An Interview with

HARRY HEDGES

OH 221

Conducted by Frederik Nebeker

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Abstract

Hedges briefly describes the creation of the Michigan State University computer science department before shifting the focus of the interview to his work at the National Science Foundation (NSF). Topics include: the work of Rick Adrion in theoretical computer science; the proposal process; NSF's Coordinated Experimental Research Program and similar infrastructure programs; and the manner in which grants influenced the development of computer science programs in the U.S.
NEBEKER: Could I ask you first to recount your personal history before coming to NSF?

HEDGES: First of all, my early background and training and education was in electrical engineering. I received my Ph.D. at Michigan State University and subsequent to receiving the degree, and actually during that time, I began to use the computer in class work and in my thesis. I was in the electrical engineering department as a faculty member, and then became assistant dean in the college. It was during that time that computer science was started as a program at Michigan State.

NEBEKER: Do you remember when that was?

HEDGES: It was started as a program in 1966, and then in 1969 a department was created and there was a search on for a department chairman. At some point in that search I was asked to become department chairman, so I went over to the Computer Science Department as Chair in 1969.

NEBEKER: And that was the beginning of the department.

HEDGES: As a department, yes. I was the first Chair. There had been a person before that, Richard Reid, who was the director of the Computer Science Program an academic program. It began as a program. Dr. Reid stayed on as a faculty member in the department. So then I was Chair of that department from 1969 until the early 1980s and I then decided that I wanted to make a change. In 1983 and 1984 that academic year I announced I was stepping down as chairman and started looking around for a location for a sabbatical. At the same time Kent Curtis, who was at that time Division Director and head of the computing research program at NSF, came to Michigan State to give a lecture. I knew him through previous activities of one kind and another. He knew that I was stepping down as Chairman and was looking at places to go on sabbatical, and in the course of conversations with him I happened to ask him if there
was any possibility of any openings at the Foundation. It turned out that just then Rick Adrion, who had started the Coordinated Experimental Research (CER) program and was the first director of that program, had just had a sabbatical approved from the Foundation. They were looking for someone to take his place and run the CER program. And so I submitted my application, came to NSF on an interview, and was selected to run the CER program, which I started the first of September of 1984. I came on as an IPA you know what those are an Intergovernmental Personnel Act appointee.

NEBEKER: No, I didn't know that.

HEDGES: Intergovernmental Personnel Act (IPAs) are assignments which can actually go both ways, from the government to universities, or usually from universities to the government. And under that kind of an appointment the Foundation makes a grant to the university, which pays the individual's salary and at least part of the fringe benefits. Each one is individually negotiated, but the appointee stays legally employed at the university and keeps all of his or her fringe benefits health insurance and all that through the university. But the appointee works at the Foundation and is under all the rules. The conflict of interest rules and so on apply to an IPA, just as though the appointee were an actual federal government employee.

NEBEKER: Can this be a long-term arrangement?

HEDGES: It's normally for one or two years. It can be extended for two more years. In my case, it was just one year and then it was extended for a second year and then for two more. My first four years here were as an IPA, and then I stayed on. There's a number of steps in there, but I stayed on as head of this office and took that position and became a regular government employee and officially retired from Michigan State.

NEBEKER: Was that in 1988?

HEDGES: That was in 1988, yes.
NEBEKER: Can we go through those steps more slowly? How did you get to know Kent Curtis?

HEDGES: I had been principal investigator on a couple of research equipment grants at Michigan State and I had served on review panels for the Foundation. I also was one of the people who started an organization which we called then the Computer Science Board. Now it has another name Computer Research Association. I don't know if you're familiar with that, but a group of department chairmen in the Midwest first got together to organize a computer science conference, which is now run by ACM and has gotten to be a big operation. I was one of that group that got that started. As that developed we decided that there were other things that such a group of chairs could do, so we formed the Computer Science Board and we had 24 members, which is still the number of members. They are mostly chairs of computer science departments, but we decided we needed some industry input too, so we generally have about half a dozen of the 24 members as industrial people for example, managers of laboratories in industry. That board grew to be fairly influential generally in computing. We started a set of meetings called the Snowbird meetings. There's one every two years. There's one this summer at Snowbird, Utah, and the chairs of the Ph.D. granting computer science departments are invited to that. It's now been expanded to include chairs of computer engineering departments, and at each one of those meetings the first meeting was in, I think, 1974, and they have grown since then as the community has grown. But we invited representatives of industry and representatives of federal agencies to join us at those meetings and discuss their programs. Kent Curtis was one of those people, so I had known Kent there. So in several ways I had known him slightly; I wasn't a close friend but I knew him. So when he came to Michigan State to speak I was the one who happened to know him and I became his host in terms of picking him up at the airport and taking him around.

NEBEKER: And you explained your interest in looking for another position. What was NSF's interest at that point?

HEDGES: Well, Rick Adrion, who had been hired by the Foundation to run what was then the CER program in fiscal 1980 had applied for and been granted a sabbatical year. And that had been approved just previously to when Kent Curtis came to Michigan State.
NEBEKER: Was that 1983?

HEDGES: No, I think that was in January of 1984. And so, just in the course of conversation I inquired about any possible new ventures here, Kent said, "Oh, yes, we do have an opening, and if you would be interested..." So we just talked about it. And he asked me to send my resume, which I did and applied for the position, and I came in the fall, in September of 1984.

NEBEKER: And that was initially to be a one-year sabbatical?

HEDGES: Not a sabbatical, but a one-year IPA appointment at the Foundation.

NEBEKER: But to fill in for Rick Adrion for one year.

HEDGES: Yes, for Rick Adrion for that year. Another thing that was happening at the same time is that Rick had started this program alone as one program director, but it's a large program now. I mean, it had grown rapidly year by year then, and it involves panel meetings and site visits. We receive a set of proposals in the program. We have an initial panel which screens those proposals and recommends to us some set that we will consider further and that means in particular a site visit. So then we do a series of site visits usually during November and December. Then we have a final panel meeting in the spring. These are five-year grants, so we would make site visits to the institutions before we would make the awards. Then we would schedule a mid-term site visit at about two and a half years out, and then another one after the grant's conclusion. So as the number of institutions involved grew, the number of site visits and panel meetings grew correspondingly. In the early years Rick would normally have one of the other program officers in the Foundation go with him on the site visit. There would usually be two people, but they would be different. Well, the year I came, Bruce Barnes and I were jointly given the assignment of running the CER program. In fact, he was the lead person, because he had been here for some years before that and had been on some of the site visits and knew the program. So he and I worked together on it that year. During that year, I believe
I raised the question about extending my IPA appointment to Kent Curtis. Kent was receptive to that and made the official proposal that my appointment be extended, and it was.

NEBEKER: Did Rick Adrion come back?

HEDGES: During that summer of 1984 Kent Curtis was selected as the first Division Director. And Rick came back as Deputy Division Director. Then, in the spring of 1986 this new science directorate Computer and Information Science and Engineering (CISE) was created. Gordon Bell was the first Assistant Director and Rick was selected as a senior science advisor in the directorate office. So, as I remember, he served as a deputy only a very short time. And in that same time period Kent Curtis became ill, had cancer, and a couple of us shared responsibilities as acting division directors for some time there Tom Keenan and I shared those responsibilities that whole period of time. The first year Bruce Barnes and I ran the program. The next year another person was hired. Robert Minnick and I ran it together for two years. And then Bob left, and I ran it alone for one year. And then we hired another person, J. Mack Adams, for two years. And then last year he went back to New Mexico State University. He came as an IPA also. He went back to New Mexico State and worked for us on kind of a half-time basis for one year. Remotely from there, but I was again involved in the program a lot. And also during that time this Office of Cross-Disciplinary Activities was created and I moved into that position as Head of this Office. So I have been involved in the CER program and what's now the CISE Institutional Infrastructure program since the fall of 1984, and I have been first a Program Director for several years and then as Office Head for the Division in which the program is located.

NEBEKER: Is that office head of the Cross-Disciplinary Activities Office?

HEDGES: Yes, Office of Cross-Disciplinary Activities.

NEBEKER: I think that sounds fairly complete.

HEDGES: You probably know that the Foundation as a whole has a lot of rotators of one sort or another. And they
can either be visiting scientists, where they come on leave from their university and come here for a one- or two-year appointment as a federal government employee, or as IPAs. Within the CISE Directorate there is something like 38% of the people are rotators of one kind or another.

NEBEKER: Can you tell me something about your duties as a program officer? You told me a bit about it.

HEDGES: The program has grown and has several components now, but they're all run similarly. But the basic program, which was the CER program when the new directorate was created, the CISE directorate, two things happened. The name was changed to CISE Institutional Infrastructure Program, and it was broadened to include not just computer science, but all the areas which are funded within this directorate. That includes computer engineering with its several components - VLSI Design, signal processing - all the things that are in computer engineering. Also, the topics that are in Networks and Communication Research in that division. And the computational science and engineering that's in the Division of Advanced Scientific Computing. So the program was broadened and the name changed. But the basic structure of it has remained the same, and that follows something like this: for the main program we have an announcement we send out to all of the applicants that are eligible and anybody else we know about that would be interested. We have a deadline date for the proposals of the third Monday in September. The proposals come in, are logged into the Foundation. We get copies here in the office. We read them and select a review panel - an initial review panel.

NEBEKER: Who makes that selection?

HEDGES: The program officers. I did when I was program officer. Now the current program officer and I make those together. We make every effort to have people who have expertise in all the areas that are encompassed within the proposals. They are five year grants, and the grants in the big program run from two million to four million dollars each over the five years. They provide equipment, maintenance cost for the equipment and support staff as the three big items. There are also some travel and supplies and software costs and all those things. But the big three items are the equipment, the support staff, and the maintenance cost. So they're designed to provide facilities for people to
do experimental research. We don't fund the research itself. But once they get this equipment they can go, hopefully, and get support for the research from the other programs here or from DARPA or from ONR or whatever.

NEBEKER: When you were program director roughly how many proposals would come in?

HEDGES: They varied a lot. In the big program maybe 20 to 30 is the right kind of number.

NEBEKER: How many of those were funded?

HEDGES: We funded generally four or five a year. The first year there was only one funded, and then after that, when money started being put into it as a program there have been approximately four or five a year ever since then. Last year we only did three, but there are other reasons for that. Generally, four or five a year. And at that time generally 20 to 30 proposals came in. Now, recently we have started other components, so a small-scale program and a minority institution program can get the same sort of support. But anyway, a set of proposals would come in (and we'll talk now only about the regular large program) in mid-September. We have an initial panel in mid-October.

NEBEKER: How many members?

HEDGES: It depends in part on the number of proposals, but generally 11 to 15 a fairly good-sized panel. We will send the proposals to the panel members ahead of time, or at least the proposals that they're going to write reviews on. And they'll spend two days here and make recommendations to us. And the recommendations are either, "Definitely consider this one further," or "Consider it further," or "Do not consider it further." And based on their recommendations we decide what we are going to do next. We usually select for site visits about twice as many as we are going to be able to fund. So generally we make eight or nine site visits and make three to five awards.

NEBEKER: Who makes the site visits?
HEDGES: Two people from the Foundation -- the program director and myself (since I have been here that's been the case), and two outside visitors -- experts.

NEBEKER: From the panel?

HEDGES: No, they're independent -- stress that. We have two experts who are selected because of their expertise in the areas that that particular proposal emphasized. It could be in AI and robotics. Another one could be in software engineering and software systems. So they accompany us on a one-day site visit to these institutions. All of the members of the initial panel write individual reviews about each one of those things. So we send the reviews to those that we're going to site visit, and to those that we don't site visit too for that matter -- copies of these comments the initial panelists have written. For those who are being site-visited, that's to allow them to prepare for the site visit and be ready to respond to the questions and so on. So we have a one-day visit normally from nine to five. Occasionally it will be one afternoon and a morning, if we are not, for various reasons, be able to schedule it all in one day. In any case, they're over an eight-hour period. We're careful not to do any socializing. We don't have a dinner with them that evening or anything. We have a working lunch. We do give each institution eight hours and ask them to make their best case they can in that period. So during that time then they generally follow something like this. They give an overview of the department and the proposal and what they're planning to do. They then spend three or four hours making technical presentations on the research that they do and what they plan to do when they get this new facility, this new equipment. We meet with the central administration of the university, usually the president; a provost; at least a dean -- usually the dean and somebody else. I mentioned Princeton. When we have gone there, for example, it's been a custom to meet with the president. We have been small enough, I guess, that he's directly involved. And that is the case in other places too, but not always. We have a tour of their department area and space to make sure they tell us where they're going to put this equipment and how it's going to fit in. They go over their management plan and who's going to run the system. We have a wrap-up session with the Principal Investigators (P.I.s) at the end of the day, and then the site visitors (the outside site visitors) write a site visit report to us. We send a copy of that to the P.I.s.
NEBEKER: Do you write a report yourself?

HEDGES: Just for internal purposes. We don't send one to them. Each institution that has been site-visited, unless they happen to be eliminated at the time of the site visit, if they really fell completely flat they would be eliminated then but generally they are then asked to prepare an addendum to the proposal. And the addendum will respond to any questions that are raised by the initial panel or the site visitors’ questions in their report, and they will send us an addendum. Generally that's what they consist of. These proposals typically have maybe five or six components in them five or six areas in which they're going to do research, and maybe one or two of those are found to be weak compared to the others. In their addendum, they might even say they've decided to eliminate this part of the thing from the proposal and the corresponding equipment to do that. That has happened; that's not typical. Generally they will attempt to justify it. So they send us an addendum and then we schedule a final panel meeting, usually in early February. The addenda are usually required to be here around the first of January. We assemble the final panel a smaller panel, usually, because we're now down to a smaller number of proposals; it would be seven or nine people something like that.

NEBEKER: Selected from the original panel?

HEDGES: No. They're new; they're different people. And this panel in particular, and the others too more so now but the final panel in particular are selected as senior people, who are active researchers but also have a broad outlook on computing and what people ought to be doing these days. So we send to them a copy of the proposal, the initial panel comments, the site visitors reports and the addendum for each of the schools that are in the competition. And they get those a couple weeks ahead of the meeting and come in here that's just a one-day meeting and they take each proposal, roughly an hour each, and discuss them and write reviews for each one, and then at the end of the day discuss them all and give us recommendations as to which ones should be funded.

NEBEKER: Do they try to come down to the number that you think you can fund?
HEDGES: They will ask us, “How many are you going to be able to fund?” Well, generally the answer is three to five. How many do they think are worthy and what our budget is are some of the factors that go into how many. But they will generally get within that kind of number. So then we decide, and based again on our own set of factors how much money we have and so on, we decide which ones we want to fund and then the program officer will call the P.I.s that are selected, and almost without exception have to negotiate the budget down based on comments of the reviewers and our budget situation and other kinds of things, and try to accommodate them not only for that year but for all five years within the total planned budget.

NEBEKER: To what extent is it the recommendations of this final panel that decide who gets funded?

HEDGES: Well, they're weighted very heavily, frankly, because they see all the material. They see from the beginning the comments of the other reviewers, and they have the maximum amount of information. So their recommendations carry a lot of weight. Not that the other ones don't. The site visitors are the only ones who actually meet the people, meet the P.I.s in person, see the facilities, meet the administrators.

NEBEKER: The program officers who have a longer acquaintance with these proposals?

HEDGES: Their recommendations are heavily weighted, that's true, but they are recommendations.

NEBEKER: You don't have any difficulty with funding something that final panel had low on its list.

HEDGES: I don't know if you can go that far; I guess I haven't found a case. If they really said, "This is poor," and they were in agreement on that I don't think we would fund it. It has generally worked out that what they have recommended we have tried to do. Generally what happens is let's say there are nine proposals in the running and we're going to be able to fund four. There would likely be two or three that are clearly top ones. The panel will agree on that. We think going in that theirs are likely to be the top ones. And then there's three or four more at the bottom that everybody agrees they're lacking something. The people aren't as strong, or the institution hasn't made a large
enough commitment. Or, equipment isn't well justified. Then there are two or three in the middle. When we get recommendations from the panel, it will end up with two or three at the top, three or four at the bottom, two or three in the middle, and we will make the decisions within that. And then sometimes it has come down to, "Hasn't an institution had one of these grants before?" If there are two that are very nearly equal we tend to give the benefit of the doubt to the institution that has not had one of these awards previously.

NEBEKER: I take it that the principal consideration is the research that will be done with this equipment?

HEDGES: The two primary criteria are one, the quality of the research that's proposed and the impact that it's likely to have and secondly, the competence of the investigators. Are they going to be able to carry out what they are proposing to do. So in all cases they need to pass those two hurdles, meet those criteria. Then we will look at, do they have a management plan that's reasonable? Is there an institutional commitment to it? Have we supported the department over the years and all that sort of thing. Is the equipment appropriate to what they want to do? Are the P.I.s up to date on what's available in such things? What impact is it going to have on students? That's one of the questions in the evaluation.

NEBEKER: It's educational value?

HEDGES: Yes, on the graduate student population.

NEBEKER: Is there any effort by program directors, in your experience, to solicit proposals?

HEDGES: In a general way, yes, but I don't know of any specifically. At the Snowbird meetings, for example, we have given presentations there on the program, and have discussed what the important characteristics of a winning proposal are. We would solicit proposals in that way.

NEBEKER: I was thinking in a more specific sense. Where you think that something particular could be done to
great advantage.

HEDGES: No, we haven't done that.

NEBEKER: Do you think that the institutional structure here works well for getting money spent in the way that best supports research?

HEDGES: I guess perhaps I am a bit prejudiced about it. I mean, I think this program has been extremely successful. The oversight reviews we have had have all been very favorable, and not just in terms of the way the program is run, but the impact that it's had on the computing community. The departments that have benefitted from these support very strongly the idea that it's the thing that has brought computer science to where it is now. Are you interested in, or do you know how the program got started and what the impetus was for it?

NEBEKER: I would like to hear.

HEDGES: Well, back in the 1970s, at least, there were not a lot of computer science Ph.D.s being graduated. The academic departments had a dearth of equipment. Computer science was kind of looked on something like math at that time all they needed were pencils and papers to do their work. And there was very little experimental research going on. The faculty were in many cases leaving the university to go to industry where there were beautiful facilities to work on. Graduate students were getting big offers from industry to go work with them and weren't going on to graduate school certainly not on to Ph.D. programs. The word used was a crisis a discipline in crisis. There was a report from a workshop that NSF sponsored the Feldman report, it was called, that studied this problem and made recommendations for the federal government to start a program something like this CER program, to provide experimental research facilities to universities. At about that time there'd also been discussions about it within the Foundation, I understand. I know there was before that, and the first couple of those Snowbird meetings discussed this. Each department had perhaps half a dozen faculty openings and there was a surge of enrollment of undergraduates but there weren't any people available to hire. So it was a tough situation -- high teaching loads, and
all those bad kind of things. A report from the Snowbird meeting was entitled "A Discipline in Crisis." That spelled out the same kind of problems and it was shortly after that that his program actually got started within the Foundation. So it was to meet those kind of needs.

NEBEKER: It's not obvious that providing the computing facilities [solved the crisis]. That's one factor there, and you think an important one.

HEDGES: Certainly that's one factor. There are other things like reducing the heavy teaching loads.

NEBEKER: And matching the attractive salaries of industry?

HEDGES: Yes, but the publication of these reports and the activities of the Foundation and the kind of ferment in the community began then to drive the salaries up. Some departments were able to limit themselves to just a graduate program and several of them didn't start an undergraduate program until just very recently.

NEBEKER: Is that because they didn't have the people to teach the undergraduates?

HEDGES: Yes, that's it in large measure, and they didn't want to take on this big, huge teaching load of undergraduates but they instead limited themselves to excellence in research programs. And they have done very well at that. I kind of got off the track in talking about where the program started from.

NEBEKER: The Snowbird support concluded that the discipline...

HEDGES: Since then the departments that have received these CER awards have become major contributors to the increased Ph.D. production. There are three or perhaps four schools who have also received DARPA funding Stanford and MIT and Carnegie Mellon in particular. Their Ph.D. production has gone up, and the 25 or so schools that have been in this program have also increased their Ph.D. production. So now, in recent years, the number of
Ph.D. graduates per year has gone up very dramatically from around the 250 level where it was for a number of years. It's gradually taken off and it's over 600 now in computer science alone without computer engineering.

HEDGES: So there are now more faculty and lower undergraduate teaching loads. The individual teaching loads have gone down, and the research facilities are in place at a lot of institutions.

NEBEKER: These grants for computing facilities, did they result in new faculty positions?

HEDGES: Getting one of these grants has resulted in significant changes within the university. This has provided leverage for the departments with the university in getting more positions and getting more space and getting more support of all kinds. They have been able to go to other agencies, DARPA and ONR, for example and be much more successful. They have credibility which they didn't seem to have before. A lot of them have developed interactions with industry. They have gotten gifts or large discounts on equipment. In a lot of cases have joint research programs going on. So they have leveraged their money in a lot of ways. They have attracted more and better graduate students across the board. So it's made a real impact on those departments. The departments that failed were able to get their administrations to provide them funding, to get up to higher levels so they could come back next year and try again.

NEBEKER: So they can use the reports of the panel?

HEDGES: Yes, of both the panels and site visitors to help them within their own university. Now, along the way, in 1988, after discussions with the advisory committees, the committees had recommended that we start what was referred to as a mini-CER program. We call it now the Institutional Infrastructure Small-scale program. What had happened is that a number of institutions had not been successful in the big program, where they might have four or five or six research projects, included in their proposal. One or two of the projects might be outstanding and the
others not so good, and the overall proposal just wouldn’t make it. So we started this new, small-scale program.

NEBEKER: When was that?

HEDGES: 1988 was the first year of the announcement. The first ones were funded in fiscal 1989 actually, because then we had the money. We didn’t have it in 1988. But that’s where the smaller institution, or it could be and has been, larger institutions with a smaller core of research excellence [could get grants]. So in that first year we made two of those awards. Last year we made two more, and then after the final evaluation process of the next set we will probably make three or four awards in this group. They fit actually both those categories. There are smaller institutions and also big institutions where they focused their research and the grant is focused on a smaller subset of the whole department.

NEBEKER: Who initiated that?

HEDGES: Well, I don’t know if there’s any one person. I think it came up through the discussions in the advisory committee, and the program officers were certainly aware of this phenomenon of proposals coming in, part of which were very, very good part of which were not. It was clear that there were a lot of departments growing who could use a substantial boost, and so it became partly just an effort to broaden our support to these up-coming departments.

NEBEKER: You mentioned earlier support for minority [institutions]?

HEDGES: At the same time we started a program for minority institutions. In the first year there were just planning grants. we...

NEBEKER: When was the first year?
HEDGES: 1988 also. Planning grants are $50,000 for one year. So each year we made anywhere from four to six planning grants, and in 1989 we made the first five-year continuing grants. We made two of those awards: to North Carolina A&T and to the University of Puerto Rico at Mayaguez. Both are underway and are very successful.

NEBEKER: What's the size of those grants?

HEDGES: Those are from $800,000 to a million and a half over five years. They actually are all going near the top. That is, they all run about a million and a half over five years. In some ways the small-scale grants are about in that same range. And this last year, in the minority program we made one five-year grant and two two-year grants, it turned out. Schools that we decided were not quite ready for us to make a five-year commitment, but yet could get on the way in a couple of years with a boost. Another factor that we have run into is that in the last couple years institutions that have had one five-year grant previously in the big program are reentering now. In the big program, original grants ran from two million to four million, usually up in the three and a half range something like that. A school that's had a grant before is now limited to a grant of two million dollars one to two million. And they run close to two million generally. The philosophy there is that the institution has to make a commitment that at the end of the five years they will maintain the facility for its useful research lifetime. So they have taken over the support for the support staff to provide those permanent positions, the maintenance costs, also. That's built in the budget by that time and the new grants are to provide new, up-to-date equipment to replace the equipment because it changes so rapidly that it needs to be replaced after three to four or five years, generally. I just mentioned then that that's now an important part of the program in that the university signs a statement that they will provide an increasing share of the support costs and the maintenance costs over the five year period of the grant and will agree to maintain the facility for its useful research lifetime. So typically the maintenance costs, for example, when you finally get down to a final budget arrangement, are something like we'll pay 100% the first year, 80% the second year, 60% the next, and so on. The university picks up the other part of that, and a similar thing happens to the support staff costs. For the support staff we pay for all those in the first year and then gradually reduce that so at the end of five years the university is able to pick up the whole operation without a big step function in their budget.
NEBEKER: Has that functioned?

HEDGES: Right now, there's a couple of schools that are in states, apparently, that are in severe budget fiscal crisis, so they may have slipped a little bit on their commitment, but then they agree, they're going to make it. They will pick it up next year. So throughout, you know, they have come through. I do not know of any that have not met their commitments. And many cases they have far exceeded this.

NEBEKER: Who?

HEDGES: A number of departments Wisconsin, Yale, North Carolina and others have new buildings which they attribute in large measure, at least, to the grant. Others have acquired a whole floor which has been completely renovated for them. So it's made a difference in universities' view of computer science.

NEBEKER: Yes. What about the geographic distribution of grants? Is that something you paid a lot of attention to?

HEDGES: Well, it seems to have worked out pretty well, actually. We've had that shown on a map. We're pretty well spread across the country. We went to Washington as the first one, and since then UCLA, and Berkeley, and Irvine all have them out there in the west. And Utah has had one, Texas, Colorado had two, Indiana, Minnesota, Michigan State has one of the small ones. And then over here in the east, North Carolina, and Georgia Tech, and Princeton, and Yale, and U Mass. They're pretty well spread out across the country. Also, Rochester, Cornell, and others.

NEBEKER: And that's come about sort of naturally?

HEDGES: It's certainly something we would consider here, but at least all the years I have been involved with it, it has worked out so that we have had a pretty good spread each year. This year, for example, in the big program U Mass and Colorado and University of Virginia were the three. U Mass and Colorado got their second award small ones and the University of Virginia their first one. But it seems to have worked out that way without any big effort
NEBEKER: When you look back on the program as it's functioned, certainly it's the success of the computer science department that you're most interested in, and there must be other things that you're hoping that you helped?

HEDGES: You say computer science and it started out in computer science, and those still represent the big bulk of our proposals and our awards. But we certainly consider equally proposals from computer engineering and computational science and other areas. Most of the awards have been to computer science departments. You probably know there is a study of the CER program going on, an evaluation. Do you know about that? Well, there is that going on, a part of the Foundation does evaluation studies part of the budget office. And they have contracted with an outside group to do an evaluation. They're including schools who have completed at least one five-year grant. In fact, there are four kinds of institutions they're considering: that set, who have applied for and received the CER grant during that time they were studying it; those that never applied; those that applied and didn't ever get an award; and the DARPA schools you know, MIT, CMU and Stanford. And so they are trying to see what impact this program has had, because there has been a lot of growth in the computing field computer science and engineering, anyway, and they are trying to determine how much, if any, is due to this program.

NEBEKER: Yes, but I am wondering in your own judgement what are the criteria of success? I mean, one of those no doubt is that the computer science department, if there is that at that university, has done well, has got good faculty?

HEDGES: We look at their Ph.D. output, their faculty recruitment history, the grants they've received research grants from the Foundation and from other agencies any industrial interaction they have been able to develop. Those are all important, but broader than that is the impact that the whole program has had on the computing community in terms of allowing people to do experimental research and the results that have come out of the research and software new languages, new operating systems, new architectures, new graphics systems and so on that have...
NEBEKER: And also research in other disciplines that may use the facilities?

HEDGES: Not to my knowledge. I don't think there's been a lot of that. These have been generally within the department. There's a core of researchers who write the proposal and are the key people and they certainly always use the equipment. Generally then, it's open to the rest of the department, as long as it doesn't interfere with the particular project. And then the systems may be available to people in other departments but not to a great extent, to my knowledge.

NEBEKER: So it's a research tool within computer science, computer engineering?

HEDGES: Yes, pretty much.

NEBEKER: You said the educational value of these facilities is also considered?

HEDGES: Yes, it certainly is. The impact it has had is on graduate education and undergraduate, for that matter, but particularly graduate. And these people who are active in these grants are also active in course and curriculum development in many cases.

NEBEKER: You have mentioned a couple of state universities that have had budget problems. Have there been any other real difficulties, real failures with any of these?

HEDGES: No, I don't think there's been any failures. Some schools have been more successful than others, none have been failures. Some have gotten through this program so many good things going they haven't come back to us for another [grant]. They haven't made another proposal. I am confident none of them are failures; some of them are more successful.

NEBEKER: Yes. What about relations with industry? You mentioned that as something that you look at. Have you
HEDGES: Yes, but I guess I can't give you any specific way we have done that. That's been more up to the institutions. Generally, industry is well aware of this program and, they and the other agencies have given credibility to institutions that have made a proposal to this program and have been successful. They know they have been carefully reviewed and then industry has been interested in being a part of that successful department.

NEBEKER: Certainly the NSF programs in this area have raised the overall quality of research being done, for several reasons that you have mentioned. What about any changes of direction that may have resulted if you take a long view of this?

HEDGES: Well, I think in general that there's a lot more experimental research being done in universities than there was before. And there are specific examples of that. One that stands out clearly is Cornell. They had, and still have, an outstanding department— one that was very theoretically oriented, until they got one of these grants and they are now into robotics and into experimental development of software tools and things that are used in experimental research. They weren't hardly in that at all before. So this made a tremendous difference to them. That's true in other places as well.

NEBEKER: But there hasn't been a particular branch of research that NSF has promoted?

HEDGES: No, I don't think so. I don't have any count on this, but I am sure that more of our grants right now than in any other area are in the area of distributed computing and parallel processing. There are a number that are in various areas— artificial intelligence, for example. There are several that have graphics and image processing. But, there's probably more in distributed computing and parallel processing. A lot of the schools now are asking for and getting the new parallel machines, and that's important. They are using those in a lot of different areas.

NEBEKER: So the distribution and support among these different areas of research...
it results would you say from sort of the quality of these individual proposals rather than any judgement by NSF officers that a certain kind of research is more profitable?

HEDGES: Yes, I think that's true. The field has, as the technology developed, as parallel processing machines began to be developed and became available people then said, "Well, gee, this is the way we ought to be going. This is going to happen in the future. We ought to be getting into that." So they followed that direction. Now it's true that the Foundation has encouraged it too, I would say. The directorate makes long range plans in areas it thinks it can emphasize. Parallel processing is and certainly was one of those when Gordon Bell was here. So people apply in corresponding areas if they're interested. It sounds like a good field. But it generally follows from a researcher's interest.

NEBEKER: Maybe where you would go for support?

HEDGES: Yes, as to one agency or another. Let me ask another question. We have talked almost entirely about the personnel of the research Institutional Infrastructure program and its various contents. Are those the main things you are interested in, or the only things? Or other programs that we have in this division?

NEBEKER: In fact, one thing I wanted to ask you was what other things you think we ought to be asking about.

HEDGES: There are at least a couple of things that are relatively new. One is a forerunner, actually, of the CER program, and that is a Research Equipment Program. Now we call that an Instrumentation Program, but it started out as a Research Equipment Program. In that case, those are one-year grants just for a piece of equipment. There's no staff or maintenance costs or anything involved just a piece of equipment. That provided and continues to provide the emphasis (and certainly did in the early years) for some of these departments to get started, and then with a VAX computer, for example, they would gradually be able to build up some experimental capability. And then after one or two of those grants they then would come to this CER program and be successful. There are several examples of exactly that happening, where the group started with an equipment grant got one or two or three of those and built
up kind of a nucleus of equipment and personnel capabilities and then were able to put together a proposal that we viewed as successful. That program continues and it still serves that same kind of function in many cases, and also it replaces obsolete equipment where we continue to make those awards every year. The program has a budget of two and a half million. So there aren't a lot of big awards but there are a fair number. Now the other thing that we have gotten into recently and this year was our first announcement and first set of awards is an Educational Infrastructure Program. In that program we support curriculum development, laboratory equipment, faculty enhancement, if that is needed, support staff, maintenance cost for the equipment all those kinds of things. We started that program this year. We had 30 proposals. We've made five awards. We haven't declined all the others because we hope we can get a little bit more money to fund a few more, but right now we have funded five out of the pool. Those have a few kind of interesting, I wouldn't call them criteria but, factors. One is that we ask that they be led by a senior researcher/educator. And many of them and certainly the P.I.s of those that won it turned out are people who have been very successful in research for a number of years and have decided they wanted to spend more time in education, more than they had previously. They are three-year grants and the P.I. is going to spend a significant amount of time in education. It turned out that the five that were judged to be the best are from different areas of computing. One is in computational science, one is in an AI area, one in a hardware-oriented architecture area, and one is in software. But they are kind of distributed across this whole directorate. It just happened that way interesting. That program is continuing and will build.

NEBEKER: Besides this administrative history part of the book that will result from this study there's this other part that I gave you some ideas that we were pursuing, I wondered if there are things you think, issues that you think ought to be considered when one is trying to take a broad view of NSF's activities in supporting computer science. Maybe thinking more from your time as chairman at Michigan State, how did it look from there the support that DARPA, and NSF, and ONR earlier, and perhaps other agencies were giving?

HEDGES: I guess I have always had the feeling, and still do, that NSF supports high quality basic research. Some departments started with a graduate program and in fact continued without an undergraduate program until recently. Arizona is one of those, for example. It's just started an undergraduate program. Michigan State went the other way.
We started in the undergraduate program, which grew very rapidly, and we didn't get as early a start in research programs, didn't get as much funding there as we needed. A lot of the departments around the country that’s typical of others too still have large and successful and good undergraduate programs and don't have as strong and large graduate programs as others. Michigan State, although a large university, was successful in getting one of the small-scale grants. And I am sure you are aware of the conflict of interest policy. I was not involved at all in the program that year. Others carried out the whole evaluation. That was an interesting thing. I knew that Michigan State had a proposal in the pot, so I was completely out of the loop. Other people handled it, went on the site visits, and did the whole thing. But in any case, in a few areas Michigan State is very strong, but didn't have the depth that some of the other departments that emphasized the graduate program did. So we were able to get two or three equipment grants, and we had a few people getting regular research grants. I don't think we had anybody at that time getting ONR or DARPA support. In fact, up until fairly recently, DARPA support has gone primarily to three or four institutions. That has broadened out a bit, and in part, I think because of the CER Infrastructure program. As I mentioned, they see that there are other good programs around and they allocate some money to those programs. So my view of NSF has always been a favorable one and I think they have and do their best to try and work with the advisory committees and the community as a whole and develop programs in the fields that are needed, and provide within the limits of the funding things that are needed. There's quite a bit of interaction, more so the last few years, with DARPA and the other agencies.

NEBEKER: This is another issue, but I am just curious about it, do you think Michigan State could have should have worked at a graduate program rather than a large undergraduate program?

HEDGES: If that were the goal. The large undergraduate program was typical of a lot of institutions in particular, many of the big land-grant institutions went in that direction. There was a big surge of interest among undergraduates in computing, and the institutions saw that was the way to go. The ones that went the other way were more I would have to think each one through but at least a lot of the private schools started with a graduate program. Some didn't do it. As I am sure you well know, in the universities there's a lot of different pressures. What the state fiscal situation is at any particular time, and what the provost and the central administration are interested in
and what other things are going on in the university at any particular time. Do they really want to put in the money that they have available? Certainly, at Michigan State or any other institution they might say, "Well, why don't you emphasize research?" And their goal might be to emphasize the graduate and research program. However, that wasn't seen as a high priority, as serving the needs of a large number of undergraduates, at Michigan State.

NEBEKER: Thank you very much.

END OF INTERVIEW