Panel Discussion

Hirsh Cohen: We've successfully covered most of the general topics that have been brought up at sessions like these without getting to the spiral of science and technology and the pace of progress. I want to have a short crack at that, and then we'll let the master, Leon Lederman, see whether any of us have passed whatever test he had in mind.

There's been a lot written recently about the fact that we are moving technology much faster from the scientific laboratory through the technology phase and out into the marketplace. That is sometimes true. As in science itself, there are many, many frequencies and many, many time scales in this process. Some of those time scales are long periods and some of them are short. If you think high-temperature superconductivity just appeared, or even that the superconducting magnets made here at Fermilab just appeared, let's remember that the concept of superconductivity was first observed in 1911 in Holland. There followed a very barren period of almost 70 years when nobody could figure out what to do with superconductivity. The people that tried, like one small company named IBM that tried twice to make computer chips out of superconducting materials, found out it was hard to capitalize on.

Look at the transistor. Invented in 1948, it appeared in radios in a few years, and in 1956 in computers. I think I understand why and you probably do, too. There was a very direct mapping from the transistor onto the radio tube. The market and the use were there, and the consumers were there, and RCA and GE and other companies knew how to exploit the technology.

Or take lasers. I don't know what your favorite laser is, but mine is the semiconductor laser because IBM and GE invented it on just about the same day in 1962. Those lasers have been around for 25 years. They're just now coming into use because they had to wait for optical fibers and the kinds of speed that computers and communications require. When lasers were introduced, there wasn't any mapping from a new science directly onto an optical product. I doubt very much whether anyone knew that we were going to go blasting onto people's retinas with the laser. Let me give you one more example: photo-

voltaics. We've done pretty good science in that area, but photo-voltaics aren't in widespread use because there isn't a marketplace.

This pace of progress, and this movement from science to technology, really does have a lot to do with whether there is a consumer available. But the press this year has been giving us the impression that everything is moving along faster than some things really are. Each of you has a guess as to where high-temperature superconductivity is going to land. My own prediction is that it will be in places that none of us have thought about yet.

I think Joel Goldhar hit it right on the nail when he talked about the product cycle. That is an absolutely fundamental change. The thing that I didn't hear Joel say, but which Lee Rivers talked about a bit, is that our product developers have to learn more about the hunt and search process. In my business, and in a lot of businesses, we get a product pattern going and we really know the technology of that area. What we don't have are all of the other inputs from new science and technology because we don't have time. We're under pressure, the product isn't getting out the door, and we have to pull people away from whatever advanced technology we have going. That goes on all the time. But that search for the new science and new technology, that sort of enlightenment at the product development phase, has to go on all the time in a highly competitive technical product business. If you're in a company with a research lab, and a product development group, and advanced manufacturing, then there are people in your own company who are supposed to be doing that for you.

How do the great national laboratories, such as Fermilab and the other DOE lab, get their scientific results, and what potentially marketable technology falls out of the work they're doing? That was the subject of the panel that I chaired for the Energy Research Advisory Board during the past year. One of our observations is that it's very difficult for a lab like Fermilab to connect to companies. This effort that's going on today is a reasonable way. I think there are better ways, but it's not clear to me that labs like Fermilab, and the Princeton Plasma Lab, and maybe Brookhaven can do that as well as Oak Ridge, and Argonne, and a few other places. The recommendation that our panel will give is that those labs that have the skills and capabilities to plan scientific research that can yield technology transfers should also focus some fraction of their work on particular industrial sectors. What's happening now is that what is transferred

out of Fermilab is what we've called spinout. Fermilab is not planning for a potential consumer to use this spinout technology the way companies' research labs plan technology for their own product people. Some of the DOE labs can do that because of their backgrounds and management styles and the way they undertake their missions, and some will have a more difficult time.

That's one of our recommendations - this focusing effect. There are examples. Argonne and their Idaho lab are trying to work with the midwestern steel industry. It amazed me to find, in the *Commerce Business Daily*, a request for procurement from INEL, the Idaho National Energy Laboratory, for research and development proposals from industry on foundry research. Other labs like Oak Ridge have begun to be an important component of the advanced materials efforts in this country. The Ceramics Center at Oak Ridge is doing some fine work. There will be superconductivity centers set up at Los Alamos, Argonne, and Oak Ridge.

Our panel will also give recommendations on how DOE manages all of this. We'll recommend a much stronger policy statement by the Secretary of Energy. We will recommend that in addition to the easing of the proprietary procedures, that contracts and agreements with industry be delegated to the laboratory manager, with certain limits and restrictions as to dollar level, so that all agreements and contracts don't have to go back up the chain to the field office or elsewhere. We'll propose that in addition to patent awards, there will be much more effort toward creating incentives for technology transfer of high value. This can be done through rewards, promotions, and additional research funding. What I'd like to see our panel recommend is a prize given by DOE for the best technology transfer effort by a group or individual at any of the DOE labs. I was amazed to find that the German Ministry of Education has just announced such a prize for German universities. If the Germans can do it, maybe we can, too.

Michael Odza (Technology Access Newsletter): Maybe some of these issues are related in terms of the problems and barriers. There is a cultural view which holds that, in federal labs and universities, one of the nice things is that you can just concentrate on basic science. You don't have to worry about applications. I've heard people at the University of Chicago say that if one of their staff found out that there was a use for something he was working on, he switched and worked on something else. On the industrial side, there's fear of

that very culture which says, how can I make a product or adopt a process if it's not going to be considered proprietary regardless of the laws or the regulations?

Steven Lazarus: First of all, you're dealing with two institutions, on the one hand the academy and the laboratory, and on the other hand the industrial enterprise, which are all in transition as a consequence of fundamental changes in the societal environment. Even though I come from the University of Chicago, I recognize the phenomenon that you describe.

But what I observed at the University of Chicago is an accommodation with an entering industrial culture. There are those at the university who find that abhorrent. There are many more at the university who find it curious and interesting. What we are discovering are positions along the spectrum that people are willing to take, and the emergence of other experimental entities, like ARCH, that operate in a catalytic fashion. The same is true at Argonne. There are folks at that lab who, given the problems of doing good science and making sure their programs survive, don't have a lot of time or interest in the issue of technology transfer. And then there are a whole host of people who are curious to see the implication and application of what they are doing. What Brian Frost and I, and others who are working on this, try to do is spot the ones who are curious and ready to participate to some degree. Then, when we're successful with those, we have a demonstration that others can observe and form their own judgments. So you're not dealing with a fixed-point situation, you're dealing with a dynamic that is very much in motion right now.

Joel Goldhar: The problem is that it's dangerous to generalize about the federal labs, just as it's dangerous to generalize about industry. There are something like 800 federal labs and other institutions doing science and technology. They're not all at the leading edge of uncovering the most fundamental secrets of matter, as is Fermilab. There's an army laboratory in Framingham, Massachusetts, that works on food and clothing. Years ago, they invented something called mud-phobic rubber. It repels mud. When you use it as a boot sole, you can walk in mud without sticking and without making noise. As far as I know, no company ever picked that up and said, wouldn't that be nice for a hunter's shoe? As a matter of fact, I'm not even sure that the army picked it up and used it, which is all right. That market may not have been big enough because soldiers don't walk much anymore. The Vietnam War was almost over,

the next war we were sure was going to be fought on the sands of the Middle East or on the fertile plains of Germany, so that when we got out of the jungles, we didn't need mud-phobic rubber.

But clearly, there are thousands of neat little pieces of technology that are available. You don't have to be a corporate version of a high-energy physics laboratory. It's not clear to me how to commercialize the quark. When we figure that out, we'll write a paper on it as all academics do. But if you go down a level within the Federal Laboratory Consortium, there are millions of ideas, even within the most basic of the labs. If all of these labs were doing nothing but basic science, we'd have a lot of basic science in this country, and it's just not true. Brookhaven National Laboratory kept appearing on the yearly list of winners in the IR-100 Awards, which are given to the cleverest new ideas of the year. I recall one, a Braille reader, that was a spinoff of some work going on at Brookhaven. Another one was a polymer that mixed with cement to create a cross-linking activity that quickened the hardening of cement and made it a better product.

When you look at a lab like Fermilab or Brookhaven, you want to look, not at their mission, but at all the things that they do in getting to the mission. The great big science projects have much of their value in the solving of the problems along the way. That's part of the science-technology spiral. For years, you could argue that technology drove science. We had engines before we had thermodynamics. We started the thermodynamics to understand why engines did what they did and how to improve them. When they improved enough, tinkerers got back into it and started to do new things. On the other hand, we are seeing in microbiology, in materials for electronic uses, and so on, new science moving the technology forward. There's a double helix in this.

Cohen: That's true. These guys at the labs are very clever and they do great things. But the gap is there and the gap is pretty broad. You have to do some experimentation with bridges across those gaps. There's not a very large payoff for the people in small or large companies to go searching through the lab literature. You have to build better bridges, such as some of the consortia or joint projects that have been created in the past several years. Those are important because they bring the laboratory together with the people in industry.

Goldhar: I'm not sure I want to close that gap too tightly. I feel the same way about the university-industry consortia. When the university gets too business oriented, it stops doing the things universities are supposed to do, which is to work on the unpopular things.

Cohen: But you've jumped to the conclusion that I want all of Fermilab to march into the gap. I want some bridges.

Goldhar: Maybe what we need are some third-party bridges.

Lee W. Rivers: That's an excellent point and I'm glad you mentioned it. I think it's particularly relevant to small-to-midsize companies. I absolutely applaud the existence of ARCH. We need to create a lot of other variations on that theme. The strength of this nation is that we don't have to find one model, we're strong enough and big enough that we can have a lot of different kinds of creative models of that bridge.

Mike, to come back to your question, since the Technology Transfer Act of 1986, for every scientist who would express the feelings that you heard today, I can find one in the federal labs who's on the phone to some entrepreneurial guy outside the walls saying, "Give me two more weeks and I'll be ready, we're going to have a commercial success on our hands." We're moving toward one another. You're not going to convert 100,000 scientists and engineers, nor are you going to convert the attitudes of industrialists in this country overnight, nor completely. I'd like to share with you the part of the speech I didn't give.

A Vision of the Future

- **Precompetitive collaboration is routine**
- **Laboratories engage in short-term and long-term relationships with businesses of all sizes**
- **A significant fraction of the technical staff in federal laboratories are on assignment from industry and universities**
- **Cooperation is strong at technical and management levels**
- **Cooperative research, development and innovation emphasizes a strategic view of future possibilities. . . with a healthy acceptance risk**

Federal Laboratory Consortium

Fig. 3.

The figure (Fig. 3) is obviously not complete, but I think it's indicative of where we as a nation should be moving, and I'll come back to a point that Joel made before. The common denominator, the one thing that's equal among all of us, Japanese, Europeans, and Americans, is that we all operate off the same 24 hours. Time is of the essence. We do not have the luxury of time. The quicker we move our institutions toward one vision, the faster we'll erode this decrease in the standard of living that is now under way. We'll be well on our way to redressing the balance of trade and we will no longer have to pay that $150 billion a year in interest on foreign debt. Time is the critical element here. We're not going to shift it overnight 100% from one direction or another. We're moving in the direction. The faster we can move, the better.

Carl H. Rosner (Intermagnetics General Corporation): This has been a most provocative and thought provoking set of presentations. They're very enjoyable intellectual exercises for someone like myself who is in a high-tech business originating from a technology-transfer experiment that was launched by the General Electric Company because the research laboratory wanted to explore whether superconductivity had any future. That was 16 years ago, and we have been struggling to make a living ever since.

I am impressed also by the fact that there exists an earnest desire on the part of the labs, the universities, and the government as a whole to address the question that's tagged by the label "national problem of competitiveness." As the saying goes, you can lead a horse to water, but you can't make it drink. Industry, as was pointed out, really isn't sufficiently interested in the management of the tremendous intellectual resource, and innovative capability, and real opportunities that exist among the laboratories and in the universities. But identifying competitiveness as a problem is really wrong. The problem isn't competitiveness. The problem is that the world has changed and the rules by which businesses, and universities, and laboratories interact has changed. I don't think U.S. industry has awakened to these changes. It may take another major setback, either by the stock market or by the economy, for industry as a whole to wake up.

In the meantime, what can we do? I would like to give you my perspectives. My feeling is that rather than searching for these global solutions and trying to find ways that benefit U.S. industry as a whole, it would be advantageous to

pick a few technologies or industries or companies. Then, collectively, with the support of the government, industry, and the laboratories, we should make those into major success stories.

The problem with trying to improve competitiveness by intellectual exercise, as I see it, is that the solution that's found here today is in Moscow or Tokyo via fax machine or a telephone call in a half an hour. The advantage of the time element has vanished. There's a vision that is required to identify the products or the technological inventions that are going to carry the day three to five years from now, because it takes that long for a sophisticated product to reach the market. Look at lasers or superconductivity. It doesn't happen overnight. So speed is not the answer. The answer, as I see it, is to really think ahead and try to determine what the world is going to be like three to five years from now, and work like hell to be there before everybody else gets there.

Goldhar: What you've just described is good corporate strategic planning. We've got a number of examples of that in the U.S. as well as overseas. To talk about it as a public-policy issue presents one small problem and that is, none of us knows anyone else whom we would trust to be smart enough to choose which of those areas or industries should get all of our resources.

Sidney Kulek (Allied Products Corporation): I don't believe that industry is asleep to the opportunities that federal laboratories have to offer. I myself have worked with laboratories in the past. What industry is concerned about is the huge amount of bureaucracy that it must go through in order to, number one, be able to talk to someone about ideas that we're interested in, and second, all the steps that industry has to go through in order to clear one of these brilliant ideas of technology transfer. That is a horrendous problem. Anytime you show an industrialist a chart and end it with two attorneys on the bottom, there are two very large red flags saying, watch yourself.

The second area of concern is the very successful Japanese approach of tying industry and the universities together with the government. Our problem in this country is that we are waiting for the government or some congressman to have the wisdom to do this. Instead, I think the idea would have to come, not from the government, but perhaps from a consortium of industry and the academicians. But if we don't do something like that, we will lose any competitive edge we might have achieved by a teaming of industry and university. We are being in-

jured economically by illegal dumping and stealing of technology secrets. Our R&D budgets are being reduced as our profit margins erode. I agree this is the wave of the future, but I don't know how we can go about doing it. The idea is not to get Mr. Rivers to tell us what products are available to me. We have to go beyond that and say, how do you get it out of the system and how do you work together with this community to develop the things that we think we need jointly?

Cohen: We've seen an interesting example of your last point in the past year in the formation of SemaTech. That's a group of semiconductor-manufacturing companies who are fierce competitors. SemaTech got half of its funds from the Department of Defense, and half of its funds from these 10 or so companies. They're giving up some of their competitiveness to look at the development of manufacturing tools. Some of the companies are putting in a few of their jewels to get it started. That smacks of industrial policy, because the government's decided that an industry is important enough, at least to one sector of the government, to survive. If you can bear the weight of a terminology like "industrial policy," I'd like to see more of those consortia.

Rivers: The question that Kulek raised about the burdensome procedures you have to go through is not unrecognized by the federal laboratories. In fact, the General Accounting Office just completed a survey of a dozen or so major laboratories. They asked the laboratory directors, how goes it with the Technology Transfer Act of 1986? What are the constraints and impediments that you see? There were four points that the directors highlighted. One was the inability to copyright software, which is another issue. The second was the inability to do proprietary research for industry. Their recommendation is that they be able to do research that industry pays for, and maintain it as confidential information for up to a five-year period at a minimum. Third was this general question we talked about, intellectual property rights and the difficulty in going after individual waivers of rights to technology versus class waivers, a particularly acute problem with some of the GOCO laboratories. But the fourth and last one that the laboratory directors pointed out was what they called the burdensome and time-consuming procedures by which interactions between industry and the laboratories have to take place.

How are you going to solve that? Obviously, it's not an easy thing to solve, but don't look to Washington for a quick solution. Washington isn't the solution, it's mostly the problem. I think the solution rests with local people getting together at the local level. That's Steve Lazarus and ARCH, it's people working here at Fermilab. You can accomplish a lot if you get to know one another, work with each other, exchange scientists, start all kinds of exciting things at the local level.

Lazarus: Let me follow that up. Since we do operate in a scientific and technological frame, my question is, why not approach it the way scientists would? That's what we've tried to do.

As I said earlier, ARCH is an experiment. It's one of a thousand flowers which are blooming right now in this area. There are a thousand experiments out there. ARCH can copyright technology and vend it. ARCH has an advanced waiver from the Department of Energy. The relationship between Argonne and its Department of Energy Chicago Operations Office is very cooperative. We don't have to negotiate individual waivers of inventions one at a time. ARCH can elect and immediately start negotiating with industry. The first licensing action that Brian Frost really accomplished was four weeks in duration from the time that the CEO of the company came in asking about the invention to the time we signed the papers and he passed over the front-end royalty payment. We still have cumbersome procedures. You are going to have cumbersome procedures as you move through this kind of change. But I think we have several working proofs around the country that it can be done. It's very important that you invest some time in observing what's going on where and try to hook into the process at a level where you can make use of it.

Gary Gustafson (Eastman Kodak Company): You identify three major players in this process: industry, academia, and government. How do you define the role of each of these institutions?

Cohen: Let me ask that we not try to define those all separately, because I think one of the purposes of a session like this is to try to bring all three of those things together and remove some of the barriers that have arisen. Leon Lederman always refers to Fermilab as a university, and yet there are big procurement orders that are going to go out from this university in the next several years. Rather than take the time now to have us stumble around with definitions of

function, we ought to agree that we're all here to try to bring these three bodies closer together and have them do something about the economic situation.

Goldhar: What we haven't done, though, is point out that there's a fourth player, either venture capital or an entrepreneur who wants to start a business. What's missing is enough emphasis on the catalysts and the bridgers. Two decades ago, we did all the studies on NASA technology transfer. NASA probably spent more money studying the spinoff benefits than anybody ever realized in spinoff benefits. What was clear was that technology moves through people. It's just like international technology transfer: You can move technology to the border of a country, but if there is no infrastructure inside to move it from the border to a place of use, it dies there on the border no matter how much willingness or incentive there is. The two parties have to have a reasonably equal balance of sophistication.

We used to talk about matching innovation quotients, IQ to IQ. If there is no one in the company, particularly in smaller companies, who can talk the language of the lab or of the source of technology, it isn't going to work. On the other hand, if there's no one in the lab or the source of technology who can talk the language of the company, it isn't going to work. You can't do that through formal programs. You do that through individuals who slowly learn both sides of the fence. You learn it through companies stealing away Leon's best people at absurdly high salaries so that they can afford to leave their government pensions. Universities lose their best people through venture capital. Within a year after a hot Ph.D., there's someone around offering an assistant professor not only a higher salary, but options, the new magic word. There's a tremendous movement of technology that way. I think we ought to encourage that, but we discourage it because pension funds aren't movable and we have lots of bureaucracy around. I don't know whether Fermilab can let someone work one day a week at a company somewhere without taking a year to make that arrangement. Then again, if you've ever tried, as an independent venture, to sell something to General Motors, their process of getting new technology in makes Fermilab's process of getting new technology out look simple and straightforward, and there are 20 lawyers involved in that process.

Cohen: Let me tell you about people and whether you can get scientists to learn about technology transfer. When we get a new Ph.D. fresh from graduate

school, he's never studied how to transfer technology from the research laboratories of the IBM company to the product development laboratories of the IBM company. IBM tried to figure out how to indoctrinate people. I'd like to bless it with the word education, but it isn't that. And you know, it actually worked. We started talking about case histories and responsibility and so on, and now, 15 years later, managers in our research laboratories understand that part of their job is to transfer technology to the product development area. It's built in at this point. Our experience was that you can change people from the raw material you get out of the academies into industrial scientists.

But that didn't turn out to be enough. We also had to build those bridges inside our own company. We had to set up formal structures between our research laboratories and the product laboratories. We have done that in the past six or seven years. I think there's a people element that's vital and I think there's an organizational activity that has to go on that the labs ought to do, that industry ought to do, and that the universities ought to do. And there are, as Lee has said, lots of experiments.

Brian Frost (Argonne National Laboratory): I've spent the last three or four years in technology transfer working with companies. I've found that the ease of doing this is inversely proportional to the size of the company. Steve Lazarus mentioned that we achieved a licensing agreement in four weeks. That was with a small company of about 40 people. The CEO himself got involved. The other side of the scale is that we have been trying to set up consortia in which we've been asking $70,000 a year from a firm. We talked to the middle management and they said, "Great idea. But we can't approve that." Sometimes, approval has to come from beyond the vice president of research, and once you're beyond that level, you're talking to M.B.A.'s and people like that. It gets to be very difficult. You get a lot of lawyers involved. There's some symmetry in the difficulty here. Industry needs to make its procedures simpler just as we do.

Leon M. Lederman (Fermilab): He just used the magic word: M.B.A. Lazarus gave us a nice history of doom and gloom that was echoed by Nicholson. We're in bad shape, we're not educating well enough, things are very bad. One hundred and fifty billion dollars interest. Rivers was more optimistic. He thinks things are going to go O.K. What I want to know, in case he's wrong, who's the villain? I want to beat up on somebody. Who got us into this? Maybe

he doesn't want to get us out. I need a big budget next year and if the stock market crashes, it's bad for quarks.

Rivers: I think Hirsh Cohen ought to answer that question.

Cohen: Maybe it's the particle physicists that got us into this with those dreams of glory they've had all these years. Promises and promises.

Rivers: I think if there's a villain, it's a collective one and it's going to be found in the culture and attitude that we have in this country of being litigious with one another. If I'm from the government and I say I'm here to help you, I've just told a joke. But when our international competitors say they're here from the government and they're here to help, they really mean it and they do. It's a cultural and an attitudinal thing that we share. We've got to get over that and turn good old Yankee ingenuity around, not be so litigious and adversarial in the way that we try to work with one another. There's plenty of blame to go around.

On the question of interaction between the various sectors of this society and technology transfer, maybe technology transfer - in my firm, I call technology transfer "initiatives" - has the wrong connotation, because transfer implies that you're handing over the documents or you're handing over the instrument. It's really not technology transfer that's important, it's something you could call technology flow, because it is an ebb and flow situation. What we should be talking about is working together to jointly develop technology. In my opinion, the interaction between federal labs and industry is not a one-way street at all. The government investigator is going to be richly rewarded, and I don't mean only in dollars, by a much more involved interaction with the industrial scientists. That technology flowback will benefit the primary mission of that principal investigator within the laboratory system at the same time that the technology flow in the other direction, through constructive interaction, is benefiting the company and the company's ability to rapidly develop new products, goods, and services.

Richard Nicholson: I believe it's cultural, too, but just saying that doesn't lead to the solution. Our young people don't have the work ethic they once had. There have been fundamental changes in our culture. That's the root problem. I don't know how to deal with that. But some NSF studies have just revealed

something interesting. We've conducted studies of the performance of Asian kids. As you know, first-generation Asian students out-perform American students by substantial amounts. What the studies reveal is that, by the time they're second- or third-generation Americans, the Asians perform just like Americans, namely, pretty crummy. So there's something about living in this country for two or three generations that changes performance.

Cohen: I think we should hear from the M.B.A.'s. What do you say, Joel?

Goldhar: I want to address Leon's question: If things go wrong, who should we beat up? Certainly, some of the fault lies with M.B.A.'s like Steve Lazarus. But in the last issue of *Forbes*, they listed the 800 most powerful people in American industry, the CEO's of all the companies, where they came from, where they went to school, and what degrees they have. I was depressed to realize how few of them, in fact, were M.B.A.'s and how many of them were lawyers, which is one good candidate to beat up on. A lot of them were ex-scientists or engineers. The biggest group were B.A.'s from Yale.

I believe this really is a pluralistic problem. One part is culture, and I don't know whether it's the culture of the work ethic or lack thereof so much as it's the culture of the quick return. The other part of the problem is public policy which encourages the culture of the quick return, ranging from tax policies to regulation of the financial markets to our bilateral relationships with trading partners. All we have to do is increase the transaction costs on Wall Street and we'll see a fundamental change in the way people view the value in a company and whether or not technology that takes more than a quarter to show its value gets any ranking in the stock price. We simply go to a capital-gains tax plan that takes 10% per year over 10 years off the tax total on a stock exchange. If you hold the stock a year, you pay 90% of the taxes; if you hold it for five years, you pay 50% of the taxes, and so on. All of a sudden, you'll see people recalculating on their 1-2-3 spreadsheets the optimum time to keep a stock and the value of an investment in science and technology as it pays out over three, four, five years hence. I think it's a public policy issue to be dealt with.

Cohen: I'd like to make a contribution to Lederman's question, too, but it's quite a bit more general than Joel's. I think we're all guilty, the academics (and I include the free-spirited particle physicists), the industrial people, and government. We're guilty of still dealing with the old models of how this triad is re-

lated to its parts and to the rest of the people. The models are still the models of the 1940s, 1950s, and 1960s. We would like them to continue working because they were successful then. We had that great boom-time for everything. We haven't renewed any of those models. The things that people have been talking about up here are part of that renewal process and so I am not going to go into that litany again. But I think that's the sort of underlying malady we all have. We'd like the government to keep on funding Fermilab the way it used to, right? That's a reasonable hope. But the models of those things may have to change in the economic warfare of the 1990s.

Lazarus: I don't want to let the work-ethic observation stand. First of all, the M.B.A. candidates that I work with at the University of Chicago are the most impressive group of young people I've seen in a long time. The job opportunities and financial services have been cut in half this year, so they're making the adjustment into entrepreneurial studies. They're committing themselves to working 18- to 20-hour days. I just wish we had more of them. The demographic point that was made earlier is true. They're part of the so-called Baby Bust group and we could use a lot more of them. I think they're terrific.

Furthermore, I believe that the natural raw talent that we have in our children coming up through the elementary and secondary school system is terrific. But we fail to challenge them. We are teaching them in a way that is almost an insult to their innate capability. We've somehow internalized this Piaget thinking, that a young child is incapable of learning tough things. But we have all this evidence piled up around us that says the young child is the greatest natural linguist in the world and can understand mathematical concepts. We can do something about that, and should.

Finally, a comment about the black population that is going to be so numerous. Sure, they're disinclined toward technical pursuits, because most of them have to fight their way through an inner-city educational system that is a disgrace. But give them the same educational opportunity that you have out in the suburbs, and you will find the same kind of talent coming out the other end.

If I were to choose my first priority for investment, it would be to invest in those education systems. It's not going to happen unless each one of us individually makes a political judgment that we're going to work for it. If you listen to the campaign rhetoric today, this is supposedly going to be an education

election, but I don't hear the underpinning plans coming out of either side of the political spectrum.

Goldhar: Steve, would you trade that off against the Superconducting Super Collider?

Lazarus: I won't answer that until I leave this Laboratory.

James S. Kahn (Museum of Science and Industry): It's a pleasure listening to all these discussions. I'd like to add something and I'll only take a few minutes.

I've heard all of this before. I've heard ERAB tell me what we ought to do with Livermore, and most of the time we could never do what you suggest we do anyway. I've heard the complaints from the back about bureaucracy at the laboratories. Let's try to fix this right now. I think it's time for us to stop talking. It would be a shame not to take advantage of Leon's beautiful, ambiguous challenge in this Roundtable's title - the spiral and which way is it going?

What we've got to do here, and we'd be remiss to leave this room without doing it, is to try and establish a new national strategy to resolve this issue. That is what we've been saying. I believe we have all these elements. (We left one out, by the way, which is American labor.) We need a national congress or a national board where the elements that are in this room today are heard loud and clear, and then something is done to change the mind set in America. We haven't got the time to continue to spend six years "playing" around. The strategy should be established now. Otherwise, we're going to fall further behind.

The Japanese have a marvelous national policy designed to make them number one in trade. We don't have that. Why don't we think about what we're going to do to solve the problem, rather than talking around the elements?

Cohen: I thank you for describing what we've been doing this afternoon as playing around. It's been fun. I'm not sure that we're going to get national policy evolved in seven minutes, although it seems at times it's been done that way in the past eight years. I must say, it's appeared in the conversation this afternoon. I like what Frank Press has been saying, that it's time to set some priorities. I would assume that we're the science and technology people no matter which of the three areas we come from. It's time that we thought about whether we have to set priorities, because big and little science, when you put them

together, is pretty big. If you want to talk about a national science and technology policy, it has to start there. That's a subject for another afternoon and another panel.

I agree with the earlier comment. This happens to be a summer when some of us can perhaps have an effect on what the next president and the next congressmen will be saying about these questions. This is the opening that occurs every four years where we get a crack at that. Isn't it about this time in an election year when committees of scientists begin putting ads in the paper for this or that and get behind candidates? That hasn't started yet. That's a way to start policy going.

I think we had better close down this soapbox.