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Norm Caplan

An interview conducted by
Peter Asaro
with
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Q: Okay, if you could just start by telling us where you were born and where you grew up.

Norm Caplan: Where was I born? I was born in New York City, 1925. That makes me quite old and I grew up in various boroughs of New York, Queens mainly, Brooklyn a little bit. Went to school in City High School, public school, and then went into the Navy where I became an electronic technician and studied radar and repairing radar and so on. Came back from the Navy and went to NYU engineering school. So I graduated from NYU engineering school and then joined the research division at NYU electrical engineering division. Worked there for six years and got my post-graduate education there at NYU, so I'm an NYU graduate of everything in New York. Then of course NYU closed its engineering school. Maybe they saw me as a result. <laughs> They closed up. They closed in 1973. So I did research there at NYU. This is up in the Bronx. They had a nice campus in the Bronx which no longer exists and then I decided I'd go out to industry, so I worked for Burrows, I worked for RCA. We did some electronic countermeasures work. Worked on the Polaris communication system which is you're familiar with Polaris, the submarine? You're not? The submarine. A missile submarine and the problem with communicating with submarines is that they're underwater and electromagnetic communications does not penetrate seawater. So there was also some schemes to communicate with a submarine. That's a whole other discussion we could have. There, what did I do then? Yeah, then I was working with a company called Tracor and we did work on direction finding, electronic direction finding. We did work on communication systems, HF communication systems. I became the vice president for the systems and sciences division of Tracor. I don't know whether you're familiar with Tracor. It's a Texas company. My office was in Washington, but it was a Texas company and they have many, many divisions. Then I left them and went to NSF and we were in Washington at that time. My office there was in Washington, so I went to NSF as what was called the rotator. NSF has this policy of bringing people in for two year and rotating them through. Well, I liked it so much and they liked me, I guess, so I stayed on as a permanent federal employee and at NSF I was a program director for the control and automation program which was the program that was handling control, automatic control and so on, and these are really prior to the days of robotics. We also did bioengineering and I guess those were the two main topics. NSF is a proposal. We accept proposals was the theme there and so we'd get many and somebody had to handle whatever came in. Something was handled, so I handled whatever other subjects were assigned to my – and from there I worked up to section head and then I was division director for three stints there. I was division director for three years or something and they brought somebody else in. Then when that person left, I went back to be division director. So and the division was electrical engineering and then we split off electrical engineering. It became biomedical engineering and environmental systems. So then we did that.

Q: What year did you start at NSF?

Norm Caplan: 1973.

Q: And how did you get into NSF?

Norm Caplan: I'm sorry. Say it again?

Q: How did you get into NSF?

Norm Caplan: How did I get into NSF?

Q: Mm-hmm.

Norm Caplan: Well, NSF is a well-known organization and I knew it and I had a friend of mine was a section head there, a gentleman named Mohammed Gouse who went on to become the dean at Davis. I guess he was the dean and I had lunch with him one day and he said come on up and we're looking to enlarge a section, enlarge the … and I said well, I'm not really interested. <laughs> That was my mistake. I said I'm not interested, but I'll go up with you <laughs> and then it looked so interesting and I said well, I'll try it for a couple years just to broaden my horizon and that was my way of getting into NSF and staying at NSF and I stayed there until I retired from NSF in 2000, I guess, but I wasn't finished yet. I went to work at Johns Hopkins University. Johns Hopkins University at that time had an engineering research center on robotics in surgery, surgical robotics. So I worked with them for two years getting them started and so on and then that was it. Enough is enough, right? I figured it's time for somebody else to get in there. So that's my history and the robotics part really started at NSF. I didn't do much robotics anywhere else. I'm not a researcher in robotics, you understand. I was what was called the funder. I had to make decisions and I was involved with organizations leading and I did a lot of international work, a lot of international robotics research. Again, not research. I never did any research in robotics. So at NSF we were in electrical engineering. You have to understand NSF is divided up into presently into electrical and mechanical, civil – not the name. The names are fancier than that, but and then there's environmental and bioengineering. Then there's a section there on centers and bigger programs and so on. So in our program, in our section we had bioengineering and automation and automation led to the beginning of robotics. So and one of the major contributors at that time was a man named KS Fu and KS Fu was a professor at Purdue and I went out there and visited Purdue and saw KS. He was a very prominent guy and along with him there were three other professors there, George Seridis, who is a founding professor of this organization, a man named Kaship and John Liu. There were four men all in this area of robotics and they were essentially each submitting proposals and doing a little bit different kind of work. One was doing pattern recognition and some others were doing control theory and so on and I talked to them and we set up what I called the advanced automation laboratory and the advanced automation laboratory at Purdue brought the four of them together and I supplied – I didn't supply. I supplied the money. That's all I supplied. For equipment. So we equipped it properly. It's an equipment intensive activity, robotics, if you want to do it right, and we set up

and I thought it was a very successful partnership amongst these guys, these professors, and that worked for many years and then that was really the beginning of my interest in it. Then we spread out and many proposals came in as the field naturally grew and of course it grew from the basic industrial interest in assembly. So the first robots, if you want to call them robots, were these things you see on assembly lines and they're picking and they're placing and they're painting and so on. Basically it's an arm. It's called a manipulator, an electronic, a robotic manipulator, and it's programmed. So in that sense it doesn't have any intelligence. It does what it's told and as the cars come down the line, it paints or whatever it does, bolts in. So that was the beginning and then the next thought was to untether it, make it mobile. So then we went into the subject of mobility. Now as soon as you put a robot or a machine in an imprecise environment, it becomes more difficult to program because now you depend upon sensory inputs. Sensory inputs like humans. You have eyes, ears, your smell and so on. So primarily vision systems came along so a robot had some idea of its environment and other senses were developed. So the whole area of robotics that had to be developed was sensory research so that the robot had some concept and then there's all kinds. Once you untether a robot, once you untether a machine, it becomes a much more difficult problem. The problem of navigation. Humans grow up from childhood and become acquainted with their environment. A robot has to learn its environment. I like to make the analogy that if you take a human like me, drop me into the middle of Africa in a jungle somewhere, I'm lost. I don't know one tree from another. I wouldn't know where to eat. I wouldn't know where to get food. I wouldn't know how to do anything. A robot's the same thing. You energize a machine. Has no concept of its environment and how to live in that environment, how to work in that environment. So that was a major area of research in the early days, how to learn the environment, learn to navigate, learn perception, and then of course the robot has to do some work. It's not a toy. So it has to have a purpose and the purpose is generally something that requires hands. Another big area of research in the robotics field is grippers. It started out with grippers, just two fingers opening and closing, but then as we got more sophisticated, one of the major breakthroughs was a five-fingered manipulator and control of five fingers is a very difficult – I mean controlling them in a coordinated fashion is a very difficult problem. So that was worked on. So various people at this point in the '80s, I would say, were working on manipulators, were working on the kinematics of the arms, were working on stability. Two-legged robots or basically two-legged humans are basically unstable. You really need three legs. So in order to make a robot look like a human, what's called humanoid robots, and humanoid robots are really a small piece of the robot problem, the robot research area, but they're very sexy type of thing because everybody likes to look at oh, robots. They're going to do this, but when you think about a robot as purpose, it either has to work, which is a basic manipulator, it has to move from one place to the other, and so that's more important than it looking, but researchers today will make nice-looking robots, female, male, so it's all cosmetic. It's not a purpose of any sort. And then we'll get back to organizations, alright? So that was really and the line continues today. They're still researching in all these areas to make robots more efficient and more – one of the big problems is speed, agility, accuracy and so on. It's a machine. A machine still follows Newton's Laws. So if you've got a heavy machine in motion, it's hard to stop it. It's hard to move it. Humans are very, very good at these kinds of things. I can move my hand and stop it and athletes are very

good at coordination. Robots are not so good. They still have a lot of limitations basically because the laws of physics are against them. To move fast is not easy unless it's very small and light. Once it gets heavier, then it's another problem. So anyway, you remember I mentioned the four people? George Seridis came to work at NSF. So I was in this office and George was in that office and we used to have coffee and we used to talk and he was a bachelor and he had a pad, a room – I'm talking like a young kid. A pad. On DuPont Circle and he'd come in Monday morning and he wants somebody to talk to him, so we'd have these long talks and he's been thinking about this and he came up with the idea. We need. We were part of the control society at that time, the IEEE control society and we decided we have to split off. We'd have to split off and form our own society because robotics is really much more than just control. So let's see now. By this time, George was back at Purdue and he did all the work. I was part of the council that worked with him, but George did all the legwork, the forms that had to be filled out with the IEEE and we got a council together. I remember KS Fu was on it. I was on it. George. I'm trying to remember who the other guys were, but I can't. Oh, Lou Paul. Lou Paul was on it. He's not going to be here. I saw he didn't answer and there were several other people on it and Seridis did the work. He got the – you don't become a society right away. You become something else, a council or something. So we ran some meetings and brought people in and they signed up and we got I guess enough people. I'm not really sure what the process is, but I guess you got enough people, you become a society. And I guess we ran the first conference in St. Louis, if I'm not mistaken and I think KS Fu was the general chair.

Q: What year was that, if you remember?

Norm Caplan: Probably '83. One of those, '83, 4 or 5, one of them because then there was a meeting I remember in Atlanta. The Professor Book. I remember him because the name was so peculiar and I think that was – you're stretching my memory now as to what came first. But that was the early days and we just continued doing it year after year building the organization and the robotics society is automation and robotics, really. Everybody talks about robotics, but there's a big automation component to it which is a completely different thing. So at the council we had long discussions about what directions we would go in and there was a considerable discussion of the social impact, the labor where we'd get a lot of feedback, a lot of arguments from labor leaders who would not like this idea of robots replacing people and we discussed this academically. None of us really were in a position to do anything. We were mostly academics. We saw it was a fruitful discussion, a fruitless discussion because we had no impact on anything. Labor and management and so on would go ahead. General Motors wasn't interested in our opinion or whether they should use manipulators or not and lay off people, so we dropped that end of the discussion and stuck with the technical aspects of it. And from there the organization just grew. It became technical societies within our society or technical I guess they call them technical –

Q: Committees. Technical committees?

Norm Caplan: Yeah, something. Subsets. And one of the subsets was conferences. So there were publication of conferences. There was technical considerations and now there's industry. The vice president on societies, the vice president for technical affairs, for industry affairs, for conference affairs and so on and the years went by. I got interested in the conferences. I was the first vice president. Well, I was president in '91 and then when the conferences became more interesting, I ran the first, one of the conferences in Minneapolis, as a matter of fact, in '96, and then I ran it again in 2006 in Orlando. So I was general chair twice. Now you asked about IARP. I could talk an hour on IARP. That's a very interesting subject. It's international. So in the early '80s, the same subject about robots and the effect of robots on labor and so on and there was a meeting of the G7. It was G7 in those days in France and G7 under Mitterrand, I guess. Probably pronouncing that wrong, but the president of France, and they came up with this idea of forming a robotics taskforce and all seven countries in the G7 agreed to serve on it. There's no power there in the G7. They just have to coordinate, but France and Japan, and Japan was the leader at that time in robotics. There was no question about it. They were way ahead of us and so they decided to form a taskforce and report to the next meeting what we could do. That taskforce was assigned by the President of the United States to his science director. His science director assigned it to the director of NSF. Director of NSF assigned it to the head of engineering. The whole directorate, and he assigned it to me. So I think it was a Friday night and I was ready to go home and he said no, we have to go over to the executive office building. So I went over to the executive office building, met with the science advisor and he gave me all kinds of advice. He said there was a meeting in Japan, an organizational meeting in Japan, and his main concern as always is that we don't do anything that would jeopardize US industry's competitive position and I said don't worry. I don't know anything that will upset the US industry. I'll take a drink of water. So I went to Japan. That was September of '83, I believe, and we had an organizational meeting there and there was Japan was represented of course. It was in Tokyo and France was represented. They were the so-called lead countries and the US, Great Britain, Italy, Germany. I'm missing somebody, aren't I? Who am I missing? It'll come to me.

Q: England?

Norm Caplan: There were seven countries. No, Great Britain. So US, Japan, France, Great Britain, Germany, Italy. Who else is there? <laughs> That's alright. It'll come to me. There's another country floating around somewhere there in the robotics field.

Q: Yeah, the seventh.

Norm Caplan: Anyway, we had this meeting and it was a very difficult meeting to organize because each country has a national program, a national program in the sense that France was directing a lot of their energy into undersea robots. Italy was into energy. They're still into

energy programs. Oh, Canada. Canada was the other country. We forgot poor Canada. <laughs> Of course Canada doesn't have much – I better not say this on camera. They don't have much of a robotics. They admitted it. They're not much into the robotics field.

Q: They built the space shuttle arm though.

Norm Caplan: The space shuttle arm, which of course is funded by NASA. But that was a matter of fact, we had a meeting in Canada. We had two meetings so far in Canada. We rotate every year. And from those humble beginnings, we're now 16 countries. So many, many countries came to join us. A lot of people try to join, but you can't join. It's a national thing. It has to be a government. So 16 countries and how and our next meeting will be in Poland in September. So Poland joined. China of course. We're very happy to see China because they're very active now in robotics. Russia joined early in the game and let's see. The Netherlands was there for a while. Norway came in. So we had a very good representation. Hungary is now in there. So we've got a lot of little countries that are highly specialized in robotics and one of the primary activities that we engage in, there are some business activities, but the primary technical activity is that we spend two days on what we call country reports. So every representative has to give a verbal report and also a written report. The host country gives a one-hour report on their robotics activities. So this is essentially a coordinating group and we all know each other. We can call each other. We send a part of the IARP is to send study missions. So for example, China, when they first came in sent a mission to the US and I happened to be working at NSF then, so we arranged a tour for the various labs. Germany did a tour of Japan. There were various activities. Each country funds their own activities. One of the first things I learned is you can't interfere with the national programs and you can't change the color of money. They will not pay anybody else to do anything. They keep their own money for their own purposes. Excuse me.

Q: And over those years have you seen trends in the way that the different countries invest in robotics or those kinds of things?

Norm Caplan: Yeah. Well, one of the things that we promoted over the years as you see different elements appear on the horizon and where the research seems to be going. We stayed away from industrial activities. Industrial activities are well funded in each country and it's highly proprietary. General Motors won't tell anybody else and so on what they're doing. So we made an agreement in the early days and it took two meetings. One two-day meeting in Tokyo and one two-day meeting in France and an interesting side story. In France I was with the Japanese delegate who was a very high-level guy. He spoke French fluently. He spoke English fluently and so on and we were in the same hotel one evening and we were taking a walk and I said to him – I forget his name. "Mr. so-and-so, Japan is way ahead in this robotics field. Why are you so cooperative with the rest of us?" He says, "Oh, Japan's way ahead, but the US has the

researchers." So they obviously knew they had to reach out for more innovative stuff in other countries and I always thought that was a very interesting remark that he made because Japan was way ahead in those days and people were all playing catch-up. And so we focused on – I'll go into the details here. Since each country was different, we created a matrix and the matrix was countries here, one axis, and subjects on the other axis. So there was bio-robotics, environment, and a whole list of robotics subjects and each country could decide what they want to be involved in and that stopped the arguments as what the whole organization should do because it allowed people to focus on what their interests are. So as I said, France was undersea and Italy had some undersea stuff, mainly energy, so we picked them out and over the years subjects emerged because there was more background research going on. So for example, the medical application of robotics, that started really to percolate the way up as companies got more interested and there was more impetus to develop that field, so we ran several workshops and meetings and brought researchers together in that field. I should've added that generally when we have these meetings once a year, the host country will also do a workshop, host a workshop, and some countries in our business meeting, they will offer a workshop and if many people agree, then they'll host a workshop on some other subject that they want to pursue. So we've had workshops in every country. In several, as a matter of fact. Some countries. France is very, very interested in various aspects, mainly in Toulouse. There's a lot of industrial work going on in Toulouse.

Q: And the people who go to these workshops and these meetings, are they all governmental?

Norm Caplan: No, no. No, the government is the organizing committees. The meetings that we hold which we call a forum and that word only came up because the Japanese came up with that word at the beginning, so we still call them forums once a year, but the meetings are held and academics are invited. Industry is invited. Whoever. For example, now Belgium is very interested in demining. There's a word for it. Demining for civilian purposes. Not military demining.

Q: Mine clearing.

Norm Caplan: There's a word. I can't think of it right offhand. So they run a number of workshops and a number of – there's a whole study group. We have study groups. I could talk for several hours on the subject. They created study groups and they're pursuing with their leadership they're pursuing this human demining or something. I forget what it's called, but they've had meetings in many places. I looked into that when I was at NSF and it turns out that that kind of work is done by the military, even for civilian purposes, done by the military, and once you get into that field, it's all classified or something. Politics. So we never got too involved in that demining activity, but they're very active. They've had experiments in Afghanistan, experiments in other countries that have mining problems. Not mining problems,

but we got interested in mining too. That was another subject. Canada was particularly interested in mining. Automated mining. So we've had several workshops on that too as to how to do underground mining safely, and there's a good subject for you because miners of course are in danger. It's a terrible job. On the other hand, they're working. So they said oh, we're going to save you. You've got a dirty job and they said leave us alone. You're going to save us to put us out of work somewhere. So that's a very complicated situation.

Q: And was the aim of these meetings mainly to exchange information or was there also some form of fostering collaborations among the countries?

Norm Caplan: There have been. These situations really, I mean things like collaboration grew not so much from us as leaders of the organization, but from the members. We'd have a meeting say on mining and not demining, mining, and Canada would be interested and then some other country would say, "Oh, we're very interested in the subject too," and there would be a little collaboration going on which is really not under our auspices, but they would figure out what they wanted to do, joint experiments and so on, and France and Japan did some joint activities and there was a US-France program that went on. I remember Lou Paul as a matter of fact who used to be a president was one of the ex-presidents. He collaborated with a fellow named Georges Giralt in France and they did a collaborative project. Let's see. I'm running out of speed, running out of time.

Q: So just to go back to –

Norm Caplan: I could tell you my other one, other activity, NATO. <laughs>

Q: Ooh, we'll get there. But while you're still talking about the labor issues. So you said that when you sort of left that behind in the '70s, but then it sort of came up again with the miners and Canada. Were there any sort of more formal relationships with the…

Norm Caplan: No. No, what I said was when we had the organizing council to form the society, that was one of the subjects we decided we would not handle. That was the only time. Otherwise it's a very important subject.

Q: Yeah.

Norm Caplan: It just wasn't something IEEE, which is a technical organization, would have any influence on at all.

Q: But under any of the organizations you were with, were there ever moments where organized labor approached you or the organization –

Norm Caplan: No, we never had organized labor. No. We've had workshops on – some of the other countries were quite interested in that subject. We've had a couple of workshops on that subject.

Q: Which ones?

Norm Caplan: Subject of human interaction with – as soon as humanoid robots started coming in, then you started to think of the interaction of robots and humans and there's still – there may be sessions here that are on that subject.

Q: There was a workshop at Vienna.

Norm Caplan: Maybe a workshop or something. So there were some countries were interested in that and they had some joint activity going on. We're talking now. This is the 30th year of the IARP. I think I can proudly say we're one of the few international organizations that last for 30 years. They come and they go, but we've managed to hang in there.

Q: Why do you think it was so successful?

Norm Caplan: Well, I think two reasons. You want to know the practical reason? We don't ask for money from anybody. <laughs> As soon as you get – I don't want to go into the US budget and how that works. I've been involved with that for many years, but when you get a line item in a budget – I shouldn't say this on the camera. Somebody looks, says, "Oh, look at that money there. They've been doing this for 30 years. They don't have to do it anymore." I won't mention any names, but congressional people will come over. So we keep a low profile. We spend very little funding. The money is very little because each country pays for their own and we're accomplishing what we think is an important work. So it just keeps lasting and more countries keep joining. Portugal is trying to join us, but they can't get a government letter because their financial situation is bad. So they can't, but they've attended. We've had what we call observers at the meetings, so if a country, Taiwan for example, wanted to join. So we give an observer status and the EU is part of this organization too, so they're observer status, but Taiwan is not an observer anymore and I don't want to go into that. The reason for that is a little difficulty between China and or mainland China and Taiwan. A subject I'd rather not be on camera with. But then NATO. NATO is a big military organization, but NATO also has a science side. I don't know whether you're aware of that. There's a whole science side to NATO and in the mid-'80s, they decided to hold a – I don't know what they call it. A council or

something on robotics. So I was involved with that for a number of years. We did a lot of workshops. We did a lot of meetings in Brussels and other places, visited plants and so on. It was a German automation plant. So that was another aspect, but the field grew fantastically fast compared to others and some of the prime things I think you see are in surgical activities and the center that I worked with at Hopkins actually was Hopkins, MIT, and Carnegie Mellon composed this engineering research center and they were primarily interested and still are in surgical robotics. So they created the steady hand for operating purposes. They created a machine that can do extremely precision type of surgery. Where humans might have a tremor, a machine doesn't tremor. I'm running out of steam.

Q: What was some of the research that NATO was pursuing while you were there?

Norm Caplan: NATO?

Q: Yeah.

Norm Caplan: That was a very broad band. I was trying to remember. Primarily the focus was on vision, vision systems, although we had a couple of meetings I remember in Toulon we had a meeting on undersea robotics and yeah, my head is really going. The northern part of Italy on the coast there. What's the city?

Q: Genoa?

Norm Caplan: Genoa, right. We had a meeting in Genoa on that subject and a lot of broad based meetings. We also had in the IARP reviews, robotics reviews. So every five years or so we would have a meeting and bring in whoever we felt were the top experts would come in and give a presentation and they would sort of lay out where they think the field is going and we would write a report and disseminate them. The main thing is disseminating these reports. There was nothing classified. We never dealt with anything that was classified. So everything the IARP does is in the public domain. Yeah.

Q: And what do you think are some of the results of for example the work of the IARP and having these reports and this dialogue among the countries?

Norm Caplan: Well, it's hard to quantify results like that because –

Q: Not necessarily quantitatively, but just even in terms of maybe how the field developed or did it affect, for example, how different countries chose to spend funding?

Norm Caplan: Yeah. That is true. The last meeting we had or not the last, but the previous, the interest seemed to be in education. There was a lot of things automating education and robotics in education, use of computers and so on, and several countries have gone into that since. Each of the delegates at the IARP meeting is a government representative and he reports to some government entity and tries to influence what that – it always gets back to money. Tries to influence where their funding will go. Sometimes I guess they're successful. Sometimes they're not. It's all according to the country and what their interests are. Again, each country, the problem we always ran into is each country has a national program. Sometimes it's called a national program. Sometimes it's just you can see from what they're doing that it's a program and they probably have a five-year funding program and you can't interrupt that and say, "Oh, you ought to do something that we came up with." It's too hard. Too much inertia in the system to try and do something like that. So what I would always the analog I would say is there's national trains going in each direction and most of them, if they're parallel, they're never going to meet. So you can't throw them off the track because there's too much bureaucracy involved.

Q: In your years at NSF, did you see the way in which the interests of the US research evolved over those years?

Norm Caplan: Well, the NSF. That's an interesting question. At NSF, we started this in the electrical division and the mechanical division also had robotics work and kinematics and so on. However, after I don't remember the dates, but NSF then started a computer science activity and robotics slowly moved into computer science. So the only place I think you'll see a robot title or robotics in a write-up of any sort would be in the computer science area. So it developed –

Q: <inaudible>

Norm Caplan: See, NSF, being a research organization, never really funded the entire subject of robotics. It would fund kinematics. It would fund vision. It would fund manipulators. Computer science and so on, and these were small individual projects that came together under other auspices. For example, another example comes to mind. <laughs> In Ohio State, we created – I funded it as a matter of fact, a hexapod vehicle, six-legged vehicle, which they entitled, the students called it "the bionic bug," but it was not a bionic bug. It was a machine. ARPA, NASA. I'm not even sure anymore. Picked up that design and enlarges it and they used it for moon exploration or something. So a lot of the work we put the feed money in. NSF doesn't have big money for those things, so somebody else eventually picks it up.

Q: So basic research.

Norm Caplan: I'm sorry.

Q: More basic research then.

Norm Caplan: Yeah. Well, NSF is a basic research organization, sure.

Q: What were some of the other big projects or research centers that you funded early on in the early robotics at NSF?

Norm Caplan: Well, let's see. I'm afraid I'll insult somebody if I leave them out. <laughs>

Q: Just the ones that you remember the best. Don't worry. It'll be our fault because we edit this stuff, so we could've edited it out by mistake.

Norm Caplan: Well, we did a lot of work in prosthetics. As a matter of fact, I remember at MIT we funded something which was laughingly not formerly, but laughingly referred to as the computer in the leg. So we had amputees, real amputees in their human gait lab or whatever and we were funding prosthetics that would – as a matter of fact, we funded leg prosthetics, arm prosthetics, and looking at various control mechanisms. You can design a beautiful prosthetic device. As a matter of fact, they were probably designed in the 1800s for rich people who lost a limb, but controlling them is the big problem. You can design the mechanical design. They look beautiful, but you can't control them. So the thought was to put a computer in the leg, but how do you control the computer? How do you connect the brain to the computer? And that's still a very big problem. They tried to use myoelectric signals. They tried to use many different types of signals and talking about human interaction, the thing that was most interesting is that the amputee, and we worked with some at MIT. The amputee who you would think would love to have this device because we had them walking and all, he didn't want it. Why didn't he want it? Because if he stumbled, and the leg kept moving, he was only afraid that he would be laughed at. So it was more he was willing to suffer the old-fashioned way of moving than to be embarrassed. So the thing had to be absolutely ensured that there wouldn't be any negative responses and walking up stairs, walking up a ramp, it's a very complicated situation, but I was always amazed how the amputees, we had a couple of them that were really discouraging us. He said it sounds like a good idea, but if the battery runs out, if we fall, the worst thing you can think of is to be falling and have his leg going up and down. That was one of the big projects.

Q: And that was at MIT mostly?

Norm Caplan: That was at MIT. There was also Carnegie Mellon, but the fellow at Carnegie Mellon who was doing leg in locomotion moved to MIT also. I forget his name. He may be here.

Q: Mark Raybern?

Norm Caplan: Yeah. You know him? Yeah. Haven't seen Mark in many a year, but he was very interested in that subject.

Q: That may be a great topic <inaudible>.

Norm Caplan: And let's see. St. Louis University, Washington University at St. Louis. They were doing some good theoretical work. Seridis was very interested in the theoretical aspects of control. He was doing things that I never understood. It was too complicated for me and very fancy mathematics that were beyond me, but everybody else. NSF sends proposals out for review, so the program director or the division director makes a decision, but only based on inputs from other places, which brings me to the NIH started a program because of us. They won't admit it, but <laughs> and this is a long time ago, so nobody's there anymore who remembers it, but we started a bioengineering program and they sent a delegation down and said, "Oh, you guys are interested?" NIH is, I may say, run by doctors, physicians, so it's hard to get them into technical things, but they came around and I think they've started, if I'm not mistaken, a bioengineering program at NIH, so we coordinated with them. We did a lot of imaging, medical imaging. That was a big subject and acoustic imaging. We got into acoustic imaging, sonograms and so on. We had some projects that failed. For example, we wanted to do characterization of tissue by ultrasound vision, ultrasound imaging, and characterizing is it cancerous, that sort of thing, but that was too complicated. We had physicians who come in. First thing they said, "Well, what do you mean by tissue? What's the definition of tissue?" Well, anything that's alive. So it never worked because it's too complicated. I had another program called noninvasive imaging, noninvasive diagnostics. Noninvasive diagnostics where we used imaging cameras inserted in the throat and many other ways of diagnosing medical problems. So that went on for a few years too. We got some good results out of that. So I was there 30 years or so, less than 30 years. Too much to remember them all.

Q: What were some of the biggest technological successes of those 30 years of robotics that you saw?

Norm Caplan: Big successes, huh? You sound like my boss. He always asks the same thing. What are you doing? <laughs> Well, I think the bioengineering area, because I happened to be interested and I was doing that personally. Even before I went to NSF I was into bioengineering.

I think that was the imaging. We did ultrasound imaging. What you see today, all these machines, I have to say that many of them were started at NSF and they were picked up. Then the subject of success, you can have a technological success, but it won't be picked up for various reasons. One is money. The thing with medical is that companies will pick them up. This is a third-party payer called the insurance company. So you're not dealing with the public. If you had to deal with the public like selling automobiles, you've got to make something that's affordable. Sometimes technical research is not affordable when it comes to commercialization. So I think we came up with a lot of success, but they may be blended into something else. One of the purposes is to publish. That's an absolute necessity was to publish. So we published. Everything that NSF does is. There's no restrictions on publications. Public funded. It's public money to fund it. It's in the public domain.

Q: And what are some of the biggest challenges facing robotics now?

Norm Caplan: What are the biggest challenges? You shouldn't be asking these. Kids walking around here. <laughs> You shouldn't be asking me. You should ask these young kids who are getting into it now. I think from what I see in the field, utilization is probably. If you go into humanoid, you have to look at the different programs. Humanoid robots, not undersea robots and so on. Undersea is another big area that I think is very successful. We had a project at Woods Hall which involved going deep and I think the same guy that found the Titanic, if I'm not mistaken, went down in a vehicle and found the Titanic. I think he was a professor at Woods Hall. I can't remember his name either.

Q: Yeah, it's escaping me right now but I'll try to...

Norm Caplan: Yeah, he writes papers and all. He's well known. So I think one of the problems is transferring robotics into usage in a more general sense. It's happening in the medical profession because in the medical profession I say the doctors will decide if it's beneficial, its efficacy and so on, and they'll encourage people to build these machines and then the public of course has to pay. Sooner or later insurance rates go up and so on, but a humanoid robot, we have one section in IARP called personal robots. Personal robots for helping handicapped people. Personal robots for you'd like to have a butler and you'd like somebody to wash your dishes for you, but very expensive, very slow, dangerous in many cases. Now there's another area of human interaction to get into is the relationship between humans and robots in a safety sense if nothing else. So there is a safety. We had a big conference on safety, human safety. So I think the promise of robotics in your house, the futuristic cartoons that you see. I forget what they are, flying around robots and so on, I've never been into that much, but these animated things and the cartoons are very far away from that.

Q: "The Jetsons."

Norm Caplan: Very far from that. And even assuming there are people that can afford. If somebody wants a robot in the house, I don't know. I don't really know anybody who would do that. You're much better off in the sense of not having a humanoid robot, but automating the house so that it can function in an automated way rather than having something that looks like a human.

Q: What's your advice to young people who are interested perhaps in a career in robotics, how to go about it?

Norm Caplan: What is my advice to young people? You have to have a passion. That's the only thing. It's a tough subject technologically, scientifically. A very hard subject to deal with, and you've got to have a passion. I know when I worked at Hopkins there were a couple of years helping them start that center. I was amazed. These graduate students came in and there was we probably had six or seven graduate students, male, female, come in in the morning and sit down at their computers all day long typing and typing and God knows what they were doing, but they had the passion to sit there. I couldn't do that. I would find it boring probably, but they just – so you got to have passion in order to be ahead in this business. And because you're not going to make a lot of money. I don't know of anybody in the robotics field that has made a lot of money. Even companies don't make a lot of money. So where it's going to go in the future, when it'll ever be a household item, more likely it's going to have specialized application. Warehousing. We did some work with the – I was on a committee that looked at the Air Force. I think it was the Air Force. Air Force material distribution and we automated, gave them suggestions to automate their whole system. That's again a huge. You see some of these warehouses that the Army has. So in applications like this, I think you'll find specialized applications. Undersea stuff. You can do that. Where there is government support for an activity, you won't even know what they're doing because a lot of it's classified. The military are doing it, ARPA is doing it and so on. You'll see progress being made there. In specialized fields where there is insurance companies or some third-party payer, but when you get down to the consumer, there you're going to find very, very slow progress in robotics outside of toys, Lego toys and things like that. It's too expensive and not utilitarian enough. So that's really a challenge to try and move that field.

Q: And now –

Norm Caplan: Conferences like this. That's the purpose of getting people together and trying to move it.

Q: Currently the NSF has the robotics initiative, the national robotics initiative, and it is really focused on this notion of collaborative robots, really robots interacting with humans, and so that

seems like veering in the direction of having more and more of this human and robot together, like maybe in some not in necessarily just the warehouse, but in a lot of other areas.

Norm Caplan: That's a good direction.

Q: Do you have a feeling for why they went that way?

Norm Caplan: Well, I mean there's many, many aspects of robotics and robotics research that they could've gone into. A lot is already being supported in other places and one of the newer fields and again IARP has had our conference on this and it is robot interaction. In other words more than one robot working together and that's a fascinating field <inaudible> but I read up on what they're doing. So I think they're basically looking for interesting problems to use as platforms for research and sensing and haptics research and so on where they can develop more basic knowledge to be applied to other things.

Q: Were there ever any controversies in terms of should we go this way that were different projects to fund or different directions to go in in terms of robotics or maybe even getting rid of robotics? Were there any controversies that you witnessed in NSF?

Norm Caplan: By management? People above?

Q: Just in terms of discussions of kind of where to go with robotics.

Norm Caplan: Well, I mean there's always discussions on it, but NSF is really a responsive organization. In other words, the researchers, the research that we funded there was always in response to a proposal. So you could organize proposals under an initiative like the robotics research initiative, or you could just let the interests of the community which was the basic idea of NSF to begin with that you had interested researchers and they will submit proposals and they will be peer reviewed and funded. So I think the way NSF has evolved is in trying to develop platforms. So there's still – I don't know. I haven't looked into it, but in my days there was a lot of money. We divided up the budget. Most of the money would go into individual investigators, unsolicited proposals. Some money we put aside for young investigators. We had a young investigator program. Some money we put aside for projects and that's still probably the way it has to go. What the future holds, I don't have a crystal ball. <laughs> But I think in my view, maybe I'm cynical, I think consumer robotics is a far, far off thing. You've got to change some basic physical things first.

Q: What about robots as a way to draw kids into engineering and science <inaudible>?

Norm Caplan: Kids are going to go in that direction because it's sexy. Robots are sexy. You don't want them to go into some mathematical formulation of equations because that's not sexy, but they see robots in cartoons and so on, so people interested go into that, but I think that young people have to get a good fundamental education. Maybe I'm a traditionalist, but I still think you're an electrical engineer first. Then you're in robotics. You're not a robotics engineer and then become familiar with electricity. You have to get a fundamental understanding of engineering or computer science and then specialize in robotics. So these kids who think they're going to get a job building robots, it's not going to happen. It's too complicated a subject. Get a good education. That's my advice.

Q: Great. Thank you very much. You should run and eat.

Norm Caplan: Have I fulfilled your needs?

Q: You have. Yeah definitely. Unless there's anything you want to add or that we missed.

Norm Caplan: Nothing I – I've got a million stories to tell you, but I'm exhausted.

Q: Yeah, no. Unless you have a really funny one that's short.

Norm Caplan: I have a funny one, but I can't tell it in mixed company.

<laughter>

Q: Close your ears, Selma.

Norm Caplan: I really don't even have that many funny ones in that subject, no. Well I have another. We had a lot of fun in the old days, but it has no bearing on the science or the field or anything. Just a human. One thing I have to say is the community, this community, in my days at least were very friendly. There was rivalry in the research and so on, but I never saw – well, I shouldn't say that. Occasionally, there would be somebody who would accuse somebody else of stealing his work or something, but generally speaking, this, the IARP, is really a remarkable camaraderie. People get along very well. Especially if you don't have any political forces working on you or financial forces. You stay with the technical stuff, you go out and have drinks with everybody later, you can have a good time. And then the subject always goes to something technical because that's what we're in. I don't know anything about your personal life, so what do we talk about? You sit and have a nightcap at night and you're going to get into technical

subjects and that's how a lot of information is and people have started joint projects just based on having some drinks tonight. That's the way life works. Humans.

Q: Yeah. Thank you. Thank you very much.

Norm Caplan: You're welcome.