Interviewer: If we can start by having you tell us your name and where you were born and when?

Carme Torras: My name is Carme Torras. And I was born in Barcelona in 1956. And well, in a middle class family of five children. My father had a university degree in chemistry. And my mother was at home taking care of us.

Interviewer: And can you tell us a little bit about your early education and how you got interested in robotics?

Carme Torras: This is a long story. I had an interest in understanding how the brain worked since I was very little. So when I had to choose studies I studied math and philosophy. I had two majors. I ended up doing a lot of applied math and computer science. And then I went to industry when I finished. But I wanted to continue learning. So then I applied for several universities in the States because I had read two books that impressed me a lot. One was Michael Arbib's, "Brains, Machines and Mathematics." So I wrote him a letter asking whether I could work with him. And the other was Frank Rosenblatt, "Perceptron". Unfortunately, he died about the time that I was writing. So Michael accepted me in the program. I got a scholarship, a Fulbright scholarship and I went to study at UMass. And there I was following a program in brain theory. And I completed a thesis in this area in neuro-modeling. And when I went back to Barcelona, while it was not easy to continue to doing research in modeling, in neurophysiological structures. So they offered a position in robotics and I accepted.

Interviewer: Why did you decide to go back to Barcelona?

Carme Torras: Because-- Well, this was a hard decision because in the States they offered me a lot of resources and to continue having a very nice environment to do research. But I like my country, Catalonia, very much. So I finally decided to go back.

Interviewer: So what was the kind of environment in robotics and the types of products and research that they offered you there?

Carme Torras: It was at the time it was the Puma Robot, the unit made Puma Robot was famous. So we had a couple of these in the department. And we worked mainly on industrial projects linking quality assessment, vision and manipulation.

Interviewer: Did you work with any particular companies?

Carme Torras: No, it was mainly doing demonstrations and well automation companies had robotics. And at the time we were collaborating but more as a counseling than really giving advice than doing research.

Interviewer: Where did the funding ~~coming~~ come from if you know?

Carme Torras: Well, we had actually a U.S./Spain project with Robert Kelly, a quite well known researcher and it was about manipulation in industrial environments. So we got some funding from this U.S./Spain committee. And also there were fairs and robots on display that gave us money also from Town Hall and things like that.

Interviewer: And was this what you did for your Ph.D. research?

Carme Torras: My Ph.D. was in neuro-modeling. So I did temporal learning. And later on I applied the algorithms I had developed from biological inspired animals-- ~~or~~ oh no, biological inspired models of animals. I applied them to robotics, to motor control. And we had several European projects on this area, actually in the period 1992-1995 we had four European projects on this area.

Interviewer: So you started working on the robots after you became faculty.

Carme Torras: Yeah.

Interviewer: Can you tell us a little bit about your Ph.D. work and who did you work with and the kinds of questions you were interested in?

Carme Torras: Yeah. Well, as I told you I was interested in understanding more the brain, but at the time-- well, this is a very ambitious. The human brain is difficult to study. So we studied low structures of nervous systems of mollusks and, for instance, in my case the crayfish that has few neurons. And the idea was to see how they adapted to different situations. And what was learned were the patterns of activity which were rhythmic. Well, my thesis was-- first it was written in Catalan, as a matter of fact, and then translated to English and published by Springer-~~-~~Verlag. And then these temporal pattern learning we applied to model control of robots in these European projects I mentioned.

Interviewer: Can you tell us a little bit about the European projects and the application of your model?

Carme Torras: Yeah. Well, we had some projects on really neural structures. And one was a project named B-LEARN named behavioral learning. And first the thing was to learn manipulation in real time environment. Another project I liked a lot was called PROMotion. It was led by Jean-Paul Laumond and it had to do with motion planning, motion planning in very cluttered environment and we applied a lot of geometrical algorithms for moving structures in very difficult places, not just mobile robots but manipulated robots. I've been always mostly interested in manipulation.

Interviewer: And when did you work on that project?

Carme Torras: When? It was from 1992 to 1995.

Interviewer: Who else was on the project?

Carme Torras: Yeah, there was besides Jean-Paul Laumond, there were a group from La Sapienza University in Rome, Alessandro de Luca, Giuseppe Oriolo and Marilena Vendittelli. There were other people from INRIA in France, Jean-Danielle Boissonnat. And also people-- well it was a project with six teams. It was another one from Utrecht University, Mark Overmars. And it was a very successful project. And afterward he developed several other works and projects. And we continued collaborating with these people, with Alessandro and with Jean-Paul.

Interviewer: And how did the people get together in this first project?

Carme Torras: Well, I was contacted. Usually, the project coordinator, in this case Jean-Paul Laumond, in the case of B-LEARN it was Rüdiger Dillmann. All of these projects are all in the front year between AI and Robotics because since my interest was in intelligence and the brain I work mainly in cognitive robotics, in projects that had to do with artificial intelligence and robotics. So I don't know if this answered your question.

Interviewer: Since you were interested in the brain initially how did you feel the robotics really added to that interest or helped with those kinds of questions?

Carme Torras: Well, in artificial intelligence, only one part of intelligence is really studied. The more logical and textual and language part I would say, the formal reasoning. But a lot of the intelligence comes in perception, in manipulation, in using the body somehow. And maybe in people it's not often aware of this. They think that well, reproducing medical behavior is-- medical, I mean, diagnosis is a very difficult task. But while there is a protocol and it's something that is always rules. While common sense and moving around the world and understanding what's going on around the situations this is much more difficult to formalize. So I got very much interested in this part of intelligence. And for this having a body and the robot has a body it's very important. So the interest comes from here.

Interviewer: What kinds of questions did you think robots kind of lead you to work on in this area? What were some of the challenges and some of the exciting findings that you had?

Carme Torras: You mean, what the development were? To me learning. Learning was the most important challenge. And first I approached learning from the neuro-network point of view. But later on I became more interested in symbolic learning, in learning to plan, learning to communicate, learning to interact. Nowadays, I'm very interested in manipulating ~~the formable~~deformable objects, mainly clothing both for folding and unfolding clothes at home or in hospitals or whatever. And also helping disabled people to dress because we found-- well, to me, assistive applications of robotics are very challenging. And in this particular domain ~~the formable~~deformable object manipulation since the object have so many degrees of freedom it's very hard to learn. And we teach the robot by learning from demonstration. So since this robot should be helping people that are not experts in robot programming. So it is important that the way to teach them is very easy. So through demonstrations showing the robot how to fold clothes, or how to help dressing someone is a way of that layman can teach robots. So I'm very interested in that.

Interviewer: How would you approach differ or be similar to some of other ones of learning by demonstration with like _____ or maybe some of the work of Andrea Thomaz and other people who also are interested in that area. e

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Carme Torras: Yeah, well, actually have-- we follow similar patterns. I would say that the application to clothing is something new. And it requires the modeling, the cloth, the formations in a way that is different from computer graphics in which very detailed realistic models of clothing are done. We are more interested in qualitative ways, more topological. So my plan is to apply topological constructs, say, that are now under

development for to bring topology and so on to this field. Because my background is in mathematics so I like to be able to apply these topological concepts in this assistive area.

Interviewer: And how did you get interested in particularly this kind of idea of clothing and assisting ~~because~~ people with clothing themselves?

Carme Torras: Well, I like very much assistive robotics. So maybe I should now enter into another-- I like to disseminate also a lot to society what robots can do for us. And what types of robot society would like to have. So I gave several lectures at home and in public audiences, trying to tell people that what society at large wants from robots is what at the end will be developed somehow. So when I gave more technical talks I didn't get as much audience as when I decided to write a novel, a science fiction novel which was about this in the future how robots could either help us to get more creative, to amplify our capacities. Or on the contrary, take all decisions out from us and make us almost useless in the sense that well these movies "WALL-E" or that robots at the end rule the world and people are just there on vacation. Enjoying but without really making a difference. So after writing this novel which is called "The Sentimental Mutation," I got many audiences interested in the topic. And they began to send what the good aspects of robotics could be and what also the bad possibilities of robots would be. So I was engaged in many interesting discussions on what the robotic research had to hit. So I really enjoyed that because I really think the society at large is not very much aware of robotics. And they would buy whatever is on the market, say. And there are, for instance, now appearing in Japan babysitters that are robots and that are in kindergarten. And well this could be good if these robots are educational. But it could also be bad if children only relate to robots that do whatever they want and do not learn to have empathy with real people. So I think when people that are not experts in robots are told about this and we discuss they get very, very much interested and they form an opinion so that they-- for their children or whatever they would buy robots that would increase the creativity and would make the people and the children, grow, not just enjoy themselves. Well, you understand what I mean, I hope.

Interviewer: When did you write the novel?

Carme Torras: When? You mean time it was in 2007. It was published in 2007, this novel. I wrote others but this one was particularly important to me.

Interviewer: And it would be great if you could tell us a little bit about your other novels as well and kind of that part of your thinking and your life. But also how did you decide to write this one? What kind of led you into it and how long did it take you?

Carme Torras: Yeah, well, I was attending many meetings, brainstorm meetings in the European Union specifically to shape somehow the field, what the money should be invest and so on. The European Union became very interested in cognitive robotics. So I went through all of these meetings in which very bold ideas of what robots we should be researching came up. So among them there were people that thought that for robots to be truly intelligent they should be completely autonomous. So at the end they should interact or go through the world with their own goals and their own structures. And they should relate among themselves and not be somehow controlled by people. And I became a bit worried about this because even if from an intellectual point of view it is very attractive to make some species, new species that these intelligent and independent from humans. I'm not sure as humans this is what we like. So to begin thinking myself of what robots I really would like to work on I started writing the novel because I had written novels before that were not science fiction. And this helped me a lot in positioning myself on what type of robotics I would like to work on. And well, that was it as a matter of fact. And I shaped it very much the main character in the novel is a girl-- well, the thirteen-year-old that is cryogenized at the present time because she has a terminal illness. And then she's brought alive again eighty years from now where her family is dead. And she finds a new world in which each person has a personal assistant that relates both the children and grownups. And there are grownups that have shape tuned their robot so that it helps him or her to increase his capabilities, the same way we tune our PCs today or to make us more knowledgeable and more intelligent, say. And others that just use the robot to do all of the tasks and they just enjoy themselves. So they became less intelligent I would say and less human at the end. Well, this is the plot of the novel. But there are some characteristics that I foresee that would decrease. For instance, one is admiration. In this new world no one admires anyone. And on the contrary, as I said, some people got a lot more creative by getting knowledge from the robot and getting help because the robots are very good at certain things. They are quick. And so this symbiosis between robots and humans could be very productive. So all of the different possibilities show up. And, of course, there is a plot. I mean this girl goes through all these troubles with an adoptive mother and kind of boyfriend. <laughs> And there are some deaths also because in novels there are deaths and not killers in this one.

Interviewer: So after writing this and having this opportunity to think through the question what kinds or what types of robots do you want to create?

Carme Torras: Well, this type of robot that are an assistant that helps you, that points to you, for instance. If you do the things always the same way you can have this assistant that tells you, "Oh, well, you could do it in some other way." And look at this device or at this news or that have appeared that may interest you. So give suggestions and helps you out in being more creative and taking the best out of you. And at the same time helps you in things that are not interesting, I mean at home, doing laundry. And for disabled that could help them to have more autonomy. Not just a wheelchair is a kind of robot, we

could say, that helps in mobility. But you can have other robots that help you dress or, for instance, grown older people or elder people have problems in putting the socks. So having an assistant that could help in this sense for grownups or elder people to live by themselves without the need of someone there to take care of them if they are okay at the intellectual level it's very nice. So this got me into this clothing thing because I think that many elder people need assistance in dressing up, in doing very easy simple things but that they cannot do.

Interviewer: And you mentioned that you got a lot of feedback from the public.

Carme Torras: Yeah.

Interviewer: And did you get feedback from your colleagues as well?

Carme Torras: Not so much I must say. <laughs> I found out there are not so many colleagues that read science fiction. And I think it's very-- well, I like reading a lot also and I get many good ideas from reading science fiction. I don't know if you know of this author Neal Stephenson. I read many of his books and, in particular, I was impressed by "The Diamond Age" that had a lot to do with education of children and I'm very interested…

Interviewer: You're still a little girl?

Carme Torras: Yeah. that's it. So he gave a lecture at Arizona State University called "Innovation Starvation" meaning that today scientists do a lot of routine research but not big challenges, great innovations like in the past. He was mentioning, for instance, the space exploration that the program went down now. He was talking about the States, obviously. Or the invention of the microprocessor big things that change the world. He was saying that the way science is developing nowadays with everyone very interested in engineering their curriculums and so on makes science to be more incremental and routine and not explore bold ideas. So he gave this lecture. And the president of the university was present and decided to open what is called a Center For Science And Imagination at Arizona National University. And there they hold groups of people from the arts and humanities together with scientists. And with the idea of having bold ideas and see if they could be really realized. So I think this is a great idea. And I think more of this should be going on. And I think the population, in general, is quite open to this type of brain storm ideas. And while sometimes the academic world because of this pressure to publish and succeed is less open to this I call them bold ideas or very innovative. Maybe they are not physical, no problem, but maybe some will be.

Interviewer: So what are some of the ideas you've gotten from science fiction? Have they inspired any of your projects or approaches to your work?

Carme Torras: Yeah, I think yeah. But it's difficult to point out a particular finding.

Interviewer: It can be generally.

Carme Torras: But generally, yes, this concept, for instance, of symbiosis between persons and robots take the best out of the robot. But if the robot cannot do something it's not important that the robot has 100 percent probability of doing it right. I think the robot should be able to see what they don't know how to do or what they are bad at doing and ask someone. If we are placing robots in human environments robots could profit also from humans. Perhaps for a human it's very easy to tell well, just pick up this tool to do this, you are not doing the right thing. Or if the robot cannot reach a given position because it asked the person and this can speed up the process very much. So in our learning algorithms we do a lot of this. We start from an autonomous learning algorithm for the robot. Say, for instance, learning to plan. We can demonstrate to the robot how to plan an assembly, even an industrial assembly and the robot learns by demonstration. But maybe at some point it reaches a situation that is different because the initial conditions of the work pieces are in a different position or because it's upside down. And the robot doesn't know how to plan this assembly. We introduced the human in the loop, we say. The robot says, "Oh, well, I arrived up to here in my plan and I don't know how to continue." And then the person say, "Oh, you have to dissemble this in order to put this back." So it's a way in which you don't need to spend lots of time, the robot trying different possibilities and maybe some are irreversible, that he drops something and is broken. And the person can help very easily. So this is one thing from this idea of science fiction of robots and humans really teaming up to make something better, more intelligent, more efficacious or came from here.

Interviewer: So c~~C~~an you tell us a little bit more of some of your projects, other projects that you've worked on related to some of these issues of collaborative or learning by demonstration. What other projects have you worked on?

Carme Torras: The two last projects I worked on one was called GARNICS and it was about when you have-- it's a botanic aid. When you have greenhouses, large greenhouses and the purpose is to grow plants o that they grow as fast as possible or they flourish is as much as possible. What is usually done is that different rows of plants are given different treatment both of nutrients, lights and watering, et cetera. And then you test which grow better. But then you have to probe to see how they are developing, what is called phenotyping. You have to take samples from leaves or measure

chlorophyll of leaves at different time periods, every four hours, every six hours. And this is done manually usually with graduate students or Ph.D. students. So this project was about taking these probes automatically. So we developed a robot that looked for the leaves and the right place to sample them because you don't have to touch the veins and so on. And sample either by taking disks out of them or by measuring the chlorophyll. Well, this project ended and we have a patent on this. And it was nice because it's a type of the formable object, plans, but it's not the clothing. So it was an interesting project. this was one. And the other one was called IntellAct. And it was about intelligent action. It was a little bit related to what I called-- I mentioned about assembly. The idea was to be able to in a space station for instance to teach a robot how to build an assembly or to do some repair operation, then monitor how it was being done. And in the case that the robot was doing some bad movement, advise the robot, "No, this was not what had to be done." And if the robot got stuck, didn't know what to do, be able to, show teaching by demonstration what to do. And then the robot would incorporate what we call cost effect rules that would be later on used in planning new tasks. So this was the project and it had the beginning we thought through virtual reality because it was much faster. But afterwards it was implemented in reality, I mean, with real objects in a real environment.

Interviewer: And who were the funders for these projects? And did you work with anybody else on them?

Carme Torras: Yeah, they both were European project. one had four partners and the other had six partners, and it was entirely funded by the European Union, under this cognitive robotics projects.

Interviewer: Would that be under COGNIRON, or no?~~.~~

Carme Torras: It was in the sixth and seventh framework programs. There was a call specifically on robotics and cognitive systems. So it was in this call.

Interviewer: And who were some of your collaborators? You mentioned there were four on one and six on the other one.

Carme Torras: Yeah, in the GARNICS project there was a botanic institute-- well a research institute in Jülich, in Germany that was the coordinator. And the final demonstration was done in their greenhouse which it's very big. We worked also with the University of Göttingen, Florentine Borgotten [ph?]. And there was another partner from Estocal [ph?]. And in the other project the main contractor was Norbert Krüger from--

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well, he moved and at the end he was in the south in Denmark University. And we work with other European partners there.

Interviewer: And when were those projects being done?

Carme Torras: One was from 2010 to 2013 and the other in 2011 to 2014.

Interviewer: Could you tell us a little more also about your earlier project, like I think we probably skipped a bunch of things in the middle.

Carme Torras: Yeah, probably.

Interviewer: Could you tell us a little bit more about the different kinds of things that you worked on over the years? Maybe some of the things that you found most challenging or some of the things that you think of as your biggest successes?

Carme Torras: Yeah, there are a couple of projects I'm very proud of. One was a European project called CONNY in which we developed self-calibration algorithms for space robots. The main contractor was Daimler-Benz Aerospace. And since when a robot is in the space station the communication is slow. S~~i~~o it's important that the mis-calibrations and the wear and tear that the arm robot suffers can be repaired on-line. So we develop these self-calibration algorithms that was quite successful. And another outcome I was very proud of also was an inspection of very large war pieces like wings from aircraft, aircraft wings that was done for Thomson and that we have the patent on it. And it was based on inspecting holes and different things that could be there using neural networks, so without really programming in detail what had to be measured but just showing good parts that were in the right condition. And then learning what the features were and trying to find these features in the pieces being supervised. I think this was also a nice outcome of our research.

Interviewer: And did you have any partners in that research as well?

Carme Torras: Well, yes, we worked in one case with Daimler-Benz Aerospace and in the other case with Thompson in France. Well, some of my collaborators, I had very, very good Ph.D. students that now are very well-known researchers. I like to mention one of them is Federico Thomas, that he has worked with me along the years and we developed, I think, very nice algorithms and systems. And another Ph.D. student of mine is also quite well known is Jose Millán that he's ~~not~~ now Defitech P~~p~~rofessor at EPFL.

And he's very well-known now for brain computer interfaces because he worked with me in the period in which I was very much interested in the brain and neural networks. So I had very good luck with my-- I have supervised at the moment thirteen Ph.D. students and all very bright and they did very well and helped us a lot. And some of them are still working with me in Barcelona.

Interviewer: Are there any other students you want mention? Any ones that kept going on in robotics?

Carme Torras: Well, most of them have the thirteen-- well, the first one went into industry and he did very well in Roca ~~[ph?]~~. it's a very well-known company in Catalonia. While the two I mentioned were afterwards. And well, there were other. I had only one woman Ph.D. student and she's now in Australia and she's professor there, so she did very well also. It's Elisa Martinez. And who else? There are like five that work still at the same institute that I'm in, that are on my team. Because in Spain it's a bit different from the States and other countries where each professor somehow has post-docs and so on but not so much work with other has in the team other faculty. In Spain, we have groups in which we are seven, six, eight, faculty so this is my case. So I could retain five of my previous Ph.D. students and this is very nice because we are very much teaming up having the same outlook on things and I think this makes us quite powerful in developing projects and so on.

Interviewer: ~~so~~ So why did Spain develop that kind of organizational structure?

Carme Torras: Well, the institute that I work depends on the Council of Scientific Research of Spain which is something like the CNRS in France or the CNL in Italy. I mean it's a research, pure research organization. And our institute depends also on the technical university of Catalonia which is in the campus of the University. So we get the best of both worlds from the research domain, having these teams with several permanent position researchers. And from the university having many students on campus. So I think this model that was set up like maybe 20 or 25 years ago where the idea was to have a research center that applied for projects in the European Union and also in the Spanish government and that had a fixed team of researchers but that could somehow get researchers from the university depending on the demands of projects. So if we got a project on computer graphics, say, we could ask the department of computer graphics in the university to have some professors join us for a temporary time. So this way we manage to have quite much broader background and we could apply for bigger projects than just being a university department or a purely research center. We had this good arrangement that has been maintained until now. So this is good. the bad part is

that the crisis in the last five years we didn't have more positions, permanent positions because there was a strong cut in research resources in Spain and in Europe, in general.

Interviewer: Can you tell us a little bit more about robotics in Spain more generally, like what the kinds of things that people focus on? Or what is the environment like?

Carme Torras: Well, there are quite strong group, many strong groups in Barcelona, in Madrid, in Zaragoza, in Castellón, in Valencia.– I would say that the focus before was mainly on mobile robotics because in universities, in particular, it is easy to set up environments with mobile, it's more mobile robots and have a large offer for students to do things with these robots, practice and so on. So there was a long tradition in mobile robots. Not so much on manipulators but it's coming. I mean there was some work on manipulators mainly for industry. And now, the field is developing more towards manipulators in human environment, manipulators that have medical applications. There is a big group in Barcelona working on medical applications. And also in assistive environments in these human robot cooperation. I see a huge application field also in industry but in applications a bit different from the production lines which we are used to. But in those tasks that could to be automatized until now because they have the formable objects like cables or tubes. For instance, even in cars there are all these tubes holding the cables. And this is done manually at the moment, the shape. And people get injuries because it's hard work and very repetitive. So if we could do better in robot manipulation of the formable objects which is our subject we could not only apply this in assistive environments but also in industry to show robots how the task should be done through learning by demonstration. The humans that are doing the task at present could demonstrate this and then robots could do it. So I think this has a lot of potential also.

Interviewer: What do you think are some of the other challenges in robotics in general but also for your future work?

Carme Torras: I think I would put it this way. There are two challenges. One is understanding because robots do many tasks but they don't really understand what they are doing, the semantics of the work that they are doing. So if we could make them to better understand scenes, not just labels, chair, table, but know that well now, we are in an interview. These are focused and what's going on, understand really what's going on. They could transfer this experience to other similar situations. While if it's only at the level of labeling then they cannot do this transfer of knowledge. So I think a big challenge is working harder on understanding both the perception and manipulation and reasoning so that this could facilitate the transfer to new tasks, new environment, to deeply understand the situation. This is one thing and the other is take profit of uncertainties because usually in computer programs yes, you could measure somehow the uncertainty of in placement,

in location. But, for instance, knowing what actions really would ~~incase~~ increase the uncertainty to an amount that is unbearable, for instance, dropping something and breaking or injuring the robot. So programs that could manage uncertainty and take profit, not just say, "Oh, if I do this I do it with uncertainty so I better skip this." But taking risks but knowing the risk one is taking. So making risk aware uncertainty aware robots I think it would be a nice thing. People usually deal with uncertainty very well. They know what reason about uncertainty. While robots at present they mainly try to reduce uncertainty to skip uncertainty or to escape from uncertainty. So these two things understanding and uncertainty I call the UU challenge. <laughs> It's very important.

Interviewer: And when you're thinking about these challenges do you take-- since your early interests were in kind of the human brain and mind and how that works, do you take inspiration from some of the ways that people do things? Or are these systems kind of inherently different and therefore the approaches also need to be different?

Carme Torras: Yeah, I really believe that the components of robots are very different from us so their capabilities are very different, are complementary sometimes to us. So I think the procedures-- we have done too much in the way of trying to imitate the way humans do thing. I think for robots the procedure should be different. I read a book that was very influential to me called "The Sciences of the Artificial" by the Nobel prize Herbert Simon. And this influenced me a lot because he was saying this with a very simple example are birds. That birds flap their wings while aircraft don't. So it's clear that depending on the materials and on the procedures and capabilities of each entity, the way to develop should be different. So I strongly think that biological inspired has clear limitation. It's not the main interest in robotics. The main interest is to develop skills and capacities that are very appropriate for the tools they have or the types of materials they are made of.

Interviewer: What would you say inspires your work now? What do you kind of use as a way to think about what type of solution you want to bring? Is it the limitations of the technology? Say something about the task.

Carme Torras: Well, I think it is very useful to look other fields, perhaps, more artistic. Well, I like reading a lot, as I said. But also, for instance, from design because we like, as I said, robots that could be easily programmed and could easily cooperate with laymen with people not an expert in robotics. So I think industrial designers have done a lot of work on trying to make things that are easy to handle. For instance these initial devices, I don't know, tape recordings and so on that were very sophisticated but nobody how to use them. and even the clock many times was not put on time. People used very few of the-- and now I think the designs with the mobiles and all of these, well, Apple did a lot on

this direction. So I think roboticists could learn a lot from industrial designers specialized in usability. And this is something I have not seen explored. And I think it could be a nice thing well to get inspiration.

Interviewer: Have you had any opportunity to work with designers or no?

Carme Torras: Well, I have friends that are designers so I interact a lot with them and this rings bells sometimes in my head. I mean they are designers, interior designers, designers of tools and furniture and also graphic designers. But I feel that the way they address design or building a new thing is very different from the scientific point of view. And they take a lot of-- take into account a lot the needs of the person. And that maybe it has not so many capabilities but it's very intuitive and easy to use. So these human robot interfaces should be designed in this way. That it would be very easy for the person to instruct the robot or to see what the problem was with the robot. So this inspired, again, this idea that robots should explain themselves not just try to solve every problem, optimize everything, but be able to say, "Oh, here I got the problem and my internal state is this," to communicate this to the person so that the person can, "Ah, this is the problem." Very easy to do this. So I feel that we have a lot to learn from people that has thought about usability and a lot, and good design. Good design in the sense, functional design.

Interviewer: And I've noticed that you've made some talks about being human in the robot age. Does this have to do more with your book?

Carme Torras: Yeah. Mainly with my book. Yeah, but well, as I said, I was very-- I think I gave this talk in the science forum in ICRA, the robotics conference in Karlsruhe because they had this forum titled "Robotics Meets the Humanities" and it was very interesting because philosophers came and artists, filmmakers and writers and scientist, roboticists also. And we had this interchange that was very fruitful. For instance, this issue about what the robot should look like for to be accepted by humans. And there are studies that show that the more human like it is the more people get attached to it, up to a point. So it increases until what we arrive to the-- how do you call this valley?

Interviewer: Uncanny valley.

Carme Torras: Uncanny valley, that's it, that drops dramatically when it has-- the robot has a humanoid appearance. But there is something strange. You see that it's not human. And then people is reluctant to relate to it. So, for instance, some animated drawings like the "Wall-E" I was referring before has much better attachment than this

very sophisticated human-like robots that imitate people like the Ishiguro replica. They made many replicas that are very, very like humans. But you see this spark that is not really human. So we discuss this because this goes back to all ages that creatures that look human but are not generate this kind of I don't know separation. And then filmmakers they said also their opinions and we showed movies. And I think this is very nice to create-- not to isolate robotic researchers from the world but to really get involved with the world. And I think in the future there will be a lot many more robots around us. So it's good that people get an opinion on what robots they want to have and not just let the multinational companies do whatever they want and sell us whatever they want. There were these-- how were they called? Takamochi [ph?].

Interviewer: Tamagotchi.

Carme Torras: Tamagotchi creatures that many children got and that they were all time dependent on them because they had to feed them, give them medicines. And these devices created a dependency of a device that was not alive and didn't give anything in return to the child. So I'm glad that-- I don't know if I should say that but I'm glad that they disappeared from the market because I don't think they added anything. So in the same way they could sell us little robots that are very nice, very entertaining, toys, but that only generate this dependency, without addiction, without giving anything in return and I don't like these type of robotics. I like educational robotics. I like robotics that make people grow and get the best out of themselves.

Interviewer: What do you think is the way to really communicate with the public? Because one sentiment that I often here is that it would be great to get the opinion of the public but the public doesn't know about robotics so really their opinion is not very well-informed.

Carme Torras: Yeah, that's it.

Interviewer: So is it kind of just giving them more of an idea of what's going on and what the capabilities are and then getting kind of feedback from that perspective? For example, as in your book.

Carme Torras: Yeah, well, this is what moved me or triggered me to write this book. And I found out that really the response has been incredible. I mean when I give more technical talks even for the general public I do not get this emotional involvement as I get when people have read the book or they have heard about it and are very interested. Because then they feel it's part of their lives and they really think that their children or

their younger relatives will live in a world full of robots. And they like to discuss possibilities and to get to know what is possible and what is not, what is hype and what is something that in ten years or less we will have. And to learn about that in Japan in many senses they have more robots than, at least, in Europe, I guess, also that means the States. So they get very, very enthusiastic about discussing. Probably because since in a novel there is emotion and there are characters that relate among themselves and there is a plot and there is something that is more close to their lives than just explaining, "Oh, well, we have developed this robot for surgery or for whatever." That well they see these scientists are progressing but they don't see these in their lives, while in a novel or in a more social context they do see. So I was impressed because it's a change. From my technical dissemination lectures to my reading club lectures completely different. And I like the ones here much more, much better. And I feel that people are very open. It's just that they need to be able to somehow place these things in their own context and mentality. But they like to discuss and in some places I went back and back because they like new generations to continue learning about this. And so I have a great time.

Interviewer: I was wondering, since you've been working in the cognitive robotics community in Europe and that's a big focus of research in Europe could you tell us a little bit about how that got started, why it turned out to be an important topic for the Europeans, how it's developing?

Carme Torras: Well, I guess, the focus went to cognitive robotics in Europe because our background, the background in Europe in both computer vision and AI and neurophysiology was quite strong. While, this is in general terms, mechanics in the U.S. and Japan I think were more strong. So I guess having this strong background together with this perspective of assistive technology and so on made the European community focused on this program robotics and cognitive systems. And it's been quite successful for quite a long time because many interdisciplinary teams formed with a lot with neurologists and neurophysiologists and computer scientists and roboticists in order to build systems that were more capable of reasoning. And maybe we bought somehow the mechanical technology and our focus was more on software and doing these type of software. So we came from I think determining what the strong points of the community, the research community in Europe could be different from Japan and the States. This is my view. I don't know if I answered it.

Interviewer: Yeah, that's great. That's perfect. I was also going to ask you a little bit about your involvement with some of the institutions, professional institutions and robotics. So I think you're the editor of the-- or were the editor of IEEE Transactions of Robotics

Carme Torras: I am at the moment editor of it. Yeah, that gives me a lot of work to do.

Interviewer: And then I noticed you were, I think, on the organizing committee of IFOLK [ph?] 1985.

Carme Torras: Yeah, I've been in many organizations. Yeah.

Interviewer: And I something like EURON II on your CV. Or were you involved in the organization of EURON at any point?

Carme Torras: Yes, I was the representative of the Spanish Council of Scientific Research in EURON.

Interviewer: If you could tell us a little bit about these organizations and how you got involved and what were some of the aims, who were some of the other people?

Carme Torras: Well, EURON was a network that tried to join all of the resources and groups doing robotics in Europe. So it went on for two periods, I think, that was financed by the European Union. And there were one yearly meeting where all of the groups got together and they wrote the roadmaps of how the robotics research should develop and like to this cognitive emphasis. And after this six-year period because it was three years, years, the companies-- because there was a separate organization for companies. So the two mixed together and now it's one joint organization. But in the early days many initiatives were set up like a distribution list of conferences and so on, this roadmap, job opportunities. There was several videos being done, advertising, educational resources also, some prices were established. So we felt like really we had a European robotics community. And I think this was very good and this helped then move and join with the companies and so on. So now it's called EU Robotics. It has the two players. And well, it's good because this way the European Union has someone to talk to, I mean, some kind of umbrella that all of the researchers are there and can relate to the European Union with a few representatives, say.

Interviewer: And does it make easier for people to find each other? Or to find funding? Find industrial contacts?

Carme Torras: Yeah, because this Web has all of these resources and yeah, all of these facilities. And somehow there is a chart of all of the resources and groups in Europe which before was scattered and you had personal relations but it was not

organized. And now it's very well organized and were with very few funding. In this way Herman Bruyninckx, who was the organizer did a very good job of putting all of these together.

Interviewer: Have you been organizing within Spain as well?

Carme Torras: Yeah, well, there is also a robotics association in Spain. Yeah.

Interviewer: Have you been active in it?

Carme Torras: Yeah. But in Spain I've been more active, I would say, in the artificial intelligence society. The thing is that my research is just at the front tier AI robotics. So in some aspects I'm more in robotics, some aspects I'm more in AI. And, for instance, I've been active also in the European AI association which is called ECCAI. So yeah I'm in the two worlds and trying to get the best of both.

Interviewer: And I saw that you were an organizer of IFAC ~~[ph?]~~ in 1985. Can you tell us a little bit about that?

Carme Torras: Yeah, well, 1985-- yeah. I studied in the States from '79 to '81. So when I went back to Spain there were not many people that had a degree outside of Spain in something related to robotics. So I was requested to do many Ph.D. courses, organize many events. And one of these was this IFAC symposium in 1985, 4 years after coming back. And yeah, it was at the time more focused on industrial robotics and IFAC ~~[ph?]~~ is more focused on that. And it was very successful. I enjoyed it very much.

Interviewer: Were there any people that you met through that?

Carme Torras: I don't remember but, I guess, Robert Kelly, we had this joint project and he came. And Michael Arbib came for sure. Rüdiger Dillmann also came. And he's also in this mixed line between AI and robotics. So from them there we did several projects together. We had first this B-LEARN European project that had B-LEARN 1, B-LEARN 2. When we had the CONNY project. Then we had this PACO-PLUS project which was very successful also. So we had developed a whole bunch of projects that were very successful. Yeah, it's a good place to meet people in conferences that you organize especially.

Interviewer: And also you've been active in the IEEE organization. Can you tell us a little bit about that?

Carme Torras: Well, I like better to review papers than to organize conferences, I must say. So I did a lot of work as an associate editor for the transactions which I enjoy a lot. And then I became editor afterwards. So now it's been more than five years doing this work. And I like this because I get to know the community very well both in what context, what are the hot topics being developed and also the people, the reviewers and the other associate editors. I like very much working and seeing the different perspectives the different people have. And I think for me I learn a lot. And also I was associate vice president for publications. And I enjoy it a lot also because you can set somehow policies on types of publication. For instance, now there will be a new journal called Letters, Robotics Letters and because in our community it's hard to publish quickly. Other communities like physicists and even other types of engineering have these letters, physical review letters that publish very, very fast. In robotics there is the transactions but it takes time. And we thought that a fast publication trail will help especially young people that need to build a career in order to get the position. So I think this is a very good initiative. So things like that and also another subject that took a lot of our time is fighting plagiarism because in order to develop quick careers people try to publish same thing many times so self-plagiarism. And this takes a lot of strength and resources from the community revising over and over again the same type of papers. So we placed a lot of effort here in this topic also and well, many others. But I enjoy doing-- trying to shape the direction of research so as to be very efficacious in the resources, the human and other resources.

Interviewer: And as somebody who has been involved in the community for a long time both as a researcher and in terms of our service, and also as a member of all of the all-woman organizing committee for ICRA. What do you see are some of the challenges for including more women? And what are some of the ways that more women could be included in robotics?

Carme Torras: Well, it's hard because I would say-- I would have thought that as time goes by more women are involved and it's not the case. At least in Europe in the areas I know, for instance, in Spain I think there are more women involved in engineering, in general, and robotics in particular in my age and a bit younger, than the ones that are entering now. And I don't know very well what the problem is. I can give an example. Computer science was called ~~liciensiatura [ph?]~~Licenciatura in computer science. That means it was not engineering. So there had about 50 percent women and 50 percent which was very nice. Until like five, six years the name was changed to engineering in computer science or computer engineering. And then the women, the number of women decreased dramatically to 15 percent. So just the name, the change of name so that

means that somehow women are scared when they see engineering. It's not that the topic itself. So I don't know what should be done but I guess there should be actions to get like this one having all women in an organization to see that engineering and robotics in particular is something that women can perfectly handle. And we do not need to freaky. We are regular women with families and children and so on and we can do it. But it's really something that puzzled me. It's not clear what prevents women from going into engineering careers. It's not just robotics. It's a problem of engineering. The word engineering, as I said, I don't know. Mathematicians there are 50 percent, even computer science when it was not engineering 50 percent and why? Who knows. Engineering it's a word that scares women it looks like.

Interviewer: Well, in the U.S. computer science is something like fifteen percent without engineering.

Carme Torras: Yeah. But there is this image that computer science are freaky also. That they are all of the time in their virtual worlds playing games which women do not like. Even at the level of children I see in my nephews and nieces and my daughter that women or girls like social networks but to socialize to speak. While boys like to play games and they all of the time are playing games, while girls are not. So there is really a cultural whatever difference that girls are not attracted to this type of virtual worlds and I don't know.

Interviewer: Do you have any suggestions for what might be done?

Carme Torras: Well, I attended several mentoring programs. In Barcelona there was a very successful mentoring program for girl engineering, for tutoring engineers, women engineers. And I think it's been very nice because women that had permanent positions advised young women not only in academic careers but also in industry. And we suggested ways to handle because sometimes they are afraid of how to relate to their male coworkers or how to deal with their families and interviews, what to say about if they want to have families or not, all of this. So I think this was very successful because many of the fears they had could speak them out and handle them better. So I think these type of mentoring programs could be very helpful. And there are also within IEEE I think there are mentoring programs of this kind in the women in engineering chapter or I don't know how it's called. So I think yes, just by trying to erase these fears from their minds should be good.

Interviewer: And one that we also ask is if you were going to give some advice or say something to young people who are interested in robotics, interested in a career, or studying robotics, what would you tell them?

Carme Torras: Well, I would tell them that basic subjects are very important. That it's not only the technology but to me learning mathematics, physics in depth is very important because once you get to build machines and so on you don't go back to the basics. So this is the advice I usually give to students that if they can do a solid career, not just jump directly towards technology but build on the basic subjects this will help them a lot to make really breakthroughs in the future. That's it. Because I mean many times tell, I prefer a well-informed or well-grounded mathematician that can study computer science or how to program afterwards than vice versa. That is almost impossible to go back to the-- and at least in Spain there are many new careers nowadays that they learn multimedia technology and, of course, it's nice because they directly interact with these programs to create photographs or videos. And it's a big like in between journalism and media which is nice. But if they then want to go to do robotics or something they would need a basis that they don't have.

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