Collaboration in Science Interviewer: Paul Verschure (Convergent Science Network)
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Welcome to the Ernst Strüngmann Forum podcasts—a series of discussions designed to explore how people collaborate under real-life settings. Joining us in the series are high-profile experts from diverse areas in society, whose experiences will lend insight to what collaboration is, what it requires, and why it might break down. This series is produced in collaboration with the Convergent Science Network.

P. Verschure   This is Paul Verschure with the Convergent Science Network and our Ernst Strüngmann Forum podcast on collaboration, together with my colleague Julia Lupp, and today we're speaking with Sijbrand de Jong. Welcome to our podcast.

S. de Jong   Hello, good afternoon.

P. Verschure   Before we really delve into the questions around collaboration, it would be very helpful if you could situate us a little bit in your background and in your career path that brought us together today.

S. de Jong   Okay. Well, I'm not completely sure what brought us together today, but I can certainly sketch my career path. So by Bildung [education], I'm a physicist, so I studied physics, but also I have completed mathematics, computer science, and astronomy, so I also picked up parts of that in my study. After graduating at the University of Amsterdam, I did my PhD research on a large experiment, so large experimental collaboration in Hamburg on the HERA ring at the DESY laboratory. Of course, there was sort of as a very junior member of the collaboration. From that, after getting my PhD, I moved on to CERN, I've been for eight years at CERN as a CERN fellow and a CERN associate, really working on another large experiment, the OPAL experiment at the LEP ring. And then after my stint, at CERN I came to Nijmegen. Somehow, I called it coming back to Nijmegen, but I'm not really from Nijmegen as many people will hear. I'm, of course, from the area of Amsterdam. But ever since I've been in Nijmegen, at what was first called the Catholic University Nijmegen, and now it is called the Radboud University. There I served in several managerial tasks. So I've been a department head, I've been the director of the School of Physics from 2002 to 2004. After that, I was the founding director of the EMAP Research Institute for Mathematics, Astrophysics and Particle Physics. After that, I founded the Radboud Pre-University College of Science, so an interface to high schools, and then I moved on to serve on the CERN council and the last three years as the CERN council president. And of course, meanwhile, I did many things both together, always all simultaneously in research, and in governance, and management. So far I have been able to always combine it. So from the first of December on, I will be the dean of the Faculty of Science and now for the first time in my life, I won't be able to combine that anymore with doing really, science myself. I had to give that up and I'm still sort of in the process of getting accustomed to that.

P. Verschure   Well, that's an amazing career up to this point. But then in the context of that experience, how do you define collaboration and what is it good for?

S. de Jong   Well, collaboration already is a very interesting word for those who are not Dutch listening to this podcast, collaboratie, collaboration in the Netherlands, means quite the opposite, I guess, from what it means anywhere else. So in Dutch, it's like siding with the enemy, which is, of course, more or less the opposite of collaboration. I've always been working in large experimental collaborations. So well, in my very first collaboration I worked on as a masters student was only like 60 people, and then it scale up from hundreds to thousands. So for me, sort of a natural way of dealing with this large and complex situations. So in that sense, it's sort of my habitat, my natural habitat, this working with large collaborations. And these collaborations they do, of course, there's the common goal, which is very unifying normally. But of course, there's also a lot of fighting, a lot of infighting, a lot of fighting between colleagues because these collaborations are usually formed from like, well, I've been in collaborations with over a thousand full professors. And of course, they're all sort of king of

their own empire. But then in a much larger context, they have to work together as equals. And depending on, especially depending on nationality, that gives more or less problems.

P. Verschure   So then how does that work? So if you look at these large, the ones you just described, the really challenging ones. Why would it work and why does it fail? Could you describe that or give examples?

S. de Jong   The foremost thing why it can work is to have a recognized common goal. Typically, the cycle in a large experiment is that people dream of doing something spectacular, and then they find out, okay, I can't do it alone, so I need companions to do this, and then they round up a couple of friends and then the circle gets larger and larger, and then at some point you have like the volume to jump into the big enterprise. Of course, at that point, everybody's very enthusiastic about the common goal. And then usually things like letters of intent are written, which are, of course…a letter of intent, it sounds like a letter, okay, but usually it's like a few hundred-page book, with quite detailed prognosis of what you want to do and studies on how you're going to do it, etc. So at that point, there's still like one community. Then the trouble actually starts when these things get approved because then suddenly, like the first hurdle, the first goal has been taken. The approval is there, okay, so what do we do? Now then of course typically there's years between a new collaboration approved and a large apparatus really being built. And so there's lots of designs in between, and this design phase is usually like a huge fight. It's like a huge cage fight because you know you're condemned to one another, yet you want to kill the enemy, okay, you want your idea to prevail. So, it's really like a big, an enormous, big cage fight, and then all sorts of things come in. So not only the scientific argument of what is best, but also in the end, like, okay, my ideas may be second best, but I pay, for it so it's my idea, it's going to be built. And actually, this is one of the better arguments. There are worse arguments that make people win, which I won't go into…And then at some point, this fighting takes usually a lot of time and a lot of energy. People do this actually typically for years in these large collaborations. And at some point I realized like, oh gee, we should have started building half a year, or a year ago to make it for the deadline of, say, the accelerator to be finished or the promised start of the project. And then sort of usually there's first a panic. Then of course there's a lot of blaming and shaming on who is guilty of this. And then people realize like, okay, this doesn't help to actually pull it together. We have to really work together again. So then there's usually a very rapid stage of convergence, typically like a month, where people realized, okay, and then people just tend to be more soft on giving up some of their own ideas, like, okay, anything okay, as long as it's being built. And so then there's this phase of building where people are pretty much unified. And then at the point where the whole thing is going to be commissioned, there's usually like a great group spirit, okay, but things tend to work together, sometimes miraculously. There's also great satisfaction, and group identity, and big parties, sometimes parties of thousands of people. I mean, you build belief in quite a lot of time, and then of course, you have to start the experiment and usually the first few measurements are again, really like the core business. So everybody's unified, big success, and then you get into the stage where you have to accumulate more data. And to either supersede the first publications or to do something entirely new, you just need so much data that you need to wait for years, and then people start to fight again because there is one analysis against the other because they're basically waiting for data. They get a little bit bored, the initial successes are over and the goal becomes sort of fuzzy. So my conclusion from all of this is that it's all in the goal. okay, if you have a strong common goal, you can get people working together.

P. Verschure   What makes it collaborative?

S. de Jong   The Nobel Prize started in 1901. At the time, the Academy of Science and the Karolinska Institute were not particularly interested in the award. The king also thought it was a very bad idea to have an international prize. It took several years for the Academy of Science and the Karolinska Institute to reach agreement on what would be recognized, but when they did, they created a very interesting structure that is still in use today. It was very insightful,

e.g., to invite universities and academies around the world to nominate candidates. Then, at the end of the nomination period, the committee meets to review the various nominations. Some nominees may have been previously nominated and thus known to the committee. For others who are nominated for the first time, the review process is more extensive: experts in the field who are on the committee prepare short, written accounts (2-3 pp) to help the committee evaluate the nominee's contribution. Those found to be particularly interesting undergo further analysis. Once this barrier is crossed, several people are asked to submit an in-depth analysis (e.g., status of the field, unique contribution of the nominee), which takes several weeks to prepare. A crucial criterion for the Nobel Prize is that of discovery. It is not an award for lifetime achievement. It honors a distinct discovery. Sometimes, after several years, different specialists may come to light, and everybody agrees that this work seems to have the appropriate scientific value. If so, it becomes a possible candidate. Again, this selection process was conceived over a century ago. No other prize has the structure of a written account and a history. This means that when the committee considers a specific area, it can go back to review what was discussed ten years ago. Within the committee, deliberations are usually very collegial. Of course, different people have different interests and inclinations, but in general, people are very enthused about being able to select a discovery that represents a very good prize.

P. Verschure	But Sijbrand, if we focus on the goal as the unifier, is that really enough? Because in some sense, it's also at some point, these phases you describe, right, of infighting, coalescing again, and so on. In some sense, now you also have a limited resource that you know you have to share in order to achieve your selfish objectives. So this is our new element that comes in. So is the goal actually still the same?
S. de Jong	So again, the resources can play both parts. So of course, when the project is defined, everybody realizes that, okay, I cannot pay for this on my own, so we will have to share it. And then everybody, of course, immediately agrees that, of course, if we have to share resources, we also have to share responsibility, and share tasks, and okay, fine. No problem. But then, especially in this design phase, when people have already committed basically their resources, then it's like, yeah, but you give like a thousand, and I give ten thousand so I can tell you what you should do. There the resources are abused again…
J. Lupp	Before we go to that stage, I want to back up again to the goal because you're talking about recognizing a common goal. But how is that common goal constructed? In other words, if you have a collaboration of eventually a thousand people, are a thousand people involved in constructing the common goal. Who constructs that common goal?
S. de Jong	So usually, of course, there's like a couple of people that really pull the cart, that really express the goal and usually those are the people that can make good presentations, presented in a very nice way so that it's convincing. But usually these goals that are then defined by individuals already, are like living in the community for quite some time. And that's what people recognize it and say, yeah, I thought the same and then they join this collaboration. Of course, also projects actually exist where people are so much ahead of the troops that they have marvelous ideas. But if it's not living in the community, they consider that they have this brilliant idea the three of them, and they have to find half a billion bucks with the three of them, and it's not going to happen.
P. Verschure	Sijbrand, do you see a stage where the people who might be in front of the troops start really an active, let's say, campaign?
S. de Jong	Yes, that's usually what is being done.
P. Verschure	Okay. So how is that structured?
S. de Jong	It's just like going for it. So you have this idea and then typically you try to get conference talks, you try to get…And also what is very powerful in our case is you try to get invited at certain research institutes. You present your case, and especially you go with these people

for lunch and maybe dinner and you try to convince them that it's really a good case and that it would be really marvelous if their group would be joining. And the other thing that is in the first stage is that, of course, at that point, it doesn't cost anything. So it's practically resource free because it's just an idea. So you join this collaboration and then we sort out the business later. First, join us, and can you do a few studies, and run a few simulations, and see what you can contribute to the goals or to the ideas of realizing the goals, and then we see? This is usually how collaboration is formed, and then it's then it acquires…it goes over a critical mass. Then you start looking for resources and then this helps because you're already tied into all the other organizations, the universities, the research institutes, etc., and then each of them has to fight in their own institute for a piece of the pie.

P. Verschure   But that means you first build a coalition, which is a process that has psychological, social components to it. Does that also lead to, let's say, a regression to the mean of the idea? Do you see that also as a compromise?

S. de Jong   Yes, of course. Like I said, at several stages, sort of the idea is watered down; there's no there's no question about it. Usually in the goals, if you're still in the dreaming world, you can actually stick goals, so it doesn't matter too much. Then when you get into the stage where you have to secure the resources, then that is the first time you are confronted with reality and then you find out, okay, maybe you have to rescope a couple of things, or maybe you have to rescope many things. And then usually, of course, the people that can secure the money, can secure the resources, their ideas will prevail. Of course, usually also a couple of good ideas that are in common to everybody will also make it, there's no doubt about that, but then some other ideas of people that are less resourceful, they will have to go, compromise on that. And in fact, it's true that sometimes good ideas go.

P. Verschure   Right, exactly. But then you form your consortium in some sense; now they start to compete with other consortia to dominate for the resource. But now the whole process is extended over years. So what's the mean? What's the duration of such a process? Ten years?

S. de Jong   In our field the process of doing an experiment is typically that you have a phase of five to 10 years, which we call proto-collaboration. So that's when the collaboration is formed. Then typically you have a phase of five, sometimes even to 10 years, where you try to secure resources. It's also true that you never secure the resources that you really need, so you have to decide at what point you're going to just go. So typically at 50, 60 percent of the resources pledged, you just go and you hope for the best. Typically, by the way, this is a short-term mechanism because this is like with all sorts of large public projects. If you go over a certain volume, it's too big to fail. So typically, what happens is you find 50 or 60 percent and there's not so much problem in finding another 30 percent. It is usually the last 10 percent, which is a problem, because then the argument of too big to fail doesn't work anymore, and for that you have to descope. This is typically also a pity because descoping for the last 10 percent actually means that typically the operators only works half as well…which is something that funding organizations do not always realize. But yeah, this is how it goes. And then there's the time of construction again, time of construction in our field is by now five to 10 years. And then there's the time of exploitation, which is typically in our field now going up to twenty or twenty-five years. So you're talking about [PV: forty years], you're talking about people that actually can spend their entire career doing one project.

P. Verschure   So this is important right to understand because now the question becomes; if the goal is so critical in keeping this together, how do you assure that that goal also stays intact over that whole period, is propagated properly, and also that you don't have mission drift, so that the goal fragments?

S. de Jong   In our case, I've never seen that really happen. So the goals are typically so…these are typically already questions that are ten, that are decades above the market; so the really big things that we want to solve. What are the most interesting cases of mission drift, of course, is that you built something for a certain goal, and then the thing is built, and then you switch

	the apparatus on, and you look at the data, and you just find out something completely different. We don't call this mission drift, okay?
J. Lupp	You adapt. Your goals would adapt if at the implementation stage you find new information that will change your goals.
S. de Jong	Typically, the old goals are still there, but you acquire new goals and sometimes the new goals sort of overshadow the old goals. So famous for that was an experiment that tried to look at the decay of protons. Protons and the elementary particle and it's predicted to decay, but with a very long lifetime, because otherwise you wouldn't be sitting here. And so you need a huge detector, and then you look for the one proton to decay, one in enormously many protocols. So they built a huge detector, they wait for this proton to decay, and what they found out is that for a completely different particle, called the neutrino, they actually did some measurements, which were done by the PhD student because, well, they have to do something while waiting for the proton to decay, and they actually found out that these neutrinos they change their nature. So the neutrino could start as one particle and after some while could end up as a completely different particle, still a neutrino, but a different neutrino, so they could completely sort of change. This was a fantastic discovery.
P. Verschure	But the thing is, if it runs over such a long period of time, doesn't that also mean you have different generations, as, for instance, the first push even by a senior generation that in the end also will hate each other so much they cannot go on. But then a younger group comes in to push it to the next stage.
S. de Jong	That's part of the dynamics. Typically, it's the old people just before or just after retirement, the dream of the new big things that they will actually never see working alive. And then in the process, of course, they drag on the younger colleagues. And the most interesting thing is that the peak of the young colleagues joining the collaboration, is typically when the experiment is already running for a while. So in the last stages and then the end part of it is because the old guys in the experiment, they're already busy with dreaming up the next project. So we go from old to young in these collaborations. The average age goes down in steps, but it goes down along the way.
P. Verschure	We looked at the important challenge of goal setting and that how this might be maintained or might also change. But you also mentioned that there are these serendipitous discoveries that are not part of the original path. On the efforts, how is that balanced? So if you look at the high-impact outcomes of all these huge experiments, are most of them on the critical path of the original goal, or are they all this serendipitous offshoot?
S. de Jong	Typically for all the experiments that I know hardly any of them actually have failed to fulfill their initial goal. Of course, sometimes you're looking for things and the things turn out not to exist, which is, among the public, then it's called a failure, but we think actually this is success because that makes a paradigm shift because we always thought something was there, now we discover it's not. So that is a big discovery basically for us, because that means that like your common theory doesn't work, which is a big overturn of the thinking. In that sense, the goals are nearly always met. Like either you find what you were looking for, and you think, personally, okay, I always find like this theoretical idea and you set up to check it and then you check it and it turns out to be true. Yeah, it's like ticking a box, it's really boring. So it's much nicer if you don't find it or you find something completely different.
P. Verschure	So we looked at the goals; we looked at outcomes. But as you mentioned, the process is complex and also contentious. There are phases where people are, like you said in a cage fight. Another aspect of collaboration is that also the different participants at least have a sense of trust in each other and in the process to move forward. How is trust then defined and maintained in such a complex process?
S. de Jong	I don't know how trust is defined, but it turns out that even in these cage fights, or at the end of the cage fights, people make up. So they still know that they are condemned to one

another. There's no way they can have an exodus of people. Like the famous thing, okay, we have is that very often we have like three ideas on a certain detector construction, and they're nearly equally good. And of course, there are some deciding criteria you could sort of say, who's best, but the second and third best, are not so far off. And so I heard one spokesman say, like, whatever I do okay, I will lose two thirds of my collaboration in this decision. And this is true. But we also know that if you lose two thirds of your collaboration, the whole thing is not going to happen. So people also know that they can be sore about things, and they can sort of, yeah, what do you do then? Okay, you kick in a door or so, and then you go home, and after a little bit of sobbing you return, and you say, well, how can I help?

P. Verschure	Okay, so you give in in the end, but is trust not based—because Physics is a very unique domain, right? It's one of the few, to my knowledge, the only area in science where people succeed in pulling off these huge collaborative initiatives. But isn't that also not related to the availability of, let's say, a theory that everybody trusts in some sense? A framework?
S. de Jong	That's also true. So like I said, that's also why there is so little goal drift. Because usually the goals are really sort of stably defined. And it also plays a role in what I said about a few forerunners that promote ideas, but there are lots of followers that already thought, well I had the same idea, okay, so I can join them and then we will make it through success together. So, if it means that the meme is already living in the clouds.
P. Verschure	Exactly.
S. de Jong	There's as much to do with like an underlying theory, which is commonly believed in and relatively stable. So it's not like we change theory every couple of years.
J. Lupp	And so what you're saying is that the trust is in the thing itself, in the ideas, in the concept, and no so much interpersonal trust. Is that what you're saying?
S. de Jong	Oh, there's also interpersonal trust. There's also interpersonal distrust. But in the end, the interesting thing is that even people that have mutual distrust in the end will work together, and really cooperate.
J. Lupp	Is competition in the sense a positive thing for the outcome? I don't mean competition over funds, but I mean competition in terms of ideas.
S. de Jong	Yes, I think overall, yes. So what the competition makes is that people are just sort of working harder, going the extra mile in developing their ideas and in presenting their ideas and getting the details right because they know that if any of these, has a little flaw, then they will be shocked by the other party. So in that sense, it works very much, elevating the quality. On the other hand, practically always it's like not quite the best idea that wins, but nearly the best idea. But then my feeling is that nearly the best idea then would still be much better than in the case if there were no competition. It's actually quite simple, the whole thing.
P. Verschure	But now, if you have competition about ideas, in science there are various mechanisms also to express this competition. For instance, in the critical dependence on peer review. So do you see that people also use that mechanism to dominate or win in that competition.
S. de Jong	In which, because I'm trying to figure out what you mean? To sort of be the referee of the other party?
P. Verschure	Yeah. There's interdependence, right, in the background, there's interdependence, because everyone is in some sense, a potential reviewer of everybody else.
S. de Jong	Yes, and in our fields, they are there more or less permanently because it's sort of in the open. So I think it's not that, it's not that that influences things so much. What does influence things is that, of course, some people are more powerful than others and so there's also a lot of backroom policy. I mean basically all the important decisions are taken in the cafeteria.

	So there's a lot of wheeling, and dealing, and hustling, okay, to set up certain people against other people, etc. So there's of course, also a physicist who is completely human.
P. Verschure	But you have been at different sides of this process. You have been in the middle of it, but also, if you head the board of CERN, you have to manage it. So do you then, from that perspective, are you able to really manage and, or engineer that process by for instance, bringing people together in a certain way or setting up forms of collaboration?
S. de Jong	That's also where we distinguish things. So I was not in management. I was in governance, which is a different game. And in fact, most of the structures are set up in governance, not by management. And actually, this is an important distinction. Because in governance there's a little bit more distance because the governance is always over a number, even a large number of projects. So it's more like a mechanism that would fit all the different things. Management is much more trying to tailor things to a certain situation, and it really helps that the structures are set up from a more global perspective, because if you have also seen structures that have been set up to tailor the situation, and they nearly always end up getting messy because they were so much still a consideration, that new events arise, they have to be adapted, and then you have to add on things, and maybe scrap a few things, and add on more things, so it becomes a biologically grown structure, and in the end, that is very advantageous for the cowboys, but not for the sort of straight-thinking people.
P. Verschure	Then the management becomes part of the situation to be managed. But then from the governance perspective, what you can do is put in place procedures, protocols to try to structure the collaboration. Now for CERN, did you also do that in a very deliberate way?
S. de Jong	All the things are structured very deliberately. So the idea is to have peer monitoring on practically everything. So that's an important thing. And so those people that are in this peer monitoring that are very knowledgeable about what was going on, but they're completely independent to both the thing they monitor and to the body they actually report to. So also, it's not like the body that is in the governance, is actually arranging the monitoring, but it arranges it through a third party, which is an independent monitor. So, they can also sort of say things that are not very much to the liking of the governance board. And without consequences. So that is a very powerful structure.
P. Verschure	So peer monitoring is a quality control system, but that has to operate on, let's say, protocols; well, let's say communication, responsibility. So do you impose structure in a very specific way, like hierarchy?
S. de Jong	Well, who's monitoring is usually…in our case, there's not so much hierarchy in the monitoring. So there's monitoring at, in principle at a rather global level, but they're allowed to actually go into the detail. So it monitors a large span of things. So part of my career I've been into one of these monitoring bodies. And on the one hand, we were dealing with bolts that we should make sure that they did not contain any magnetic material, and on the other hand of the spectrum, we were also dealing with the accountancy of material requisitions, and how this was done, and how this was monitored, and whether all sorts of buying procedures were in place, etc. So over the whole span, we were actually…
P. Verschure	I'm a bit confused now because the monitoring, I understand. But the monitoring will very often have to refer to certain standards to look at different parts of the process, and these standards also must be defined. And I would assume that's also part of the of the governance structure.
S. de Jong	Well, okay, that's the other interesting thing. The real monitoring is done by committees which have very little constraint.
P. Verschure	And who establishes the committees?

S. de Jong	The committees are established by the governance structure. Of course there's a subtlety there because usually they are proposed by management, but then have to be established by the governance structure.
P. Verschure	But that sounds very loosely defined then because that would also mean…
S. de Jong	That part that part is loosely defined, okay. Actually, the strict standards are, of course, things like safety, accountancy, they are quite strictly defined. But since we are in the process of building things that have never been built before, it is very hard to set standards for this. And we go for the common sense of the people in the review committees or in the monitoring committees to see what is right and what is wrong.
P. Verschure	But then you don't try to then extract a rulebook or so, or a playbook from successful projects who say, well, this was the playbook of this project and this could be standards for a future playbook.
S. de Jong	Yeah. That's again, not in the monitoring side, but that is in the implementation side. So on the management level. And yes, there's also like a strong idea of how collaboration is formalized. And there are variations on that. But if you look at it from a distance, then you see that the overall structure is the same and the variations are minor. So one of the interesting things about these large collaborations, for example, is they don't have a boss. So the acting boss is called spokesperson. So traditionally that was the person speaking to the management and the press; most likely a role of management to say how things were going, and to the press to say what they discovered. And basically, that is the person now who was in charge of the collaboration. But that person has no personnel, so there's no hierarchical relation between that person and the rest of the collaboration. Usually, it's somebody from a larger group, showing us like some of the group members, but typically in larger LHC experiment, like 3,500 collaborators, then the spokesperson has, like at most 20 people that he or she can fire. And all the others, there's no leverage. So you have to do it by persuasion and the spokesperson is elected. And that actually is an important thing because that gives credibility. So you're elected. And then, of course, your power in the collaboration comes from the fact that you were elected, and you can always say; okay, you don't like it, then you shouldn't have chosen me.
P. Verschure	Are people also vying and competing for this role of spokesperson?
S. de Jong	Yeah, of course, it is highly prestigious. Then again, okay, so there's like the formal thing, there's the competition, and there are usually several candidates, and then there's the voting, and then there's all the things that you have in the voting process, like people try to gain votes and they make all sorts of promises, etc. But there's also, and that is maybe different from a normal democracy or at least from a national democracy, then there's a lot of things going on behind the scenes. So there's a lot of trading. Like, if I become spokesperson, then this and this person from your institute gets this and this position in the collaboration. One thing, we the Dutch are really not good at this, okay? So that's why Italians always win. They're much better at these things. So we always think that it should be fair and honest, etc., and they don't care. It should just be effective.
P. Verschure	Exactly. But it's also something you mentioned earlier, that there were cultural differences in how people approach the process and without necessarily wanting to hear you say certain stereotypes about different cultures, still, it would be useful to understand how these cultural backgrounds make a difference in how collaborations get built up and work or fail. So what are what are the basic dimensions there?
S. de Jong	Well, again, okay, so in these large collaborations actually it helps to have a lot of cultures because some of them are more risk-taking than others, some of them are more solid than others. And if you somehow can deploy all these qualities more or less in the right places, then it's a very powerful combination. And so again, this is in the process. So usually like the more risk-taking people, they're the ones with the big dreams and the fancy ideas, and they

try things and sometimes succeed and often they fail. But sometimes you get very good ideas from them and then in the end, you have to have an apparatus that actually works. And then there's also a large part of the community, which are just pretty solid working people and apart from the one or two highlights where we have a fantastic idea that works, most of the apparatus is actually built on steady progress. But this combination is quite powerful, and again you never get it perfectly, sort of everybody in the right position, but there is a sort of a natural selection on this because the risk-taking people, they tend to focus on the parts where they would be allowed to take a risk. The people that are delivering solid work, they would go to places where their solid work is appreciated. So there is some sorting out mechanism. The nature of people sort of fits with the thing they're doing.

P. Verschure	But then who are the real players in this context? Who are in the end managing to grab the most control over that complex process? Like you say, these are more the Italians, or the Americans, the British, who are the strong players there?
S. de Jong	No, in the end what you see is like a spokespeople, etc., they're very often, like more of the risk-taking types and the outgoing types. And then there's also a very important role in all of these large enterprises, it is something we call technical coordinator. Which is just what it is. It's the person who coordinates all the technical stuff. And therefore, you need a very articulate and stress-resistant person. And that also selects itself, because typically people that are not robust and stress resistant will actually disappear within a period of time.
P. Verschure	But now so we looked at the process. Can you give an example of what you see as the biggest success of your time at CERN and what was the biggest failure and what's the difference between these two?
S. de Jong	Yeah. Of my time at CERN and of course, I had different times at CERN.
P. Verschure	You can choose.
S. de Jong	Okay, well, but by far my biggest failure, that I consider was that I lost the detector. So I was responsible for a detector which actually melted. It was not a small detector, it was actually a fairly substantial part of a large detector. And that was because basically not all the security that should have been there was in place and then there was a series of human failures in my absence. But okay, I still was responsible for it.
P. Verschure	How does it reflect on the process of collaboration? That was a failure of collaboration, or there was a failure of you just not being there?
S. de Jong	No. It was a failure on my part of sufficiently recognizing human weakness and trying to exclude the risks associated to that, with the fact that there was like a sequence of human failures. A highly unlikely sequence. But then you can say, okay, well, normally this wouldn't have happened, it's not your fault, etc. But any of the failures that was there could have been prevented if the right procedures would have been in place. And so in that sense, of course, after that, you immediately see, okay, if we had done this, this, and this, then this would not have happened, it would have been prevented and at least three or four different things that would not have failed. But of course, that yeah, and what you learn is that you can be more careful and thinking out all the possible scenarios of what...and even if you think like, well, who on Earth will do this, okay? If it can be done, somebody will do it.
P. Verschure	Exactly.
S. de Jong	Well, so yeah.
P. Verschure	But in terms of the collaborative projects...
S. de Jong	What's interesting is that in that case, again; so this was a case in which the experiment was essentially coming to a grinding halt, not only that, it was actually one experiment out of four on the left accelerator, and so the accelerator that we stopped, so the other three experiments would also victim. So it was a big thing because you also have to realize that the

	running costs of these things are about a million a day, and this failure took out like one and a half months. It is not like a small problem.
P. Verschure	So now you're the sixty-million-dollar man at CERN.
S. de Jong	This was spelled out to me very explicitly when I had to go to the director to explain how on earth this could have happened. You feel very tiny at the time. But, I had nothing but support. And even from the director, it was not like, of course, this is really bad, but the immediately like a switch like, okay, how do we recuperate from this? How do we get back on track?
P. Verschure	But what do you see as the biggest success then of these large-scale experiments over the last decades? What's the biggest success story?
S. de Jong	The biggest success? Well, the biggest success, you know, there are several dimensions. So of course, there have been like marvelous discoveries, expected and unexpected, and we have a very different view of our universe actually from the discoveries of the last, well, I would say three decades. So this is one asset from this and that crisis. The other asset is that we have this worldwide collaboration. It's like practically all nationalities of the world peacefully cooperating. I've seen Israelis and Palestinians doing shifts together and actually getting along, etc., so I consider that also to be a big success. And then probably the biggest success for society is that we educated many people in performing beyond state-of-the-art things in large collaborations, in an international setting, and of all the people that come to do these large experiments as a master student even, or PhD student, or a postdoc; in the end, 90 percent end up not in research, but in some other part of society there they play a large role. For example, the whole of ASML would not have been possible if not for the science that we do. Not in terms of that, we invented what they do because we didn't, what we did we delivered the people.
J. Lupp	If you were to construct a future major collaboration using your knowledge of what works very well, using your knowledge of the frameworks that you have in place, but mindful of the fact that failures are inevitable in areas of science where there is not a basis of already understanding mechanisms, as you say, in many of the parts of the project. How do you try to compensate for the unknown when you are constructing a collaboration?
S. de Jong	Compensate for the unknown when constructing collaboration? Well, I think the sort of the best robustness you can gain is by having a fully formed collaboration, to have many talents on board. That is actually the main mitigation mechanism. Is that if something fails, you have so many different angles to look at it that you fix it again. And also before it fails, to have so many different angles to look at things that failure is avoided. And that again, this competition within collaboration plays a large role. Because if you're competing for building the same piece of equipment and you see a flaw in the other ones, you would not hesitate to actually say this will never work, or your thing will burn down in the first instance because, etc. I think that's probably an important thing is this competition in collaboration and the diversity of talent.
P. Verschure	But are you also describing a sort of humility in the face of the challenge, that therefore all the people give each other space? Is that also what you were expressing here?
S. de Jong	No, I don't think it. Yeah. Well, what I say, people only give other people space when they are more or less forced to do so, in terms of things are more relaxed. They don't get humility. And I think humility is not one of our features.
P. Verschure	But I was thinking more about humility in the context of the theories that people tried to pursue. Because there, of course, you enter highly complex, conceptual frameworks that not always everybody understands all aspects of. Where you also need to have a sense of a common approach towards the more challenging scientific objects that you're dealing with.

S. de Jong	Yeah, but I'm not sure that…It's not like we were sort of in awe of all of the big things, because that would be sort of freezing us. So in that sense, there's no humility. We think we can find out how nature works. We really do. It's probably not true, but we really do.
P. Verschure	So there's a lot of confidence there I understand?
S. de Jong	Yeah, because why would you otherwise embark on such things if you think you're not going to understand it anyway? In the end you better play golf.
P. Verschure	Well, but you could also see it like the constructs are for certain complexity that I need to be in a continuous dialogue with others to get my head around it. I'm not going to solve this on my own.
S. de Jong	Oh, yeah, most people realize that. And of course, there are also some individuals that think they know it all. But most people realize that they then need all this other input from all the others. And it's I think by now probably you cannot find anybody anymore who was actually even willing to claim that the understands one of the large experiments, like completely. So in that sense, but it's not humility, I think it's because many people would like to, but they feel forced to be realistic.
P. Verschure	Understanding the limits of your knowledge is a form of humility that stands in contrast to overconfidence. You can find that balance?
S. de Jong	I would rather sort of phrase it in terms of optimism, of pessimism. There again, in the collaboration, you find these hopeless optimists, who think that anything goes, and then you also have all this group of people that are always like, "it'll never work, it'll never work." And they both have a function. It would be unhealthy for collaboration not to have these groups.
P. Verschure	I understand. So before we go to the final stretch, I want to understand a little bit the continuity of large-scale projects in physics. So is it fair to say to the Manhattan Project was the first one?
S. de Jong	Oh, dear, I don't know. It was really like a huge construction project, but of course…Well, wait a minute, before that, the Manhattan Project is basically the answer, on sort of a much larger scale, of a German project. Both for building an atom bomb and also in rocket science, to call it that.
P. Verschure	Yeah, but that's the scale. That's my point I'd look at…
S. de Jong	So they were also of a certain scale, okay? And actually, then the Manhattan Project, of course, was independent and they really made it happen. But it was like, really, that was really like power, it was an enormous project.
P. Verschure	But, you know, it was not the biggest project during the war by the US. It was the second biggest. The biggest one was for the B-29 super fortress.
S. de Jong	Yeah, okay.
P. Verschure	So but my question would then be, was the dynamics and the organization of these early projects, like the Manhattan Project, already anticipating how they run today at organizations like CERN? Or was there some transition point?
S. de Jong	No, no. That's an interesting thing, because of course, the Manhattan Project was really run as a military project. And since then, there has been tried, one more time for one of our projects, which was the SSC, the superconducting supercollider, which ended up in demise, because it was at some point really converted into a military operation, really with military leaders, and that doesn't work with us. Again, it's all about the goal. So it probably works if you have like a world war going on, but it doesn't work for anything less.
P. Verschure	Yeah, right, exactly. So how much is your science worth to you?
S. de Jong	Yeah, it's a lot of worth, okay, but running that as a military operation didn't work.

P. Verschure	Right, exactly. But now if you look forward and also if you look at the current situation we're in, we have two big crises in front of us. The COVID pandemic and ecological collapse, sustainability of the planet. Do you believe that our society could learn something from the rulebook of these large-scale physics experiments?
S. de Jong	Well, first of all, I'm already sort of, I heard a lot of people doing it, so I'm not surprised anymore. But I think there's quite a big difference between COVID, and of course COVID is just hitting us now pretty hard, but COVID, is just a ripple compared to our ecological problem. COVID, we'll get over, our ecological problem, probably not. So, it's over quite a different scale. And I think many people in my field are of the same opinion, if not most. And because I think in my field, people can actually look like 20, 30, 40 years ahead and look at it in that perspective. And also, when you talk about COVID, it's not COVID-19, which is the problem, maybe will be COVID-22, COVID-25, COVID-27, COVID-28...
P. Verschure	Or a completely different virus.
S. de Jong	I know, that's why I label them all by year.
P. Verschure	Right.
S. de Jong	This is how it's done. But we're not done yet with that type of vulnerability. And so that requires something different than what we're doing now in fighting this one virus or even this one type of virus. So you really think about how we organize this.
P. Verschure	It was ever under question...Can we learn from you guys to do it and respond to...?
S. de Jong	Exactly this, okay. Of course it's important that the next week we cannot go to a café anymore. Well, is it, is it really? Or is it that over the years, we will have a very limited life for 20, or 30, or 40 years, that our children will have a completely different life because they will have to isolate one from the other more or less continuously. So think a little bit further, okay, so think about what you're doing in terms of a much longer time scale. And of course, I mean, if there's an imminent disaster, solve it. But at the same time, you should live in a long-term perspective. And that's of course, in general, missing.
P. Verschure	But my question was a more specific one. Can we learn from the models that the physicists have developed for their large-scale experiments to really also advance collaboration in society as it responds to various crises
S. de Jong	I don't think that with COVID it was because of our organization in that we organized things that way. But the fact that in a years time you have a vaccine, is due to this focused effort. So this is how we would have done it, but it's not because they looked at us and they said, oh, we do it like those guys. But because there is this this huge common goal which just has to be met.
P. Verschure	And then how do we bring that to the ecological challenge?
S. de Jong	Yeah, so there my feeling is that apparently people are only compelled to actually go for the goal when they really feel it.
J. Lupp	When they recognize it.
S. de Jong	So as long as you just drive your car, you hardly notice from day-to-day that things are deteriorating. So, it's about time, it's about time scale, it's about thinking about the long-term perspective. And I think in general, humans are not very well adapted to that. But it's also completely logical in terms of looking at the evolution, okay. Because if someone is threatening you today, you should immediately respond to survive. And if it's threatening you in 20 years, you can still produce some offspring and you survive that way.
P. Verschure	But now, do you believe humans will be ever able to collaborate effectively to answer these kinds of challenges? Are we able, intrinsically?

S. de Jong	Yes. In particle physics we are, in astronomy we are. There's more fields like this. So there are fields in which it has been demonstrated. So, yes, it can be done. But I think what may be important there, of course, is that is the subset of people that you…
P. Verschure	It's also selection bias, right, because it works in physics, because it works in physics. But maybe in other domains of human endeavor, the conditions are not conducive to actually instill this kind of collaboration because of whatever, competitive forces, resource limitations, what have you.
S. de Jong	Well, it's more like a short-term win. That is the most destructive force I think, for these things.
P. Verschure	But if you could change one thing in humans in order to make them successful collectively, also as non-physicists, you can change one thing, what would you change?
S. de Jong	Probably it would help if you could kill the instant satisfaction gene.
P. Verschure	All right. Sijbrand de Jong, thank you very much for this conversation.
S. de Jong	Okay. My pleasure.
P. Verschure	It was great to meet you. I hope it was not too tedious for you because I really tried to drill down into details. Let me tell you what I really hope we can achieve with these podcast and with our forum; humans are so terrible at collaborating, but also they're they have no rulebook. Also among the experts, there's no real rulebook that we can...
S. de Jong	We didn't talk about that aspect of it. But for example, the interesting case is the CERN council. The CERN council, of course, is the high-level body of CERN, and it determines both the strategy and it monitors the director-general. So these are the two tasks of council, and big projects have to be voted by council. So if there's like a new big accelerator, it has to be approved by council and it's far reaching because if they approve it, they also have to pay for it. Which means typically that for years and years they have to cough up many millions per country. And so actually, it's half the people in council are actually already professional diplomats and there's absolutely a rulebook, there's rules of procedure. Which actually really help. So the last version of the rules of procedure, I actually wrote myself. And there's lots of historic material on the rules of procedure, etc., which also made me study the case, for example, of the British parliament, which is really special. Because they have rules or procedures, but they don't. It's complicated. But the fact that you have these simple rules, that the president of the meeting gives the floor to people, and takes the floor away from them, or gets this power makes that you have a sort of a much more civilized discussion. And I even found that things like, that you insist on people properly dressing up for the meeting so they come with the jacket and a tie, actually changes the atmosphere to be more agreeable, sort of better behaved, more civilized. And in the end that really helps with the result.
P. Verschure	Are there rules that stand out for you?
S. de Jong	Yeah. So rule number one is that you have to have a set of rules to behave civilized. The other set of rules is who is allowed to inject what into the discussion. So in the CERN council, this is very strongly regulated okay, if you want to bring up a point, it has to be like so much time in advance and depending on the subject; so some subjects are so touchy that you have to bring it up like half year in advance, it has to go through two cycles of discussion in the council before any decision can be taken. And the fact that you have these rules and people cannot just like I have, but for this time. And so if you just stick to the rules, that actually avoids a lot of error and a lot of problem. If you're clear about it and also people know that you cannot circumvent it, you have to go by the rules. And so things are properly discussed. So that these type of things really help in positioning the discussion in what can you bring up? It's not like all meetings are a free running discussion, and you can shout whatever you want, and also everything is on record. So yeah, that that that type of thing really helps.

P. Verschure   But just really structured the communication, that's very relevant. Is that rule book public?

S. de Jong   I think so.

P. Verschure   If you wrote it...

S. de Jong   But not everything I wrote is actually public.

P. Verschure   Okay, now it would be really interesting to look at it.

S. de Jong   Yeah. So I will find out. I think it is public. I think there's no problem in this.

P. Verschure   Well, great thanks for bringing that up. I will just edit it into the sequence. And look, we will do some post-production, clean it up, intro, outro, share it with you. okay? Hopefully, you sign the release form because otherwise this will also be a bit of secret communication and we'll never see that.

S. de Jong   I know. I try to sort of be careful about what I said, so I think it's okay.

P. Verschure   But also I will send you a quick cut. But in case you want to check for certain things that you would like me to remove, that's not a problem. I could just take it out or I'd drop something else in there, you know? So thank you very much.