. The reasoning I shall present is not original although I find it compelling. It has been given by Jean Rostand, for example, in more detail by the physicist Robert Ettinger in his book[2] *The Prospect of Immortality* and by Leo Szilard, in a story "The Mark Gable Foundation."[3]

Future progress of science

It has become commonplace to note that most people who have ever worked in science are still alive. Furthermore, most of the known fields of science have short histories, measured in decades. In view of these facts and of the obviously great advances in science and technology in this century, it is reasonable to expect that many problems we can not now solve will be solved by future scientists and that many limitations of our present technology will not be limitations of future technology. Predictions by scientists of the future of science and technology do not usually recognize this and are therefore almost certain to be insufficiently imaginative or optimistic when compared wih actual developments.

I believe the opposite approach is better, and a good first approximation for such predictions is to assume that everything will be accomplished that does not violate known fundamental laws of science as well as many things that do violate these laws. This is not a statement within a field of science but a statement about science. The distinction is important because some of the very talents required for successful work within a science, for example, step-by-step logic and suppression of extreme speculation, may be disadvantages in predicting what will be accomplished by methods as yet unknown. This paradox is neatly summarized in Arthur Clarke's law,[4] which

Gerald Feinberg, professor of physics at Columbia University took his PhD from Columbia in 1957. His main interests are elementary particles and quantum field theory.

Temperature Change and Metabolic Rate

ΔE (kcal/mole)	T_1 (°K)	T_2 (°K)	$\frac{Rate\ (T_2)}{rate\ (T_1)}$
10	310	80	$\exp[-46] \approx 10^{-20}$
10	310	190	$\exp[-10] \approx 10^{-4}$
20	310	80	$\exp[-92] \approx 10^{-40}$
20	310	190	$\exp[-20] \approx 10^{-8}$

says, "When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong." Although this law may not be universally true, it does suggest good advice for distinguished scientists.

The principle that everything possible will eventually be accomplished does not give any guide as to how long it will take to do any particular feat. Here again predictions are usually too pessimistic. Things we can think of today as possible, without knowing how to do, are the ones that will be done in a relatively short time. It is these things we cannot yet even imagine that will take longest to accomplish. I am inclined to put 200 years as an upper limit for the accomplishment of any possibility that we can imagine today.

Application of this view to progress in medical science leads to the conclusion that cures for all diseases that afflict man eventually will be found. This accomplishment would be just a step along the way toward regulating biological processes in living organisms on all levels from molecular to macroscopic. There seems to be no reason why macroscopic regulation should not be possible. Some biologists have already suggested steps that could be taken towards this goal.[5] If one accepts that aging is a particular set of chemical and physical changes that occur within living organisms, the logic of this argument suggests that it will eventually be controllable and reversible, even if the methods are as yet unknown. This seems to me a much safer bet than the opposite view.

If it is true that "tomorrow will be better," in the sense described above, there remains the question of how this is relevant to prolongation of life for those alive today and in the near future. After all, someone dying of pneumonia in 1920 was not materially helped by development of penicillin therapy 20 years later. There is an approach to this problem that holds out promise to those alive now of taking advantage of future medical advances. This approach does not involve any major revisions in physics such as travel through time or any immense practical difficulties such as would be involved in using relativistic time dilatation. It is based on the fact that biological processes are temperature dependent and that at sufficiently low temperatures, biological activity can be stopped for arbitrarily long periods, and then, in principle, and in many cases in practice, restored by rewarming. It is this possibility that will open the door to the future.

Cryobiology and the future

It has been known since Arrhenius that the rate of biochemical reactions depends on temperature in a relatively simple way. The dependence, not hard to derive,[6] is given by

$$\text{Rate} \propto \exp\left[-\frac{\Delta E}{RT}\right] \qquad (1)$$

(R is the gas constant = 2 cal/deg-mole, T is the absolute temperature and ΔE is a constant characterizing the reaction, called the "energy of activation"). ΔE can be taken as an empirical constant although some estimates of it can be given theoretically. For typical biochemical or biological processes, ΔE is 10 or 20 k cal/mole.

The rate equation holds not only for elementary biochemical reactions but even for such phenomena as human-heartbeat rate.[6] It is clear from the equation that a substantial temperature reduction from the ordinary temperatures of living organisms will produce an enormous slowdown in the rate of biological processes, as shown in the table.

The data indicate that a biological system maintained at low temperature would for all practical purposes not undergo any metabolic processes involved in life or aging. But can such a system be brought to and from such a temperature without destroying it?

This question has been affirmatively answered for such simple systems as bacteria, yeast and protozoa.[7] These have been frozen and stored at temperatures down to −190°C for periods up to years and then successfully rewarmed and revived. The deterioration rate of the stored organisms appears to follow the rate equation reasonably well.[8] Techniques for ensuring survival of the organism have been developed somewhat empirically and are not completely understood. For example, in yeast, survival is greatest when the yeast is cooled slowly (~ 1°C/min) and warmed rapidly. This is not, however, a uniform phenomenon for all cells.

Successful freezing and thawing of a wide variety of cells of different types and from different species of multicellular animals have also been accomplished.[7]

In general, such cells do not remain viable if they are simply cooled below −10°C and later thawed. In 1949 C. Polge, A. U. Smith and A. S. Parkes[9] discovered that avian spermatazoa in a 10% glycerol solution could be frozen, stored at −79°C, thawed and revived. It has since been found that glycerol has a similar protective effect on many other kinds of cells as do certain other agents such as dimethyl sulfoxide. There is no completely convincing theory as to how this protection occurs since it is not clear what causes damage to cells frozen without protection. One plausible theory, advanced by A. M. Karow and R. W. Webb,[10] is that damage in freezing occurs when the part of the water within a cell that is bound to the cellular protein freezes. This destroys the lattice of water molecules that helps to maintain the shape of protein molecules, and the protein then denatures. The function of the protective agent is then to strengthen the water lattices sufficiently that they are not destroyed in the freezing process. Other theories have also been suggested. This problem requires co-

öperation among physicists, chemists and biologists. With development of an understanding of freeze damage and protection, a more systematic search could be made for optimal protective agents, and it would not be surprising if better ones were found.

The next step to the freezing and preserving of organs over long periods has not quite been accomplished although partial successes have been reported in the journal *Cryobiology*.[11] There are obvious problems in freezing organs such as assuring reasonably uniform cooling, perfusion of the organ with cryoprotective agents and optimal methods of rewarming. It is also unclear whether the damage to the organs occurs during cooling, storage or rewarming. Here again collaboration between physics and biology appears called for.

Freezing mammals

In the meantime, interesting experiments have been done[7] involving cooling of small mammals to temperatures not far below 0°C. Experiments have been carried out with hibernating animals such as golden hamsters. In the most successful experiments hamsters were cooled so that their deep body temperature was about −2°C, and about 50% of their total body water had frozen. They could then be kept for up to an hour this way and then revived by diathermy rewarming. Approximately half of the hamsters so treated recovered and lived out their normal life span. Thus far it has not been possible to extend the storage period or lower the temperature and still revive the animals for a long period.

Recently this work has been extended to nonhibernating mammals, rats, by P. and V. P. Popovic.[12] They were able to maintain young rats at −1°C for up to an hour in a supercooled state (that is with their body water still liquid) before thawing and reviving them. Short-term survivals (up to 24-hr. after thawing) of frozen rabbits and primates (galagos) have also been achieved. It is not clear why these larger animals eventually die or whether more efficient rewarming methods would serve to increase these survivals. None of these experiments involved use of cryoprotective agents, which would have obvious advantages in view of the results with cells.

Smith in her book[7] concludes her section on mammals with the following comments. "So far no technique has been evolved for perfusing individual organs or the whole mammal with glycerol and removing it without damage. If this could be done, it might be possible to cool the intact mammal and resuscitate it from temperatures as low as −70°C. Long-term storage of frozen mammals might then be considered . . . . Progress along these lines may require a team of physiologists including experts in surgery, electronics and other disciplines." The experience of physicists working at low temperatures would be of great value in some of the technical problems in realizing this goal.

An interesting by-product of the experiments on cooling mammals came from work by R. K. Andjos et al,[13] who cooled rats to temperatures just above freezing and maintained them there for 1-2 hr. At such temperatures the rats show neither heartbeat nor electroencephalography. The rats, however, could be revived fairly easily by diathermy rewarming. Rats that had been trained to solve problems of finding food in a maze were cooled and revived in this way. They retained the memory of their training by still being able to solve the maze. This experiment shows that memory is stable under cooling and thawing of the animal and indicates that memory involves some kind of chemical imprint in molecules rather than circulating electric currents since the latter had presumably ceased at the temperature where the EEG trace vanished. This conclusion about the nature of memory is in harmony with other recent experiments.[14] The result is of vital importance for the prospect of freezing and long-term storage of humans at low temperature since the preservation of memory and personality would be the main reason for undertaking such storage.

Freezing humans

Successful methods for freezing, storing and reviving humans would evidently have widespread applications. One that has been considered by many

Engravings after Holbein

authors would be to make interstellar voyages possible; they would otherwise be rather difficult. Other technological problems, however, might delay this for some time. A much more important application would be to make it possible for people of the present to benefit by progress of the future. In our lives we make constant use of progress of past generations. Indeed civilization would be impossible if it had to be reinvented by each generation. With the advent of successful freezing techniques, we shall be able to rely on the future as well. Imagine a patient dying of a now incurable disease. If he could be frozen and stored indefinitely at low temperature, he could be revived when the cure for the disease is developed. He would then be in a position similar to someone born when the disease was curable. As an example, if freezing techniques had been available in 1920, a man then dying of pneumonia could have been frozen and stored and could now be thawed and treated successfully. In addition, he would be able to take advantage of whatever else the future has to offer.

It is quite possible that all diseases will eventually be curable, and aging may be avoidable and even reversible. When successful freezing techniques become available, no disease need be considered hopeless. A person dying of whatever cause could be frozen and stored in the hope that he could eventually be revived and cured. One can think of possible drawbacks to this for both individuals and society, but a great many people, and not only the incurably ill, would be quite willing to try it. Although PHYSICS TODAY is not the place to begin discussing the social consequences of a successful freezing program, it is perhaps worthwhile to remark that progressive increase of possibilities open to humanity has been one of the major contributions of science. In view of this increase and the 40 million people who die each year of diseases that will some day be curable, the need for an energetic program of research on cryobiology appears strikingly clear. It is hard to think of any scientific advance that would open greater possibilities. Yet relatively small amounts of money and few researchers are involved in this quest in the scientific world at the present time.

Ettinger, in his book, has carried the argument one step further. For the living it is necessary to await successful completion of freezing research before attempting to freeze them. For the newly dead this consideration is irrelevant since the dead have nothing to lose by being frozen, even by imperfect methods. Ettinger therefore proposes that even today bodies of those just dead, as determined by cessation of heartbeat, could be immediately frozen by whatever techniques are available. This freezing will cause some damage to cells, but we can hope that many of them, in particular brain cells, will be preserved by the cold before enough time has elapsed for them to have been damaged by deprival of oxygen and nutrients. After freezing, the body must be stored until scientists can both counteract the damage done in freezing and undo whatever led to the death of the person in the first place, such as a heart attack. It may seem unlikely that this combination will ever come to pass, especially with the primitive freezing techniques now available. Ettinger makes the point that damage done in thawing is not a problem for this approach since thawing will be done in the future only when that problem is solved. Furthermore a dead body is no deader for having been frozen and stored, and the expenses would not be orders of magnitude beyond those of ordinary funerals. Since many people might wish to take the small chance that they will some day be revived if they are frozen on their death now, it would seem reasonable to make this possibility available to some of these individuals. ■

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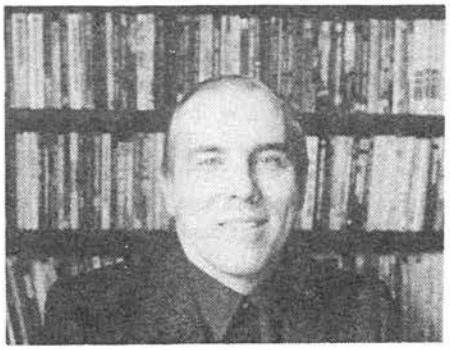
Remember the Memories

H. Keith Henson



Arel and I did a serious article this month, so I will try to do something fun with the column this time.

Scientists and engineers like to measure things. A story at least 30 years old is the development of the milli-Helen by engineers at a name school (MIT? Cal Tech?). According to legend, Helen of Troy had the face which launched a thousand ships. The one milli-Helen measurement implied a woman beautiful enough to have launched *one* ship.

Thus it should be no surprise that computer engineers would try to measure or at least estimate human brain power and memory in terms they use for computers. Typical desktop computers in current production are rated at a few MIPS or millions of instructions per second. The best supercomputers are roughly a thousand times that fast.

Some nerve systems, such as those in the retina of the eye, are fairly well understood, and we can get a good idea of what it would take to do the same functions using silicon circuits. By comparing the measured functions of the retina of the eye with motion detector programs running on computers, and extending these comparisons to the entire brain, Hans Moravec (in *Mind Children*) has estimated that simulating a human brain would take roughly 10^{13} instructions per second, or a thousand times the power of today's largest supercomputers.

We are far ahead, not by virtue of being fast, but by the vast amount of parallel processing we possess. If this level of processing power is required for intelligent behavior to emerge, it is no wonder that research on artificial intelligence has gone so slowly; in fact, it is amazing that any progress has been made at all. We have been trying to get intelligent behavior out of machines with the processing power of an insect.

The development of parallel computer hardware and ways to use that hardware to solve problems is a topic of considerable interest and rapid progress in the computer business. At the current rate of improvement, the "human brain" level of computer power should occur some time in the first quarter of the next century. Having vast amounts of computer power available means a lot for speeding the nanotechnology revolution.

We still have an edge in processing power — how about memory? Computer memory is measured in bits, or, nowadays, in megabytes (where a byte is 8 bits.) Computers come with a specific amount of memory plugged in, and a specific amount of slower (but still fast by human standards) disk storage. Typical desktop computer memories these days are several megabytes of main storage and tens to hundreds of megabytes of disk storage.

In spite of using the same word for both computer memory and human memory, we don't understand the mechanism of human memory well enough to make an estimate of how big it is from a count of cells and a mechanism. Moravec's estimate based on 10 bits per synapse gives an astonishing 10^{15} bits. We get a radically different result from direct measurement, considering the human brain as a black box, and measuring what goes in and comes out. The result of several lines of inquiry have led to a disturbing result: A lifetime of human memory seems to be smaller than that of a good-sized disk drive! (On the other hand, if this little data is stored redundantly in so many synapses, the prospect of coming through a suspension with your memory intact is much improved.)

At the current rate of improvement, the "human brain" level of computer power should occur some time in the first quarter of the next century.

When I first ran across this result I was sure there was some problem. Human memory smaller than a thousand books? When a picture is worth a thousand words? That sunset, a memory of the Grand Canyon? The skill to ride a bike? But the numbers have been known to psychologists for years. Human learning rate is a few bits per second; extrapolated across an average lifetime it comes to about 150 megabytes, a fourth of the data on a CDROM.

After studying this in more detail, I found it hard to fault these results, which, of course, don't measure the ultimate capacity of human memory, but what we actually store. After getting over my initial surprise, I was amazed that we do so well with so little memory. The organization must be very efficient, especially for places. We may really remember a lot less than we think we do; anybody who has visited a childhood neighborhood after many years finds a lot of discrepancies between memory and reality. Part of this may be in remembering procedures as opposed to facts — and then generating facts as needed from a small amount of information. We also use a lot of extensions to human memory in the form of books, data bases, and other humans who specialize in knowing something the rest of us don't need to know very often. A lot of university-level training is getting to know a smattering of this and that, enough for a top-level index. If you need to know more, you get training in how to find material in a library, or at least what kind of librarian

to ask.

If you consider books and libraries as part of human memory (just a little slow to access) then we get up to respectable numbers — a lot more disk drive than a person would want to purchase, perhaps approaching Moravec's estimate.

What direction will computers and communications take us in making information available? I suspect that communication nets and vast data bases, coupled with powerful search mechanisms, will continue to grow. The interfacing method will change from typed commands to spoken ones and eventually the simple mental activity of trying to remember something will trigger direct input to your mind from the global data base. The inputs might be hard or impossible to distinguish from your personal memories.

Which finally brings me to a subject Ralph Whelan wanted me to discuss. What would it be like to regain consciousness after being suspended? Wouldn't it take a long time to come up to speed on what has gone on since you were frozen? Maybe, but given the high value our society would put on improving human access to memories, you might wake up *already knowing* the history of the world since you were suspended, plus having every human skill imaginable at your fingertips.

Now, if they just take care of remembering where I left my car keys.

Isn't That You Behind Those Foster-Grants?

(Part Two)

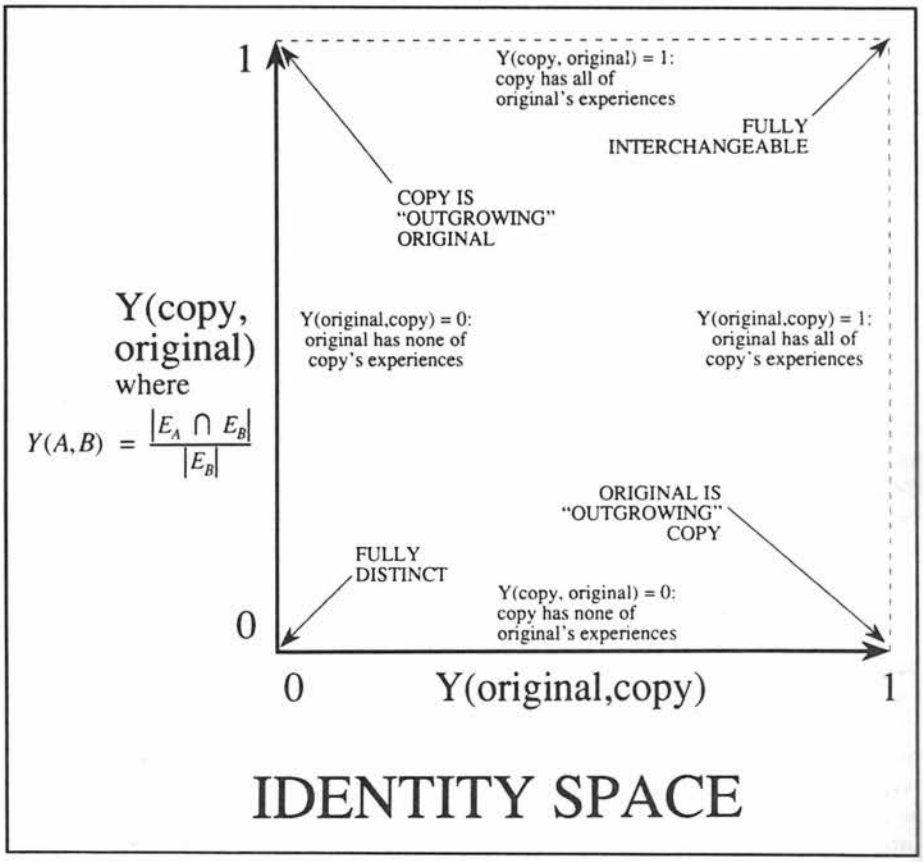
David Krieger

Introduction

In my first column (April, 1992 *Cryonics*), I addressed the problem of what we mean by survival — Is that person who emerges from the reanimation process really "me"? Discussions of this question usually flounder due to a lack of rigorous language for describing definitions of personal survival. I then introduced the **Y** function and the **S** relation in the hopes of giving a more rigorous language to discuss the question of personal continuity.

The function **Y(A,B)** is defined as the fraction of **B**'s experiences shared by **A** (where **A** and **B** are two instances of the "same" person) and takes on values from zero to one inclusive. **Y(A,B)** is a statement about **A** in terms of **B**; one interpretation is, "how **B**-like **A** is." The two **Y** values **Y(A,B)** and **Y(B,A)** define an "identity space" (Fig. 1). The survival relation **S(A,B)** then can be identified with the region of points in identity space for which **B** is considered a continuation of **A** (**A** *survives* in **B**). This can be restated as **S(original, copy)** as in Figure 2 of Part One. [In Part One, this is erroneously stated as "**A** survives **B**," which is inconsistent with the rest of that column. The actual meaning of **S(A,B)** being true is "**A** survives *in* **B**" (i.e., **A** is "original," **B** is "copy"). I apologize to readers who were confused by this error.]

Differences in opinion on whether a person is perpetuated by processes like cryonic suspension, backup copying, etc., are thus differences in opinion on the shape of the survival relation in identity space. In this column I will begin to map identity space and to apply the **S** relation to some of these cases.



Extremism in the Defense of Identity

First, however, let's examine what is happening at each of the extreme corners of identity space. At the upper right, the point (1,1), **Y(A,B) = Y(B,A) = 1**. This is the ideal case, in which the two instances of the person are fully interchangeable, within our limits of detection. (Recall from Part One that our definition of "A's set of experiences" E_A includes any and all qualities that are representable in the physical state of the brain.)

At the lower left, (0,0), the intersection of the two sets of experiences is completely empty — neither body incorporates any of the memories of the other. For all intents and purposes, these are fully distinct individuals.

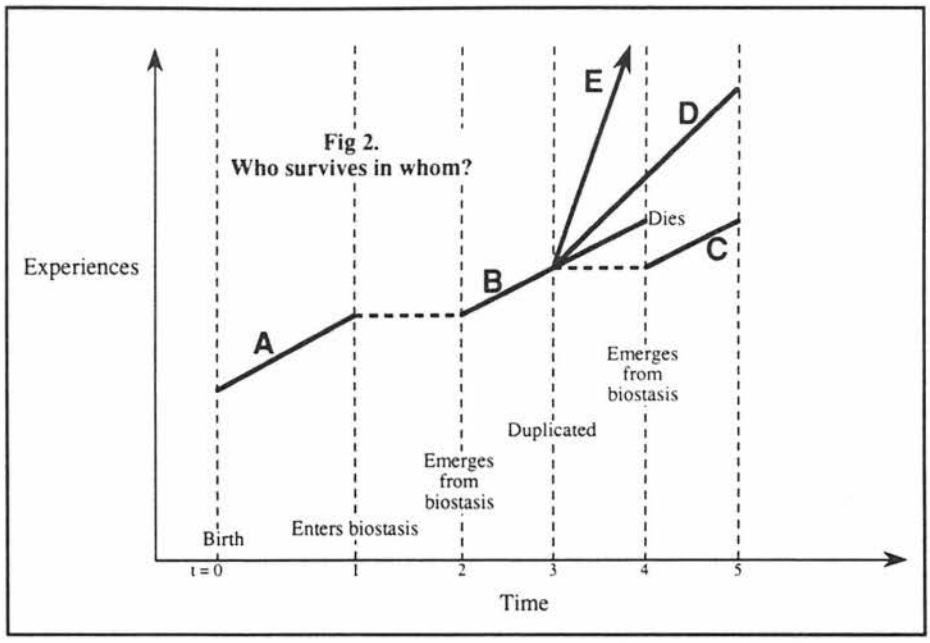
At the upper left and lower right, one of the **Y** functions is approaching zero while the other remains 1. What does this mean? Taking the upper left point (0,1) as an example, **Y(B,A) = 1** means that $| E_A \cap E_B |$ (the size of the set of experiences common to both **A** and **B**) remains equal to $| E_A |$ (the size of **A**'s set of experiences), while **Y(A,B)** is approaching 0 means that $| E_A \cap E_B |$ is growing much smaller relative to $| E_B |$. One way this could happen is if $| E_A \cap E_B |$ and $| E_A |$ are standing still while $| E_B |$ is growing large: **B** is racking up experiences not shared by **A**. An everyday example of this would be if **A** represents "the author at age two" and **B** represents "the author growing older."

At the opposite corner, **A** is "outliving" **B**. A tragic everyday example of this might be an Alzheimer's patient, retaining less and less of her memories with the passage of time.

Maps of Identity Space

Figure 2 depicts the history of a person who undergoes several of the types of processes we foresee as a result of nanotechnology. The horizontal axis represents the advance of time, and the vertical axis, the accumulation of experiences. (The diagram is not to scale.)

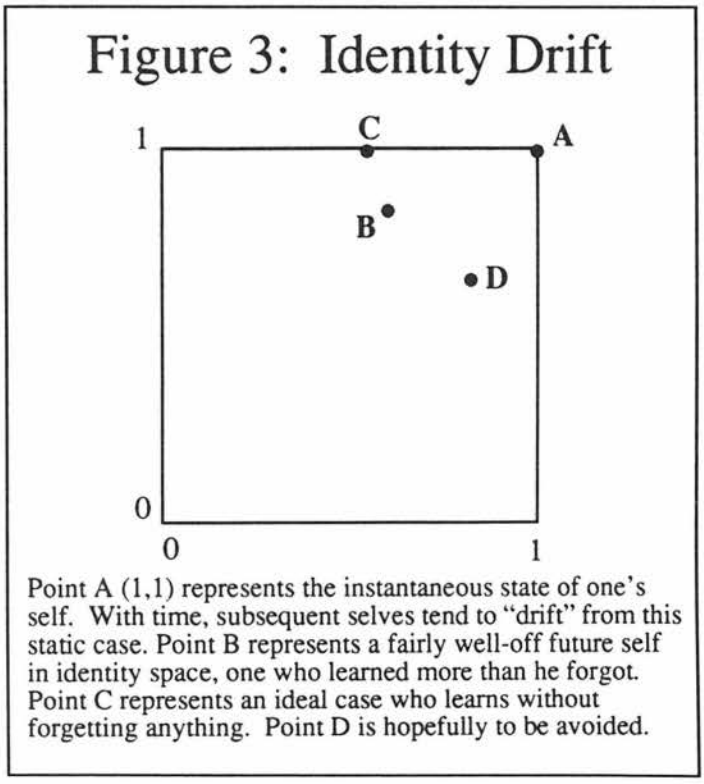
Let us first consider the most prosaic case of "survival," represented by line segment **A**: normal growth and aging. In 1984 there was a person walking around named Dave Krieger who shared some of the characteristics of the present Dave Krieger. However, "I" have learned a great many things since then (so **Y(Dave'84, Dave'92)** cannot be 1), and forgotten a great many as well (so **Y(Dave'92, Dave'84)** cannot be 1 either). (The general trend for today's human is to "drift" downward and leftward in identity space, like Point B in Figure 3.)



Has "Dave Krieger" survived? If not, what kind of "survival" can cryonicists possibly be hoping for? We thus assume that **A** is "the same person all the time." Recently on the CryoNet electronic mailing list, Arel Lucas put forward the Eastern view that "identity" is an illusion, that we are a different person each moment — or, in our notation, that the survival region **S** includes only the unattainable point (1,1) (See Figure 4a). In this discussion, I have made the contrary assumption that identity is "real," from which we must conclude that our definition of the survival region **S** cannot be limited to only the "fully interchangeable" point (1,1), but must include points representing imperfect reproductions as well.

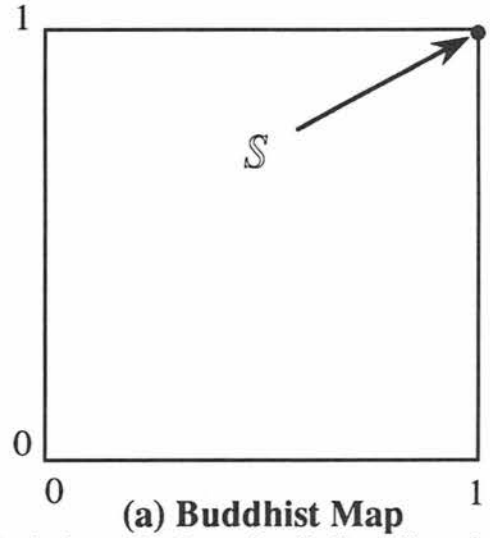
Going back to Figure 2, at time **t = 1**, our subject suffers an acute lack of the ability to live any more and is placed into biostasis. (Biostasis is represented as a horizontal line — I presume that the suspendee is not accumulating new experiences or losing any old ones.) Let **A** stand for the pre-suspension person and **B** for the person who emerges from the revival process at **t = 2**. (By the argument presented above, every point along the length of the line segment **A** is "the same person," so we can simply compare **A** to **B** rather than specify particular instants on each segment.)

Now, does **A** survive in **B**; that is, is



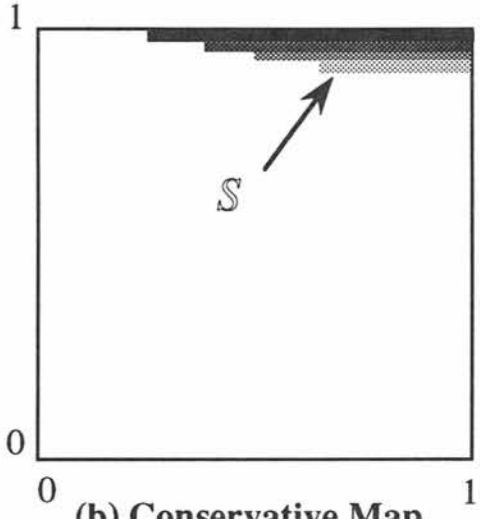
Point A (1,1) represents the instantaneous state of one's self. With time, subsequent selves tend to "drift" from this static case. Point B represents a fairly well-off future self in identity space, one who learned more than he forgot. Point C represents an ideal case who learns without forgetting anything. Point D is hopefully to be avoided.

Figure 4: Maps of Identity Space



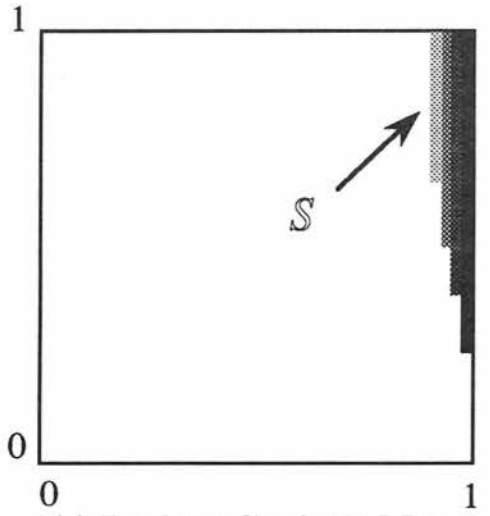
(a) Buddhist Map

Includes only the point (1,1) — "survival" is an impossible illusion, because we are never identically the same from one moment to the next.



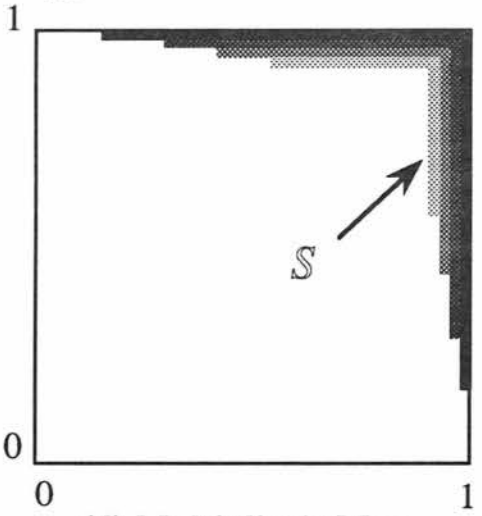
(b) Conservative Map

Includes all points for which Y(copy, original) ≈ 1 — the copy possesses all of the memories of the original, plus, possibly, some new experiences unique to the copy.



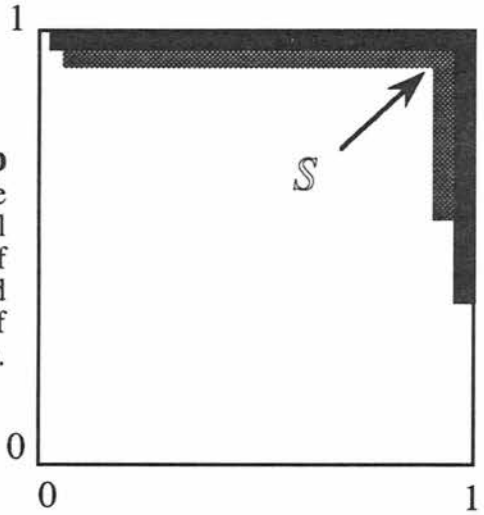
(c) Backup Copier's Map

Also includes points for which Y(original, copy ≈ 1 — "original" survives in "copy" even though some of original's memories are lost... so long as "copy" is pristine.



(d) Multiplier's Map

Accepts a significant amount of non-shared experiences in both "original" and "copy."



(e) Uploader's Map

Over extremely long periods of subjective life, "identity drift" will carry an individual nearer and nearer to the (0,1) corner of identity space — as greatly expanded far-future selves dwarf the the capacity of "Mark I" human beings.

S(A,B) true? This is the whole objective of cryonics, so I assume that most readers of this column would agree that, if the revival process is performed properly, A does survive in B. I have characterized this as the "Conservative" map of identity space (Figure 4b). The subject is not losing a significant amount of ground; at least as many of his memories are carried forward to the future self as would happen in normal aging.

The technique of backup copying, as popularized in the fiction of John Varley, assumes a very different map of identity space. On a regular basis, the subject makes a backup copy of himself — for our discussion, let's assume a physical replica, accurate down to the molecular level, assembled in biostasis — and stores it in a safe place (in Figure 2, C is a backup copy of B). B immediately departs on a round-the-world cruise and, after visiting the beaches of Hawaii, is tragically stepped on by a large radioactive dinosaur in Tokyo and dies. The backup copy C is activated as a replacement for B.

Before considering the identity map for this case, let's complicate things a little. At the same time that copy C is created, another copy, D, is also created. This copy is also faithful to the limits of our ability — molecularly identical to both B and C. Rather than entering biostasis, however, D runs off to join the circus as an acrobat.

Now, is B "survived" in either of these cases, and if so, by whom? If you accept C but not D as a continuation of B's personality, you subscribe to the Backup-Copier's map of identity space (Figure 4c). All of C's experiences were part of B, but a significant fraction of B's experiences — seeing the black sands of Diamond Head, for example — are not part of C. C has no experiences independent of B, and might be described as a "pristine" copy of B, while D not only lacks B's memories of Hawaii but has also gone on to have experiences that were never part of B — the roar of the greasepaint, the smell of the crowd. According to the Backup-Copier's map, D is "sullied" by these distinctly non-B experiences.

If on the other hand you maintain that B survives in D (that is, that S(B,D) is true), then you accept the Multiplier's map of identity space (Figure 4d). The Multiplier's notion of identity is the most liberal, asserting that two instances can be the "same" person even if each has a significant amount experiences not shared by the other.

E in Figure 2 represents the final case I will discuss — uploading, defined as the reproduction of a human consciousness in faster and more capacious hardware. Hans Moravec of Carnegie-Mellon University discusses the prospects for uploading in his book *Mind Children*. The acceleration factors that would result from such a transformation range from conservative estimates of 2000 times the speed of present human thinking to less wary estimates in the millions and billions. Such a being would experience years or millennia of subjective experience in a matter of days (represented in figure 2 by the steep climb of the E arrow). Those who believe that the product of such a process would still be the "same person" as before have adopted what I call the Uploader's Map of identity space. For an uploader, the survival region S edges arbitrarily close to the (0,1) point, as the memories and experiences of the final person expand to dwarf the consciousness of their original human incarnation.

As I wrote in my previous column, my goal in this analysis has been to provide a more rigorous language for the discussion of topics like the nature of human identity under a variety of transformations. I hope that *Cryonics* readers will find this notation useful. In my next column, I'll address a more concrete topic — techniques and a proposed support structure to help the members of Alcor transport and suspension teams recover afterwards from the emotional and physical stress involved.

Talk at Alcor's 20th Anniversary Celebration

Fred Chamberlain

A greatly foreshortened version of the following was presented at the actual event, due to the lateness of the hour and the fact that schedule revisions necessitated compressing the presentation from half an hour to fifteen minutes. The text which follows was designed for oral presentation, with pauses indicated by "..." in many places. It is reprinted in that form, rather than being edited to a more usual grammatical convention, to better convey the way in which it was (or would have been) spoken.

It's great to be here... with you, in this room, all of us alive and active, looking forward to the promise of a potentially endless future of growth and self-transformation. And if Alcor's patients in suspension could look in on this gathering tonight, I think they'd be very glad... to see Alcor still strong and viable, despite some recent losses, still able to keep them moving on their travels through time.

We cryonicists see what we're doing as a productive, positive, worthy thing, trying to circumvent deaths which people a century from now will surely see as a needless waste of human experience. But many of those who ask us about cryonics... whether through skepticism as to its workability... or concerns about imagined overpopulation problems... or just through inability to confront the idea of death logically, find cryonics a gloomy, morbid subject. They ask, "Why in the world would you want to be frozen if you died?" and it's hard to know exactly how to answer them.

In the past, I've tried plunging into

The early version of the Alcor/Manrise Transport/Suspension Meds kit.

the more penetrating, far reaching aspects of cryonics, but this generally leads nowhere, like butting my head into a stone wall, and since that's the part of my anatomy I've made arrangements to have frozen, I've given that up. In the future, I've resolved to take a lighter approach... to stick with simpler things, to which more people can easily relate.

Maybe I'll say something like, "Look, you know, 'death' is a lot like flunking out of school... I mean, both of them are a kind of 'failure'. You fail too many courses in school, and you're out. With death, it's even simpler... just a 'failure to stay alive'."

And many people will say, "Wait a minute! You're going to 'blame' them for dying, like it was their fault?"

And I'd say I think we do have to blame them. After all, if they'd lived a healthier life... or lived more safely, they probably wouldn't have died at that particular time. And you can follow this argument on, step by step, until even if someone dies after attaining a hundredth birthday, you can still call it a "failure to stay alive," but clearly by that time you're into diminishing returns... what you need isn't just more health consciousness or safety consciousness, but radical anti-aging therapies like Michael West is talking about (if you saw the February, 1992 article in *Longevity* by Carol Kahn).

In any case, even in the event of "failure," there are still alternatives. In school, if you flunk out there are still two possibilities. One of them is you'll be "suspended," a term we cryonicists use ourselves. If you're suspended from school, it means maybe, if things work out, you'll be back in the swing of things after a while.

But if you're expelled from school, there's an entirely different interpretation... it means "you're not coming back" ... and with cryonics, it's the same. If you die and you're not suspended, you're not coming back either, so I think I'd say since this is the case, I'd rather be off somewhere awhile "cooling my heels," than be literally "expelled" from life.

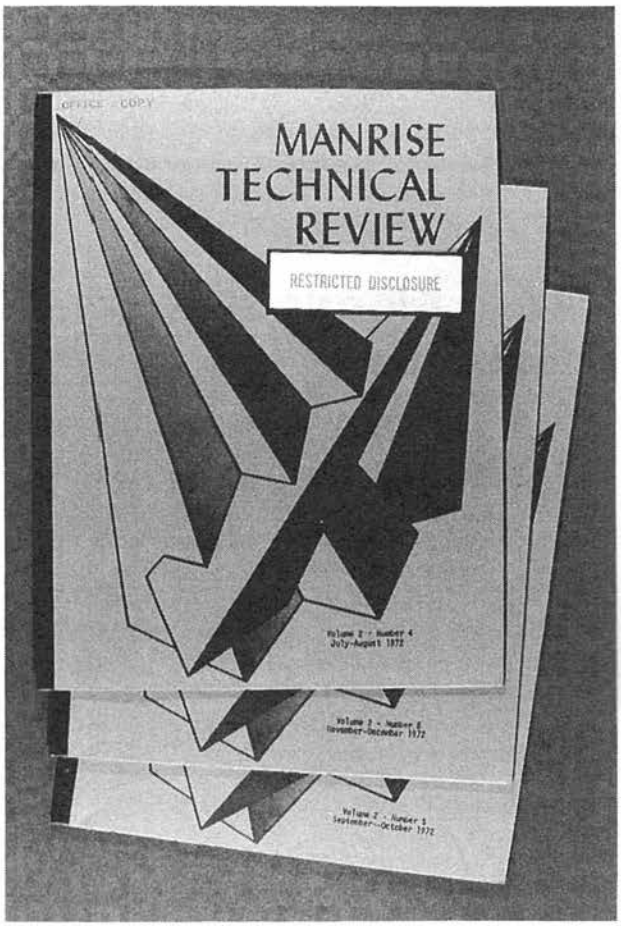
About which time they might remind me, "Hey wait a minute, you're signed up for 'neuro', aren't you? You're not going to have any heels," and I'd have to apologize and admit... "Yes, you're right, I should have said I'd be off somewhere awhile cooling my ears!"

And hopefully that would bring the question to a friendly halt, but if there were a need for a deeper, more serious answer, I think I might say that we cryonicists have hit on a very fundamental, general, positive answer to Shakespeare's great enigmatic question, "To be or not to be?"

And we've chosen, we cryonicists, "To be!"... To be whatever is possible for us, however undefined that may presently be!

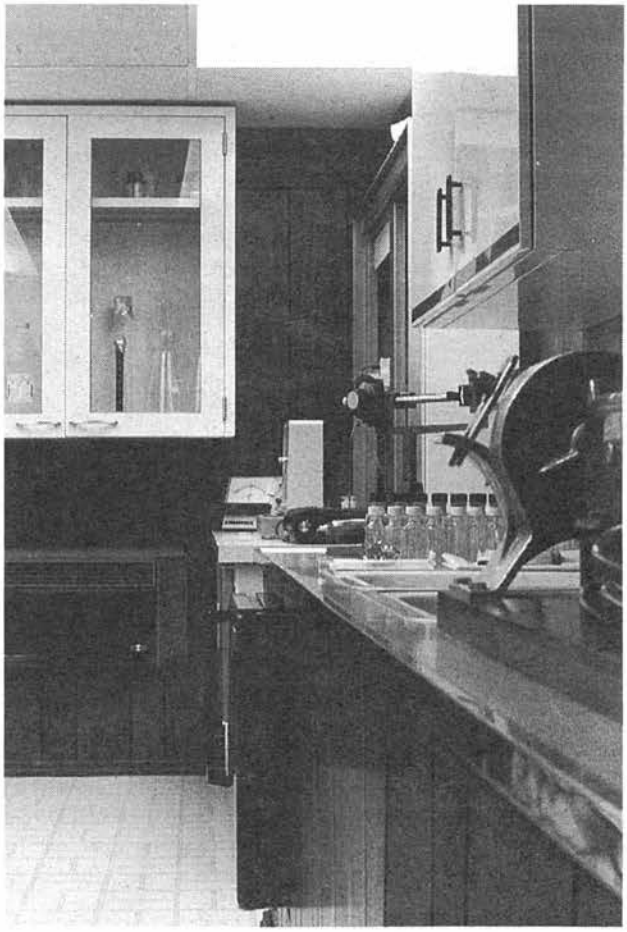
For example, it's undefined if we'll be able to be brought back with our memories fully intact... It's undefined if we'll even be able to be brought back with our memories partially intact. We have no way of knowing whether or not we'll find a fulfilling and satisfying role in life fifty to one hundred years in the future. There's no guarantee that our cryonics organization will survive another fifty to hundred years... and there's no absolute certainty human civilization will survive that length of time, either.

But still... in the face of all these uncertainties, we cryonicists choose... "To be!" To be whatever may be possible for us... rather than choosing "Not to be!" Rather than choosing to let ourselves be-



Manrise Technical Review.

Exterior of "Big Al."



Interior of "Big Al."

come..... nothing at all!

Let's move on to something less abstract... Linda and I are supposed to do some "history" stuff for you tonight, so... here's a brief (or not so brief) glimpse into the past. Twenty years ago, tonight... Alcor was... something of a five week old "infant"! It consisted, for all practical purposes, of Linda Chamberlain, myself, and my father, who was in pretty terrible shape... he'd had a stroke four to five years earlier, lots of other things wrong with him, couldn't really take care of himself, was in a convalescent hospital; we were never very sure at the beginning of any month whether or not he'd have to be suspended before the beginning of the next.

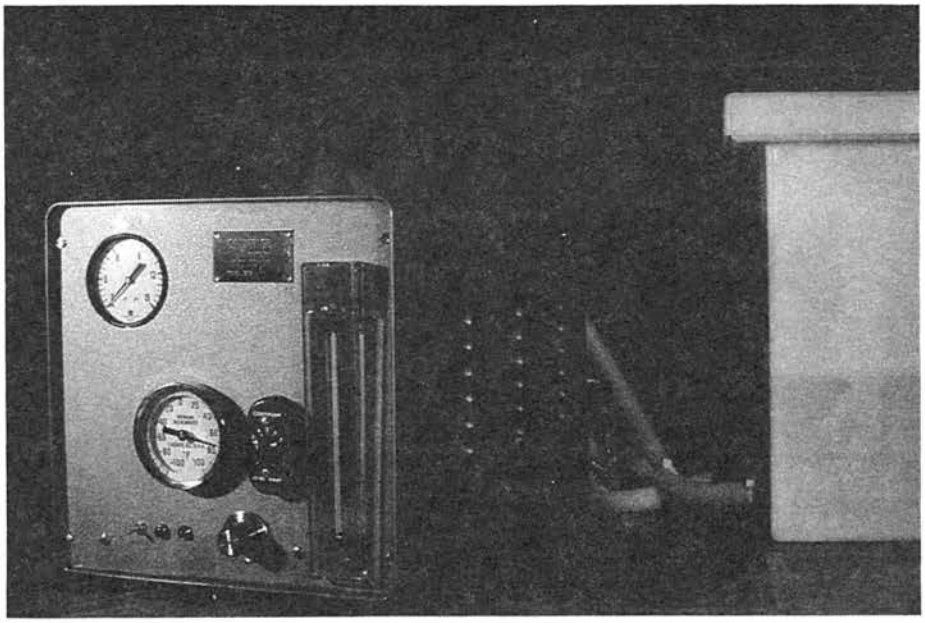
We did have a basic system of perfusion equipment, an outgrowth, a refinement of a prototype we'd exhibited a year before in San Francisco... at the Fourth National Conference on Cryonics. And we did have a basic manual of procedures for cryonic suspension... a little over a hundred pages... which we'd self-published; actually, we ran off about a hundred copies of it on an old "Liberator" model mimeograph machine... eventually, we'd wind up selling some fifty copies nationwide (a few copies overseas) to people who would want that sort of thing. So we had some equipment and some procedures written down.

But we had no signed-up members, other than ourselves, and we had no "facilities," unless you want to use that term to dignify a couple of loose contracts with funeral directors, who said they might let us use some of their work space for our procedures, if they weren't too terribly tied up with more important things at the time (like an overload of ordinary dead bodies).

And even a little over four years later, when my dad finally was suspended, Alcor was still a pitifully tiny handful of people, although by that time we were into our third president, if memory serves me correctly (Linda and I had both had a shot at it by then). Allen McDaniels, M.D., was Alcor's third president. Think of it! Only about four years downstream and we had a physician for president of Alcor. There really seemed to be some light at the end of the tunnel.

And we did have a commercial facility in a little industrial park just north of Burbank, on Tuxford Street in Sun Valley... it seemed a cavernous thing, with two high bay doors, a little office in front and a couple of rest rooms at the back... you could stand in the middle of it, and even with a ten foot pole, you probably couldn't touch the ceiling... seemed like acres of space, although it was surely less than half the size of what Alcor has today.

Into this "cavern," we just barely managed to drive a huge van (it seemed huge to us, because it barely cleared the top and sides of the high bay doors)... drove it in and positioned it crosswise in the center... hooked it up to water and electricity. The van must have been about twenty five feet long; we'd named it "Big Al" (for Alcor). And Big Al seemed pretty "cavernous" itself, until we'd built a suspension laboratory into it... At the outset, we even included a controlled temperature cabinet for perfusion below the freezing point of water (Farrant style, we were very ambitious in those days). It was almost nothing compared with what Alcor has today, but at the time, it was the finest thing of its kind in the world.



The Modular Perfusion Apparatus (MPA) by Manrise Corporation.

And we also had a second, smaller vehicle, which you can probably already guess was nicknamed "Little Al," with rear opening doors, just about the right size to roll in a stretcher after you folded up the wheels... a little cabinet to sit on in the back to keep the HLR going... room for the heart-lung resuscitator, large oxygen bottle, medications, CB radio and still... at that time, Alcor was barely a shadow of what it would later become, due almost entirely to the efforts of others than Linda and myself.

When Allen McDaniels stepped down as Alcor's president, he was followed by Laurence Gale, who held Alcor together for a number of years...

Laurence got our name changed to the Alcor Life Extension Foundation, from the initial name... I think we were trying to avoid the term "cryonics" and maybe nobody had thought up "biostasis"... any way, the original name was the "Alcor Society for Solid State Hypothermia."

Laurence also instigated Alcor's very first animal experiment, at the laboratory of Ben Schloss over in the San Fernando Valley, and persuaded Jerry Leaf to participate. This experiment was financially supported by Thomas Donaldson and was an attempt to find out how well we were preserving brain structure with our methods of that time.

And Laurence vigorously and persistently promoted Alcor and the idea of cryonics at Libertarian Supper Club meetings, by means of which he brought into Alcor people who would be very important to it, as I'll try to illustrate... three of them are still Directors of Alcor:

Hugh Hixon, an old friend of Laurence's, one of the most productive, steadfast, full-time, long-term people the cryonics movement has ever known.

Paul Genteman and Bill Jameson, also still Directors of Alcor, came in about that time. Paul and Bill were leading members of Jerry Leaf's first suspension team. Paul Genteman was First Assistant Surgeon and Bill Jameson was the primary Perfusionist; by then, I was a "backup" perfusionist.

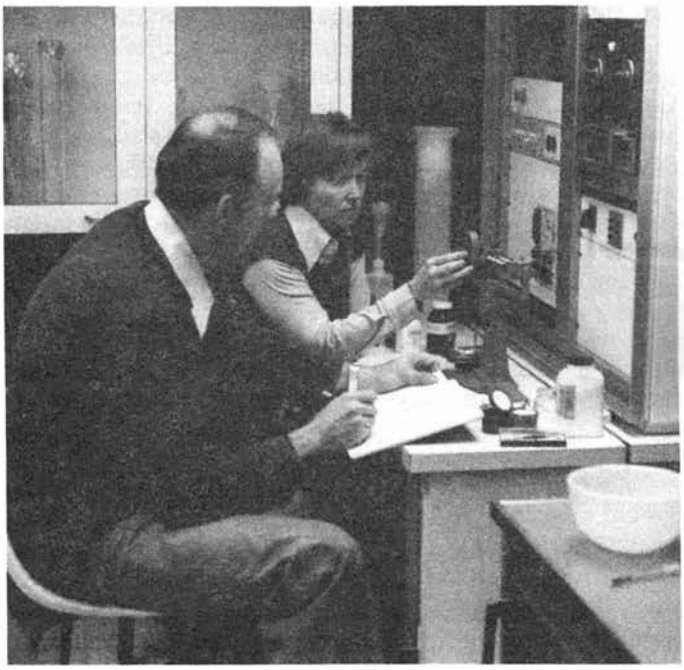
And... Laurence brought us Linda Abrams... it may seem incidental to mention that we held one of Alcor's earliest CPR courses at Linda's apartment, back even before my dad was suspended, and his suspension went much better because of that training... because a number of people now knew how to use the HLR.

But it is far from incidental to mention that during the tensions over Dora Kent's suspension, Linda Abrams pointed our way to Christopher Ashworth, without whose brilliant and skillful defense... Alcor might not be here today... we might not be here tonight celebrating Alcor's twentieth anniversary. But we're still talking about long-term consequences of Laurence Gale's leadership.

In the early '80s, a merger loomed on the horizon for Alcor... with the Institute for Advancement of Biological Sciences or IABS, which Steve Bridge and Mike Darwin had founded in Indianapolis. By that time, Mike had moved to Los Angeles to work with Jerry Leaf in Cryovita... it was the second such move for Mike, who had moved to California in the early '70s to work with Linda and me in Alcor, and had moved back to Indiana about a year before my dad was suspended.

Anyway, Mike Darwin was back in California now, this time affiliated with a different organization than Alcor, and Jerry Leaf (at that time) was primarily involved with a third non-profit organization he had founded, ICE (Institute for Cryobiological Extension), which at that time had no suspension program.

So, a merger took place which consolidated all of the suspension memberships under Alcor. Jerry Leaf eventually came on Alcor's Board as Vice President, replacing Eugene Hartnell, who had held that position for years, Mike Darwin succeeded Laurence Gale as president, and



Fred and Linda measuring dry chemicals in Big Al.

under Mike's and Jerry's leadership, with a huge amount of help from Hugh Hixon, Alcor's membership grew dramatically. Alcor acquired its own facilities, through a limited partnership headed up by Mike Darwin, and Jerry Leaf led the organization in an astounding amount of research, largely perfecting the entry phase of cryonic suspension, down to the freezing point of water.

Then, in connection with the very tense period following Dora Kent's suspension, Carlos Mondragón took over as President. I think he was perhaps the only person with the right combination of knowledge, experience and... this is probably most important, the strength of character to calmly, deliberately and safely guide Alcor through what surely was its most dangerous period to date.

And none of this would be fully in context without a further acknowledgment, of the tremendous contributions of Jerry Leaf.

From a time shortly after my dad's suspension until last summer, when he himself was placed into cryonic suspension, Jerry Leaf provided Alcor with a base, a foundation of facilities, equipment, training, research, and leadership... both as head of the suspension team and in connection with Alcor's administration and long-term planning... a foundation and base without which Alcor and cryonics in general might have taken another twenty years to reach the point where it is today. And the fact that Jerry Leaf is not here with us tonight to celebrate Alcor's 20th anniversary is one of the most profound and monumental tragedies I can imagine.

There are a couple more things I have to say which concern Jerry...

I think most of you would agree with me that... the moment we have perfected suspended animation we should turn our attention to imperfect and compromised suspensions...

Because we can't kid ourselves... even after we have perfected suspended animation, we're going to have lots and lots of imperfect, compromised suspensions... just because of the circumstances in which people will die... the time it takes to begin the procedures.

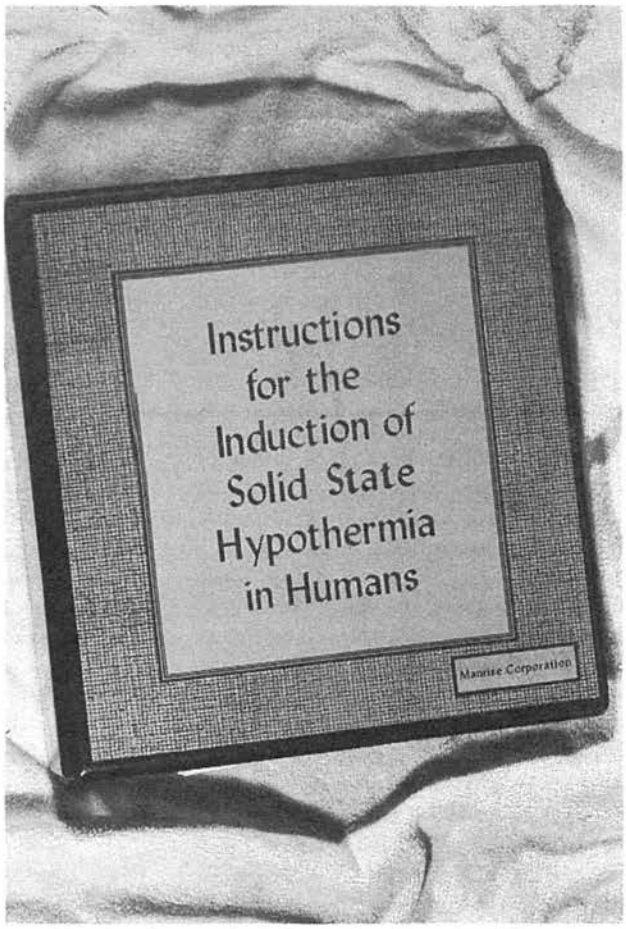
Once we turn our attention to imperfect suspensions, we're going to need a gold standard... a shining goal... to keep us on track... to keep us vividly aware of the magnitude of the challenge we've taken on...

And I think that goal should be.... to Get Jerry Back!!!

We miss him, those of us who knew him at all well, and we want him back among us!

He's earned it... He deserves to be the primary focus of our research on reanimations from imperfect suspensions!

And more broadly, once we get Jerry back, we'll have a way to get back many, many others who are dear to us as well! Including some who haven't even been suspended yet... They'll be the victims of future tragedies where they can't be placed into simple suspended animation because of delays, legal problems, who knows? But we'll be able to get them back, because we've attained the goal of getting Jerry back.



Manrise Corporation's Suspension Procedure Manual.

And one more thing... a suggestion... that when we're able to mount a major research effort on reanimation, whether as an Alcor project or through another research institution which spins off from Alcor for that purpose... it might be appropriate for that project or institution to be named for Jerry... Not as a "tribute" or a way of "making sure he isn't forgotten," but rather as a fine and fitting "welcome back" present... for Jerry to find, when he rejoins us, that, symbolically, he'd guided and inspired our efforts, he'd "carried the flag" for us, every inch of the way!

Well, I could go deeper into the detail of Alcor's history... and I apologize to all of you who would also have been mentioned, except for lack of time... As an example, Saul Kent has done a tremendous amount for Alcor... and that's just an example... but I think you can sense that even if we had an absolutely complete list of such contributors, we'd be barely scratching the surface of the kind of list we'll need when another twenty years have passed... to chronicle the amazing number of creative contributions that will have been made to Alcor's development during that period.

In just the last few years, many very strong, capable people have joined Alcor; a lot of them have already come on line, with totally unexpected and creative ideas and contributions, which will be vital to the process of transforming Alcor into the awesome lifesaving network it can become over the next twenty years. A lot of those people are sitting in this room tonight... and the thing I really want to say to you is: I'm glad you're here!

And there's something else... an important personal favor I want to ask of each of you... over the years ahead... and that is: Please! Take very good care of yourselves! Do everything you can to preserve, protect and enhance your health! Drive and live safely! Hold down your stress and fill your lives with joy! So that twenty years from now, if Alcor holds a fortieth anniversary celebration, or something sooner, perhaps a "welcome in the new millennium party"... I'm sure there's going to be one of those... you'll be able to be there, just as you're here tonight, alive, active, enjoying yourselves, rather than being off "cooling your ears" in a capsule somewhere!

Thank you!

Medical Ethics in Cryonics

H. Keith Henson and Arel Lucas

You know it is going to be a rough day when you start by looking up from the bottom of a Pizer tank. — Anon.

At a recent cryonics meeting one of us (Arel) talked to two Alcor members who were considering taking Emergency Medical Technician (EMT) training as a step in the direction of becoming Alcor Transport Technicians. Both of them in separate conversations made statements to the effect that they thought EMT training would not be very useful because (paraphrasing) "what could you do wrong? The people they would be working on for Alcor would already be dead."

A prominent cryobiology researcher was horrified when he happened to overhear one of these conversations. I (Keith) was assured that one of these two came away from the resulting conversation with a very different viewpoint from the one that he started with. However, in the press of the meeting, one of them got away. While the one who got away seems to have been joking, there may be others out there in the membership with similar ideas. Since we certainly want such views corrected before any of them work on *us*, we decided to describe medical ethics and practice as it has been adopted by Alcor.

In spite of the "legal death" requirement, Alcor suspension patients are *not* dead in any meaningful sense of the word. Consider the last suspension. Our patient underwent an (almost certainly) reversible cardiac arrest as a result of dehydration. When that happened, the transport team restored circulation (mechanically) and breathing and forced IV fluids into him. This process would have a good chance of restoring *consciousness* if it were not combined with drugs which greatly reduce brain metabolism. After that, we cooled him and did a blood washout. Is this irreversible? Hardly: Alcor has recovered dogs after many hours of cold bloodless perfusion. All it takes is to warm them up and replace their blood.

Is the cryoprotective perfusion step irreversible? No again. The people working on organ preservation routinely load and unload organs with cryoprotectant levels similar to what we are using, and the organs resume functioning when they are unloaded and reperfused with blood. How about cooling? Dr. Suda (see Dr. Perry's article in the April *Cryonics*) found that cooling to -20°C for 5 days does not damage a cat brain beyond its ability to produce nearly normal brain waves after rewarming. So, at least until a patient goes below -20°C, the evidence is strong that all steps could be reversed and the patient could recover consciousness. (Doing this to a terminal patient would, of course, be a cruel and meaningless extension of pain and misery.)

It is certainly true that our patients are badly injured. So badly injured (by disease usually) that current medical practice has no way to extend their lives (at least with any quality of life). But this is *far* from saying that a patient is beyond sustaining further injury. In fact, by the very nature of the process, our patients are ***uniquely vulnerable*** to injury, especially to ischemic injury during the earliest stages of the suspension process when their metabolic rate is still high. (The colder a patient gets, the more time you have to correct a situation as it develops.) Mechanically taking over ordinary life-sustaining processes — oxygenating and pumping blood, controlling temperature, pH, glucose, and electrolytes — is a difficult task, and if it goes wrong, the patient can be seriously damaged. A functioning organism maintains these automatically. I (Keith) got a sample of just how intense a task it is to maintain the correct levels on the last patient when I was in charge of sustaining him on intermittent flow on the MALSS (Mobile Advanced Life Support System) cart for several hours.

Dr. Suda found that cooling to -20°C for 5 days does not damage a cat brain beyond its ability to produce nearly normal brain waves after rewarming.

What happens if we fail a patient? It depends on how much damage we do — and we do not know exactly where the damage limits are. Like Humpty Dumpty, all the king's nanotechnology will not bring back a patient's memories and personality beyond some point. We try to do as little damage to the patient as possible, guided by our experience in recovering total body washout animals. If you take EMT training you will learn that any time patients receive IV fluids they can be damaged by air entering a vein through the IV set. Air blocks blood flow through the smallest capillaries, so some section of the blood-flow path gets clogged when a patient is given air. Air in the arterial side of the flow is even more serious. (The lungs filter out bubbles in a vein before it gets to the brain.) A bubble of air into the brain from a mistake in operating the perfusion machine is known to cause multiple strokes and seizures in experimental animals and heart bypass patients. It blocks brain perfusion in suspension patients wherever the bubbles lodge. We are unhappy to report that two of the last three patients have been given IV air (fortunately in small amounts), and it's possible that the last patient received arterial micro-bubbles toward the end of his cryoprotective perfusion, if any got through the filter. (Though the filter producers assure us that this is vanishingly unlikely.)

In addition, there is a complex regimen of medications Alcor gives to reduce/reverse tissue damage from low or absent blood flow and to keep the patient's blood

from clotting and closing off the circulatory system. Failure to give these medications in the proper amounts at the proper time may cause tissue injury or result in blood clotting. Tissue injury or failure to keep the circulatory system open seriously compromises our ability to introduce cryoprotectants. This damages the patient because freezing injury is a lot worse if we cannot reach the desired cryoprotectant levels. A procedural error by the surgeon on the last suspension prevented us from reaching the target cryoprotectant level (though we came very close).

Alcor Transport Technicians are expected to use EMT and paramedic methods to stabilize a critically ill patient in a presuspension setting.

In short, we are performing a very critical service for patients who are inherently unstable. We are attempting to stabilize them in the same way that emergency medical technicians do their best to stabilize accident or disease victims in what is known as the "prehospital setting." Alcor Transport Technicians are expected to use EMT and paramedic methods to stabilize a critically ill patient in a presuspension setting. After watching patients stop breathing and be pronounced legally dead, we can tell you for certain that no visible transition takes place in that person at cessation of breathing and heartbeat. There is a slow process during which these vital functions slow to a stop, a gradual, damaging decline which team members itch to block, but in which we can not intervene until what EMTs call "crossover" is accomplished.

Crossover is a transfer of care based on medical ethics. Medical ethics and the practice of those ethics has a history going back to the Greeks. It has generated a hierarchy of medical authority, directly related to the level of education and experience of the practitioners. This hierarchy, the specialties of the practitioners, and the needs of the patient determine (without argument) who is in charge of the patient's care. Two doctors may have training and experience that is equal in length, but in different specialties. An endocrinologist would be expected to hand over a diabetic patient normally in his care to an orthopedic surgeon (or even a resident) for treatment of a broken limb.

This does not break what is called the "standard of care." But if the endocrinologist called in someone with a first aid certificate from the waiting room and told *him* to take care of the patient's fracture, that would break standard of care. Why? Because patients are always handed over (crossover) to those more skilled in caring for the patient's current needs. It would be an exceptional doctor of any specialty who did not know more about treating a broken bone than someone with a first aid card. Individual care in critical situations may be "handed off" to those less skilled only if the caregiver cannot meet all the patient's needs, and the skill or skills being handed off can be explained and done on a transient basis. For instance, an EMT can ask a bystander to put pressure on a bleeding wound while she attends to more skilled functions. The same EMT could not ask a bystander to spike an IV bottle or place a splint without breaking standard of care or even being judged to have abandoned her patient.

Does this apply to cryonics? It does at Alcor. When we are needed (after pronouncement of legal death), our skilled specialty Transport Technicians jump to the top of the heap of the medical hierarchy for that patient. The attending doctor (or pronouncing nurse), whether he or she recognizes it or not, is performing a crossover, as though from paramedic to emergency-room staff, or from general practitioner to specialist. Although the law regards us as experimenting on dead bodies, as far as we are concerned we are *the* critical-care, trauma-center specialists who take over when all other medical authority has given up. We should add that doctors very often *do* recognize our sudden authority. This was why they stood back in awe as an Alcor trained Transport Technician started CPR and administered transport medications to his mother. The doctors were impressed enough in the professionalism they saw to refer to her continuing treatment as *cryonic therapy* in their discharge summary.

When we are needed (after pronouncement of legal death), our skilled specialty Transport Technicians jump to the top of the heap of the medical hierarchy for that patient.

Just like first-on-the-scene EMTs, Transport Technicians have to stabilize a critical patient whose heart and breathing have stopped. We do it by paramedic methods — giving oxygen, cardiac support, and intravenous fluids. At that point we have only bought time, and not much of it. Pounding on the chest with a cardiac thumper cannot be done for long. In tens of minutes the lungs will fill with fluid and lose the ability to absorb oxygen. As quickly as possible we must accomplish a femoral cutdown and put our patient on cardiac bypass.

This is a skilled procedure by any medical standards, well beyond anything EMTs do. There are *lots* of places to make serious errors which may result in great damage to our patient. Besides the lungs filling with fluid, there are other reasons to put a patient on cardiac bypass as quickly as possible. Poor blood flow results in ischemic injury and breakdown of the patient's tissues. The best mechanical CPR does a comparatively poor job of providing blood flow, and even emaciated patients cool slower than we would like despite being immersed in flowing ice water.

There is a major crossover in patient care when the patient is put on bypass. The "head end" crew turns off the HLR and is released from their critical job of providing blood flow and oxygen to the patient's tissues. These functions are taken over by a blood pump/oxygenator/heat exchanger circuit which now requires monitoring as closely as a similar circuit being used on a heart bypass patient. The cooling rate greatly increases with ice-cold blood flowing in the circuit and through the patient. When the patient reaches 12-15°C, blood (essential to this point) becomes a liability. The red cells start to stick together and clog the smallest capillaries. Fortunately, the reduction in metabolism caused by cooling, coupled with the fact that cold water holds more oxygen, allows a blood washout (with Viaspan or similar fluids) to be done. At the end of washout it is possible to pack the patient in ice and ship to Alcor, though we get better results by maintaining

patients on low flow if the patient deanimates within the area we can service by MALSS/ambulance. The patient is still critical, but deterioration has been slowed so we now have up to a day to get him/her to the next stage of care. Our patient is still quite vulnerable. Being lost in airline freight would be a disaster.

Crossover happens again when this critical patient is delivered to Alcor, cold and (ideally) on artificial circulation. The patient is still unstable, but with each transition she has gone to a lower plateau of urgency, becoming more stable, less subject to rapid tissue damage. Notice that in Alcor, as in medical circles, care of the patient is being handed to more and more skilled practitioners, with the first stage stabilizing technicians (like EMTs) handing over care to technicians trained in surgery and bypass perfusion (like emergency-room personnel), who hand over care to those who do the complex cardiac surgery and cryoprotective perfusion in Alcor's operating room (like hospital personnel).

Cryoprotective perfusion completed, the patient is monitored over a period of a day or two to reach the temperature of dry ice, and over several days to a week to reach final temperature, -196°C. Eventually, care of the cold, now stable patient (at liquid nitrogen temperature) is handed over to personnel skilled in cryogenic management for the remainder of the patient's trip to the future.

While the level of effort required to maintain a patient is greatly reduced when he or she reaches final temperature and is placed in storage, the responsibility is truly that of life and death. Everybody recognizes that a patient warming up to room temperature would be lost — and as Dr. Perry discussed in his recent articles on the subject, a number of them *have* been lost at this stage (though none of these were Alcor patients).

In medicine, as a patient becomes more critical, standard of care always goes up, not down. Crossover goes from less skilled to more skilled — although this may include transferring the patient to care which takes less training, but is specialized for the patient's needs at that time. (For example, a stable patient may be sent to a nursing home, which is a less skilled facility than a hospital, but better suited to the patient's needs at that time. The same is true for a critical patient who is sent home to die — at some point a hospital may become the wrong place to take care of a patient.)

That puts Alcor personnel in the position of being the most skilled and specialized, the most critical people in a terminal patient's care. It puts us in the position of being able to do ultimate harm — or (if this whole business works) a near ultimate amount of good. If you decide to take EMT training as a preliminary to Alcor transport training, pay close attention to the medical ethics in the course. If the responsibility you are undertaking does not wake you up in the middle of the night, you just don't understand.

Southern California Alcor Chapter Forming

Mike Darwin

Sometimes it takes an outsider with a fresh perspective to make a suggestion so obvious and important you can't believe you didn't think of it yourself. Such was the case when Canadian Alcor member Paul Wakfer arrived at Alcor in Riverside a few months ago and suggested that there be an **Alcor Southern California Chapter.**

My first reaction was "why on earth does Alcor need a Southern California chapter?" After all, Southern California is where Alcor's primary facilities and administration are located.

But as Paul pointed out, the "Alcor staff" are busy serving *all* the Alcor chapters and as a consequence don't have the time or resources to focus on the special needs of the locals. This has become increasingly true as the administrative load has grown at Alcor headquarters and as the local Southern California members have come increasingly to rely on paid staff rather then volunteering to help out themselves.

The result has been that many things that could and should be done to improve suspension readiness and improve member recruitment in Southern California (such as maintaining a supply of crushed ice in constant readiness, or having more local people trained to respond to an emergency (if Alcor *staff* are out in the field doing a remote case) just haven't been done.

If there was any doubt about the importance of having an independant Southern California Chapter of Alcor, that doubt should have evaporated with the recent discussion of Alcor moving out of the basin and possibly to Arizona or other parts unknown. It doesn't take a genius to realize that if Alcor Central leaves, Southern California will be left with a degraded emergency response capability. Unless...we do *something* now.

For this reason several of us locals (Paul Wakfer, Saul Kent, and of course myself) have decided to set about forming a Southern California Alcor chapter. To this end, we have decided to meet on the weekend of Sunday, 26 July at 1:00 PM to begin organizing Alcor Southern California and discuss some early goals for training and equipping ourselves to prepare for Alcor Central's possible (probable?) departure.

Those interested in attending this inaugural meeting of ASC should RSVP Saul Kent so that the hosts (Bill and Maggie Seidel) will know about how many people to expect. Contact information and meeting location are provided below:

WHAT: Alcor Southern California Chapter Inagural Meeting
WHEN: 26 July, 1992 at 1:00 PM
WHERE:
The Home of Bill and Maggie Seidel
10627 Youngworth
Culver City, CA 90230
RSVP: Saul Kent at (714)780-3252

See you there!

P.S. We're bubbling over with ideas and we're very excited about the prospects for getting some local action going. Please, if you have concerns about suspension readiness in Southern California, COME TO THIS MEETING!

How We Are Not Computers, And What That Means

Thomas K. Donaldson

This article, while not a book review, does depend strongly on two particular books, *Artificial Life* (ed. CG Langton, 1989) and *Brain Organization and Memory* (ed. JL McGaugh, NM Weinberger, G Lynch, 1990). My discussion comes from my own thinking, but one article from each book has particularly influenced me. From *Artificial LIfe*, S. Hameroff and his colleagues argue (p. 521) that we should not take nerve cells as simple computational units. Even single cells have complex abilities. Nerve cells, and even signal transmission between them, has much more complexity than a stream of single bits. Hameroff reinforces that point. Second, the article by WJ Freeman and CA Skarda ("Representations: Who Needs Them?" p. 375, *Brain Organization and Memory*), helped me clarify my own thoughts about brain models.

The computer model

The idea of brains as computers has become very popular. It lies behind the idea that someday we will upload (download?) ourselves into *other* computers somehow better than the wetware one we work in now. It also underlies a lot of mainstream theory about how our brains function: cryonicists believing a computer analogy have many other scientists to point to for support. If our Selves are computer programs, uploading becomes trivial. Before anything else we first need to clarify just what a computer program and a computer are supposed to be. For the purpose of this article, I shall consider programmability as the main feature distinguishing computers from other objects. A program is a combination of instructions and data which controls the operation of the object. If that object is a computer, then means exist by which a wide variety of different programs can (at different times) control its operation.

Clearly devices (and living things) fulfill this criteria to greater or lesser degrees. Even within the class normally accepted as computers, some may be unable to perform a set of instructions because memory capacity is too small. Performance of instructions, in general, requires not just ability to compute but peripherals such as monitors, printers, and disk drives. And some devices often thought (perhaps loosely) to be computers cannot run a wide variety of instructions (ie. embedded devices each with one single program burned into its ROM). So no object can lie at the (theoretical) end of the computer side of the rainbow. As for the other side, for objects totally unable to perform any separate instructions, rocks or stars fit that description very well. Perhaps some living things do also.

The analogy of our brains as computers suggests many common ideas. Behind it lies an image of human brains as objects which are all, fundamentally, identical. They differ only in the programs they are running; these programs are Persons, everything that makes you You.

Again, computer programs operate on Data. Data is always a *symbolic representation* of some part of the real world. By the computer analogy when we remember our home town, then, we do so by forming a symbolic representation of it in our brains. We must distinguish the symbolic representations we use in talking to one another from those in our brains; most mammals are quite inarticulate, but somehow find their way around their environment. A computer analogy for their brains would suggest that they too have such symbolic representations. If our brains *do* work as computers, such representations become essential to their operation.

Furthermore, in principle we might devise ways to transfer specific memories between one person and another. The language of the symbolism may differ from person to person; but with the proper translations that becomes a detail. A computer analogy implies that training of any kind might someday be compressed into a few hours on a "brain trainer." It also causes us to spend special attention on these supposed symbolic representations. The ability to manipulate symbols becomes identified with intelligence itself. This body of ideas about how our brains work ties in very well with such efforts as Chomsky's, to explain our spoken language as a form of translation from a private symbolic representation to a public one.

It has become, in short, the dominant image of brain operation in the late 20th Century. Dominance, however, does not make it correct.

One major theme in the study of memory has been the idea that learning (even in adults) involves the very same processes by which our brains develop from embryos.

Another and different analogy

We can already see signs of another quite different idea. I shall call this model for memory the Growth Model.

One major theme in the study of memory has been the idea that learning (even in adults) involves the very same

processes by which our brains develop from embryos. That is, remembering something *long-term* means that our brains have formed new physical connections between neurons; these connections persist by the same processes maintaining our physical form. This idea easily answers one major question about long-term memories: why are they so durable? No one knows a way to destroy a memory without physically destroying neurons involved in it.

Processes of development also include healing. True, neurons in adult primates may divide only rarely (although some experiments suggest the contrary). But healing in our brains includes more than simple division: it can involve massive rearrangement of circuits, as in recent (unplanned) work with monkeys with severed nerve connections to their hands. Development involves not only passage of signals between neurons which already touch one another, but chemical signals causing growth of a dendrite or axon toward a neuron not within "touching distance."

Any dominant analogy creates an impression that no other possibility can even exist. Yet, if followed out, the developmental hypothesis just sketched above suggests very different conclusions about how our brains work.

First, *long-term* memory forms when our brains grow a set of new connections. These connections would contain new synapses. Hence (contrary to other estimates based on a computer analogy) to estimate our capacity for new memories we must do more than count nerve connections. A maximum capacity *would* still exist, reached when present connections left no room for more. How that might happen remains an open question: perhaps simple crowding, or again single neurons might only support a limited number of connections.

Furthermore, our long-term memories would *consist of* the connection patterns that have grown up between our neurons. They would not be "coded" into our brains, in any sense of "code." On a gross level our brains *do* resemble one another; but when we find out how to look at a brain closely enough to distinguish memories, we would find these memories identical to the connectivity itself.

This model resembles the neural net computers that computer scientists now use, successfully, to make machines to solve problems our brains do easily. Neural net computers don't store their memories in any one connection, but in the pattern of all their connections. In this way they resemble our brains. But neural nets start with a fixed set of *possible* connections, some of which are turned on, others off. Unlike neural nets, brains would form memories by growing *new* connections. Disused connections would disappear.

Our thinking would also proceed totally without any *symbolic* relation to the world. Instead, our nerve cells have grown connections so that their total response to any outside event deals with it successfully. (Note that neural net computers, too, do not use any symbolism in their computation: in this way they follow brains.)

Learning, in this model, involves growth, which takes time, energy, and materials. Already our brains burn a large share of the calories we eat, as high as 40%.

Such systems resist any easy transference of "programs" from one to the other. In that sense they aren't computers. (Although we certainly can imagine some massive intervention which reconnects an entire brain. As before, "computerness" is a matter of degree.) Nor could we make learning easier simply by separating out a set of skills and knowledge and then reading it into our own brains, for no single memory can be separated from any other. And even if someone else could follow all the excitations in your brain for every neuron and synapse, they would need a long prior period of observation to read off from them just what it was that you were thinking. . . other than in the very broadest sense. (That is: whether you are sleeping or awake, you are thinking something about food or sex, you are afraid, etc.)

Directions for use

If our brains follow the Growth Model, some common ideas about possible improvements would require rethinking. Simple transference of our Selves from one body to another ("Uploading") raises far more problems. Improvements in learning ability, or transference of particular skills or knowledge, do also. But here are some ways towards the same aim.

Preservation of alternative copies

This technology should interest every cryonicist. By storing inactivated copies of ourselves we can survive total destruction of our main, living copy.

Even if we are not computers, our structure might perfectly well be stored *in* a computer system. Graphs give the main data structures needed. We would store each connection with additional information (just what isn't fully known yet: transmitters used, its age, and possibly other items).

The practical problem to solve for such a system is how to read out brain connectivity as rapidly as possible. Fast read-out rates let us frequently update our stored copies. If you have not been updated in the last 10 years, then any destructive accident would mean a loss of 10 years. One idea would be to add a system of "watchdog molecules" to each synapse; these shed copies of themselves constantly. They might then be gathered together to find how your brain has changed.

Increase in memory capacity

No one yet has faced this problem, but at some stage it will arise. I believe the most likely brain response (by our unmodified brains) would be to forget all information least used, rather than to simply stop learning (some neural nets already do this). In the Growth Model, synapses between neurons would disappear.

Basically, increased capacity requires unwieldy increased storage space. Miniaturizing brain circuits (while keeping the same connectivity system as before) only puts off the problem. True, you might separate your "extra brain" from your main brain. But even if your "extra brain" connects with your "main brain" at the speed of light, your memory will fade significantly if you even go to the Moon.

We can still add off-line storage space, relearning older memories when needed. Relearning, of course, involves growing new connections.

Note that the same problem arises with neural net computers. One other point needs stress: despite the limits, by miniaturization and larger brains we might increase our capacity by at least a factor of 10. That is still very worthwhile.

Increase in learning speed

Learning, in this model, involves growth, which takes time, energy, and materials. Already our brains burn a large share of the calories we eat, as high as 40%. To cut down energy and materials expense, we might first use miniaturization. After that, we might add a special cooling system, perhaps an extension of our present cerebrospinal fluid. Our blood would bring more materials and also take away excess heat. For temporary periods of learning at very high rates, we might also imagine special "Learning Stations" to rearrange our brains, allowing not only increased blood flow but cooling solutions.

What about increasing "intelligence?" But just what does "intelligence" consist of? Besides ourselves and other animals, we now have computers, capable of spectacular feats of processing on some problems and spectacular stupidity on others. Even other animals can do processing we cannot (dolphins and sonar, for instance).

The lesson of these examples is that many different kinds of brain processing exist. In the end, we will want some increase in our learning ability, but rely on many different systems for other kinds of processing. These would connect to us in detachable ways, more or less like present computers. We may even develop special interfaces to attach to them, much as our hands attach to our machines; but they would still remain apart from us. Hands were a good idea and remain so. (The problem with making *any* kind of ability a permanent part of yourself is that you may not always use it: one more piece of baggage. With too many additions you grow too fat, metaphorically and actually).

Why not move ourselves over into computers?

Some would say that by doing this we would become essentially different, and so lose our Selves and our personality. That may be so, although I know no logical or experimental means to find an answer. Instead I will discuss one major *practical* reason why a growth model may have prevailed for brain design.

I shall discuss only neural net computers since, so far, they alone can do some kinds of learning needed. Suppose then a neural net computer with the same capabilities as our brains in all respects. Neurologists have classified about 100 or so different processing regions in our brains, each one a neural (sub)net. The advantage of a neural net computer (with fixed connections) over a brain would be that all connections had been grown in advance. (Even at start this "advantage" may mean little: short-term memory allows a temporary learning until growth has finished. That may even be its explanation.)

With 10^{13} neurons in each processing region, each neuron needs 10^{13} synapses to make all possible connections. (Neurons now have a maximum of about 1000 connections, within a factor of 4.) Let each connection cover only 1 nm^2 of surface. Total area of all connections becomes 10,000 $meters^2$, or 100 meters on a side, for only *one* neuron. A brain designed this way carries along one billion (10^9) times the mass it actually uses. What about virtual connections? That merely turns one kind of unused capacity into another (virtual connections use other neurons to transfer impulses, invisibly to sender and receiver). Virtual connections may not even work: direct connections between neurons must exist for a reason. (This is an argument valid for both silicon and protoplasm).

If we try to limit connectivity a priori we find another problem. By limiting possible connectivity, we limit the kinds of connections our brains can make. Given that all new connections form on a background of the old, this means a limitation on connections between responses. Brains with fixed connectivity, then, will lack adaptability.

These two factors, combined, may tell us *why* our brains operate by growing new connections rather than staying solely with the old. Yes, growth takes longer. But it may also support our mental flexibility, which is still far more than any computer and may remain so. Perhaps someday we will modify ourselves to even more flexibility. We can see now how to do so.

Reviews

Set No Limits

edited by RL Barry, O.P., and GV Bradley

Reviewed by Thomas Donaldson

Daniel Callahan, a "medical ethicist," published a book in 1987 called *Setting Limits*. In it he explicitly argued that medical care and even medical research should be limited to the problems of people under the age of 70 (the point is the limit, not the particular age). Particularly as cryonicists we are all very familiar with the reasoning behind his proposal: more and more people survive to high ages, not as healthy human beings but as miserable shells of what they once were. The cost of supporting them keeps increasing. So therefore (Callahan claimed) we should all decide to put an end to such support after a given fixed age. (Perhaps we might give the old a bit of food and water, and aspirin for their pain. But we would not devote any serious medical effort to them.)

Naturally his argument took no account of possible future advances, in gerontology (finding ways to slow or actually reverse these effects of aging) or (as expected) cryonics. Callahan's ideas have not been worth discussion in cryonics circles (aha! so a "medical ethicist" is someone who tries to think of moral ways

to kill people). But I read this book because it claimed to be full of arguments *against* Callahan's thesis, and I wondered about the extent to which "medical ethicists," or anyone else thinking about this age problem, might have worked out for themselves that we need not simply put up with aging at all.

In one way I found it fascinating to read, and in another very sad. *Not one* of the contributors showed any awareness at all of the possibilities even now inherent in deprenyl and HGH, nor of the near-future possibilities of much stronger methods using genetic engineering. They took as an unquestioned axiom that we must grow old, sicken, and die. And cryonics of course lay completely beyond their horizon. I won't use this article to present arguments in favor of either gerontology or cryonics. But clearly both give a strong criticism of this kind of thinking and the problems it creates, and the only *solutions* likely to succeed.

So this book review may simply tell readers something about what *not* to bother reading. On the other hand, it may give some insight into the psychology of all those people who do *not* understand either anti-aging or cryonics.

First of all, not one writer raised any problems with the central notion of "life." All (except one) took as an axiom that we must preserve "life" so long as it continued to exist. (The other one, an economist, studying the economic processes by which we allocate medical care, didn't need any notion of "life" for his analysis. His article was also the most illuminating one.)

When we make any definition or redefinition, of course we cannot do so arbitrarily. Our difference in definition from the normal one goes farther than simply the definition of "death." There is a definition of "life" that specifically does *not* include the present human pattern: being born, childhood, education up to age 20, marriage, raising children, working. . . then dying. That pattern of life simply could not persist if people had lifespans indefinitely long.

One reason why none of the participants even thought of immortalism may come exactly from an *unconscious* feeling that an immortal person could not remain human at all. I'd like to know how much others have discussed that specific issue when talking about cryonics to those who are not cryonicists. I still remember the comment of a colleague at ANU when I was teaching there: immortalism had bothered him "until," he said, "I realized that it's just a change of scale." (Though it is *not* simply a change of scale!).

Logically, people who are put off cryonics by the changes it implies are not being so completely foolish as it might seem. We too would refuse to give up some traits *permanently* just to live forever. Suppose for instance that we found some way to make a computer imitate you in all respects, *without* at the same time having any personal awareness? If we turned you into that computer, your consciousness would end. . . even though something would persist that seemed to everyone else the same as you. Or suppose again that we found a way to make you turn into a bristlecone pine; you would certainly, then, live a long time. (It's important here that the loss is *permanent*. . .we would all give up many things even for centuries if we knew that eventually we would regain them.)

There is a definition of "life" that specifically does not include the present human pattern: being born, childhood, education up to age 20, marriage, raising children, working. . . then dying.

I do not intend for these comments to excuse the authors of this book. Their problem lay not in an *explicit* choice of what must be valued in "life" but from a total failure to think out their own feelings about "life" itself. (Although perhaps if they had done so they would have come to different conclusions, and even some insight. And just perhaps they would have noticed immortalism and cryonics.) One interesting point about most of these articles comes from just this failure: in many ways their argument echoed that of anti-abortionists: Human beings can be alive, even without any prospect of awareness. Human life must be preserved. Therefore. . . .

The economist, Laurence DeBrock, had some quite different arguments, which actually shed a bit of light on what was going on. In the first place, economics deals with scarcity. We must all face the fact that no good is free. But no one (including DeBrock) would claim that this scarcity itself is a *good thing*. Any increase in our medical care is a good; one major way to increase that care (this is not a quote, but follows DeBrock's argument closely) consists of technological advances, which provides higher levels of medical care at the same cost.

Most of DeBrock's argument, however, dealt not with the potential of technology (so much a given that he didn't really consider what that potential might be in the case of medicine). It dealt with market failure. In economics a market failure is a situation in which the person choosing to buy something does not incur a cost corresponding to that incurred by others due to his/her purchase. One key feature of medical cost, as funded in the U.S., comes precisely from market failure.

In real terms, available medical care always remains limited. Somehow a choice will be made about who receives it. That choice best involves *price*. That price need not be the same for every user (this opens the possibility of aid to poorer people); what is important is that every user must incur a cost somehow graded to the amount of medical care they buy. This is a summary; DeBrock has a good deal more to say. Most of all, DeBrock was the only author who did more than simply refuse to accept Callahan's proposal.

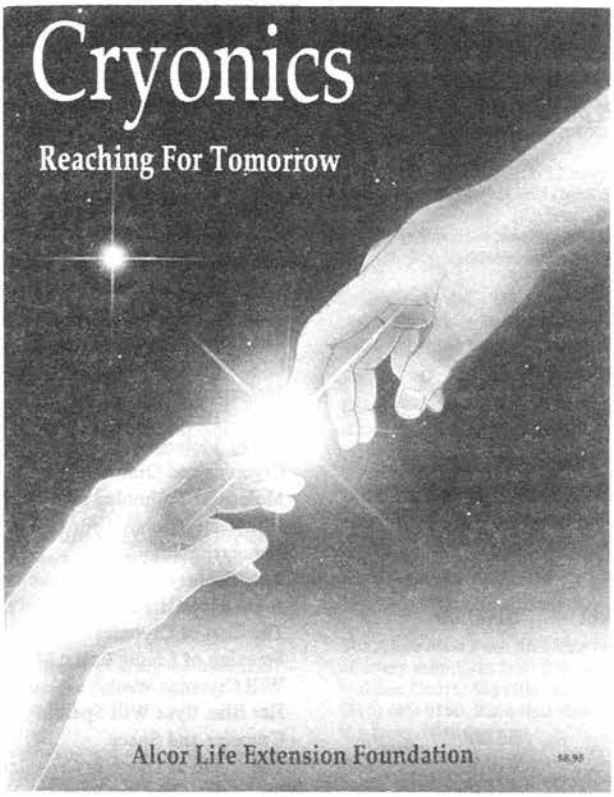
All others argued, one way or another, that "human lives" should not be abandoned regardless of all questions of what that "life" actually is and means. That dumb unreflectiveness, most of all, prevented both Callahan and his critics from seeing all the possibilities which lie so clearly before them. It is also what Ettinger has referred to as a monumental stupidity. And it may ultimately lead to still greater problems with American health care. . . and the deaths of many people who go blindly to their ends, not knowing of any other.

Cryonics Is. . .

Low-temperature preservation of terminal patients when medicine is unable to heal them. This treatment is called *cryonic suspension*. The goal of cryonic suspension is the transport of today's terminal patients to a time in the future when cell/tissue repair technology is available, and restoration to youth and health is possible — a time when freezing damage is a fully reversible injury and cures exist for virtually all of today's diseases, **including aging**.

It is our belief that if human knowledge and medical technology continues to expand in capability, people with conditions that would cause them to (incorrectly) be considered dead by today's medicine will be routinely restored to life and health. This coming control over living systems should allow us to fabricate new organisms and sub-cell-sized devices for repair and resuscitation of patients who will have been waiting in cryonic suspension.

There is already substantial scientific evidence available that current suspension techniques are preserving memory and personality — and that the repair and resuscitation technologies we envision will be developed within the next 50 to 150 years.



Non-members may call toll-free (800) 367-2228 or write (see reverse for address) and receive the book, *Cryonics – Reaching for Tomorrow* for free (regular retail price: $8.95, member price: $5.00.)

Alcor Is. . .

The Alcor Life Extension Foundation: a non-profit tax-exempt scientific and educational organization. Alcor currently has 17 members in cryonic suspension, hundreds of Suspension Members — people who have arrangements to be suspended — and hundreds more in the process of becoming Suspension Members. Our Emergency Response capability includes equipment and trained technicians in New York, Canada, Indiana, and Northern California, with a cool-down and perfusion facility in Florida and the United Kingdom.

The Alcor facility, located in Southern California, includes a full-time staff with employees present 24 hours a day. The facility also has a fully equipped and operational research laboratory, an ambulance for local response, an operating room and the world's largest and most technically advanced cryogenic patient storage facility.

All Alcor Directors and Officers are required to be full suspension members.

Call toll-free (800) 367-2228 or write (see reverse for address) for the free book, *Cryonics: Reaching for Tomorrow*.

Table of Charges and Dues

Sign-Up Package: $100 (certain limitations apply; call 1-800-367-2228 for details)

Whole Body Suspension Minimum: $120,000

Neurosuspension Minimum: $41,000

Outside U.S. Surcharge: $10,000

Annual Adult Dues: $288.00

Additional Adult Family Member Annual Dues: $144.00

Additional Family Member Child's Dues (under 15 years of age): $72.00

Adult Student Annual Dues (must be full time student): $144.00

You can tour the Alcor facility in Riverside, California under the expert guidance of the Alcor staff. The facility is open to small groups (15 people or less) who wish to learn how terminal patients are placed into suspension and how they are cared for at -320°F.

The Alcor tour also features a discussion of the scientific evidence that patients in cryonic suspension have a realistic chance of being restored to life, health, and youthful vigor as well as a fascinating exploration of the advances likely to come in the 21st century and beyond. The tour provides an invaluable opportunity for you to have your questions about cryonics and the prospect of an extended human lifespan answered.

The Alcor tour is free of charge. If you'd like to make arrangements, call (800) 367-2228.

Yes, I want to make cryonic suspension arrangements with Alcor. Please send me ____ Sign-Up Package(s).

Name_____Age_____

Address_____

City_____State_____Zip_____Phone_____

I understand that an Alcor Sign-Up Coordinator will contact me at the above number.

Sign-up fee: $100 per person.

☐ Payment enclosed (check or money order). ☐ Bill me.

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