

Clifford Brangwynne was invested as a member of the American Academy of Sciences and Letters in 2024.

In [this video](#), Academy Executive Director Greg Forster interviews Dr. Brangwynne about why a healthy university community is like an institutionalized Uber ride, the vital importance of humility to intellectual life, and the challenges of interdisciplinary work.

### **Greg Forster, American Academy of Sciences and Letters**

Hello, this is Greg Forster with the American Academy of Sciences and Letters, and here with me is Clifford Brangwynne, who is the June K. Wu '92 Professor of Chemical and Biological Engineering at Princeton. Cliff, thank you so much for being with us.

### **Clifford Brangwynne, Princeton University**

Thank you so much, Greg. It's nice to be here.

### **Forster**

Tell us, what are some underappreciated ways in which work in your field contributes to human understanding and to human well-being?

### **Brangwynne**

My field, like a lot of fields that are doing interesting things, that are pushing the boundaries of human knowledge and its impacts on society, is integrating lots of different areas. I work in bioengineering and cell biophysics, cell biology, the organization of cells, trying to understand how that all works. We bring together lots of different but related areas to understand all of that. We've been studying these structures in living cells and how they assemble through a process called phase separation. That idea has a long history in physics in general and then in the specific space of materials physics and soft matter physics. Those ideas have come into cell biology, and we've discovered the class of structures assembled by a process called liquid-liquid phase separation. That ends up having impacts on genetics and many different areas of biology, chromosome biology, aging, cancer, neurodegenerative diseases.

Because so many different fields have converged in this space, there's something meta happening. You've got a whole bunch of geneticists who are deep in their space, and they know everything about that space. Now they have to talk to polymer physicists, and they have to talk to material scientists, and they have to talk to computational scientists, and vice versa. The folks coming from the physics side have to speak these different languages and then think about applications in cancer and with physicians.

In my area, that has broader impacts in the sense that it requires coming to the table with tremendous humility, which is not always at play in academia. There's no way that any one person can know all these things, and there's no way one can be expert in all these things. You've really got to leave your ego behind and say, there's no way I'm going to be a deep expert in, let's say, these advanced physics theories or applications in thinking about sequence space for proteins or RNAs and genomics. We find that really refreshing. It just means everybody shows up and says, here's what I know, how does it intersect with what you know? Certainly in the academy, and in society, that's something we all need right now. We all need a deeper appreciation of all the things that we do not know. If I could quantify

the space of things that can be known and are known, and then the space of those things that I actually know myself, it is humbling. That's something that we all need to appreciate a lot more.

### **Forster**

A while back, one observer remarked that the natural sciences, and I think this person meant engineering as well as the natural sciences, are the only part of the university where the different disciplines work together efficiently, because they're not in turf wars nearly as much. There's recognition of where the boundary of one discipline stops and the boundary of the other discipline starts. I wonder, since I'm not in the natural sciences and haven't had direct contact, do you have a sense of that? Are there turf wars among the natural sciences?

### **Brangwynne**

Everybody has their disciplinary bias and identities. I actually just coincidentally made this comment in a lecture to some PhD students earlier today. In the early 1900s, thereabouts, there was a lot of interest in the ideas of physical chemistry in living cells, which is something that we're thinking about now as well. But back then, it was much more natural because people were not in these disciplinary silos and the colorful way that I said it to the students earlier was, they didn't get into this situation of white-knuckle gripping onto their disciplinary identities; I'm a chemist and I'm a whatever. That can be really counterproductive.

There's a nice quote from Richard Feynman that I'll sometimes share with folks: nature doesn't know about these boundaries. What's more important in cells? Is it physics or chemistry or mechanics? The answer is yes, right? Nature doesn't know about these disciplinary boundaries, and they are counterproductive. In some ways, I'm a disciplinary anarchist, even though I direct the Bioengineering Institute and I think about these things. The reality is that all the interesting stuff is happening at disciplinary intersections, and if we pay less attention to staying in our lanes, coming at these conversations with tremendous humility and understanding that there's a lot to human knowledge and we're never going to be deeply expert in all areas of it. That's where the interesting things happen.

### **Forster**

It's fascinating to think that the accelerating accomplishments of science and engineering might be changing the landscape in terms of interdisciplinary collaboration, which in a way brings me to my next question: how would you describe the mission of the university and why is it important?

### **Brangwynne**

It's a great question. It's certainly timely. What is the purpose of a university in these times of increasing politicization and questions of free speech and education more broadly in a world of AI and an information-rich age where there are very clear data on people reading much less. A headline that I found amusing is, to read books in college, it helps to have read one in high school. At Princeton University, obviously, there are tremendously talented students, but these issues are coming up all over the place. It's an interesting time for academia. Lots of headwinds from lots of places, and the recent federal changes are severe on that front.

Princeton University's mission statement speaks of advancing learning through world-class scholarship, research and teaching with emphasis on undergraduate and doctoral education and a commitment to serving the nation and the world. Those are certainly noble aspirations, and I subscribe to them, especially the big picture of commitment to serving the nation and the world. What should be the mission of any university in the broadest way? It has to be a place where ideas come together and, in some cases, collide and intersect. A place where we have cordial discussions in a respectful way around ideas that we may not like, we may even hate, and we may think the other person doesn't have any idea what they're talking about, but we're going to respectfully engage.

Through the process of discussion, engagement and kicking the tires as a crucible for different ideas, we're going to get to the best ideas. We're going to see where the flaws are in our own logic. We're going to understand that many colleagues here, Daniel Kahneman and other pioneers in this space, have thought about the gaps in our thinking, the blind spots in our thinking. We all have this notion that we have an omniscient understanding, that we see things very clearly, but the reality is there are gaps in our thinking, there are logics in our thinking, there are biases in our thinking, and only through constructive dialogue are we going to see those and be able to refine our arguments and maybe realize we're wrong.

I'm always prepared to be wrong. I'll argue as strongly and forcefully as anyone else when I really think that my ideas have strength and grounding, but one has to be prepared to be wrong, and this takes us a back to the earlier question around my field and interdisciplinarity and humility. We've got to come into any conversation with respectful caution that we might be wrong, and we're going to listen to ideas and see where we might be wrong. If it's the other person who is wrong, it's our imperative to respectfully guide them into what seems like the better version of the idea.

The university should be a place where that happens. It's not going to happen out there on Twitter. It's not going to happen on Fox News or MSNBC. It's not going to happen in the societal silos set up by socioeconomic stratification or people in this religion or that. So where is it going to happen? Where are those conversations going to happen? One of the few places I've seen it happen is on Uber rides. I get in an Uber, and it's a pretty reasonable cross-section of all different types of people driving and riding, and I end up having productive conversations. Unfortunately, the university has slipped away from being a place where people can speak completely openly about different ideas with an understanding that those ideas will be respected and there will be a thoughtful exchange, even with folks who disagree. That's got to be a central part of the mission of the university, in service to the country, in service to the world, because it's not happening anywhere else.

## **Forster**

The university as institutionalized Uber ride, in the sense that you have the freedom to speak because in that Uber, you can say what you think and you know that you're going to get out of that Uber and nobody's going to track you down and try to hurt you for what you said. The university needs to be a place where that's protected, that life of the mind is so difficult to maintain, but we need it to grow and learn as human beings for the reasons you were saying. When I was trained as a social scientist, one of our methodology professors had the class recite together two three-word phrases. He said, I was wrong. He made us all say, I was wrong. Then he said, I don't know. Then he said, okay, now you've said those, you have no excuse that you didn't know how to say it. You know how to say it now. So say it when you need to say it. That really stuck with me.

## **Brangwynne**

That's terrific. We all have got to come with that kind of humility and the ability to speak freely. It's funny, this Uber analogy is actually quite apt. The other day I shared something somewhat personal in an Uber ride, almost like deep secrets with a therapist, but not quite that level. There are conversations one can have in those contexts because you're not going to see the driver again. They're not going to say, this person thinks that, isn't that terrible or whatever. We need to have places where people can speak freely.

## **Forster**

And the university can sustain those relationships over time.

Let me ask you my last question. The university, as you've mentioned, has many different aspirations. Two of them are pursuing truth for its own sake and making truth useful in the world. Sometimes it's hard to maintain a good balance between truth for its own sake and making truth useful in the world. Where would you say we're doing a good job at that? And where would you say we might need to improve?

## **Brangwynne**

This is a really interesting question. I'll start with some thoughts on a micro version or a particular place where this comes to mind. I'm based in the School of Engineering and Applied Science at Princeton. As the name implies, we're thinking about knowledge, a knowledge base; Princeton has a long history of embracing the creation of knowledge and a basic understanding of how the world works at the level of physics and chemistry, and the application of that knowledge in an engineering context for society and so forth.

I direct an institute at Princeton that's called the Omenn-Darling Bioengineering Institute. We just got off the ground, and we're about to move into a new building. We talk about the interplay; those things [truth for its own sake and making truth useful] aren't really separable. This is a micro example, but one can think about immediate extrapolations. Basic science, like how cells work, we still don't understand. Sometimes I talk to people not in the biology world. I say, we know the genome, but it turns out we really don't understand how that works. Proof of that is we don't know how Alzheimer's works, even at a basic mechanistic level. Many of these diseases are just devastating, and there's no cure. Then in the next breath, how do we take that understanding and think about applications, whether it's medical devices, things for the environment, things for materials, energy, et cetera? In our institute, we talk a lot about the feedback between those applications, the application space. Maybe some of those applications go back into advancing the frontiers of knowledge, and then we have this virtuous cycle. That's a specific thing in the domain.

More generally, though, I worry a little bit about this balance not being quite right. There's been, in recent years, perhaps an overemphasis on the academy, universities certainly, that has a huge impact on a lot of folks coming out, the folks who do go to college. Of course, not everybody in the United States goes to college, but the folks who go to college come out and have an impact on culture, media, law, technology, and that has big impacts throughout the country. We've seen that in different ways. I worry

a little bit when the program of the university becomes a little too self-confident about the impact and the vision of what should be happening in society and the impacts that that's going to have.

I come from a working-class background. We have plumbers and electricians and painters in my family, and none of my parents' generation went to college. Sometimes we talk about things that are front and center in the academy and the university, and for those folks, these discussions are divorced from what matters to them on the ground. We should be thoughtful in the university, playing leadership roles in bringing what we think are the best ideas that are road-tested in conversation, in debate, in dialogue, in an environment that supports discussions in an open, respectful way, taking leadership of the best ideas moving out and having an impact on society.

But I don't think that the mission of the university necessarily should be that. If people are cycling through this environment where there's active dialogue, respectful dialogue, respectful discussions, that then will move out into the world, into the marketplace, and we'll have open dialogue and the best ideas will emerge. But I worry a about the balance. I think we've moved away from universities focusing on the pursuit of knowledge for its own sake and a more toward advancing what is viewed as a mission for influencing society. There are discussions around the best way to do that. That's a little bit oblique, but my sense is that we're not quite on the mark in some of those ways.

### **Forster**

The danger is we assume that we know more than we really do about what the world needs and how we can affect it, and there's always been a temptation for the academy to lose touch. People have been complaining about the ivory tower for as long as there have been ivory towers, but I wonder if in the new world of social sorting, there isn't an even greater danger of losing touch than there has been.

### **Brangwynne**

That's exactly right. I keep coming back to this word "humility." One can take a role in being a thought leader and bringing constructive dialogue and what seem to be ideas that make sense and bring that to colleagues, out in the world, to the Thanksgiving table. That's what we should be doing. On the other hand, we've got to show up to those conversations with a lot of humility and respect for the life learning and different experiences that people have in different domains, and that's a place where I'm not sure we've gotten the balance right over the years.

### **Forster**

Humility is not just a moral virtue. It's an intellectual virtue. Thank you, Cliff. Really appreciate you being with us.

### **Brangwynne**

Thanks, Greg. It's been a pleasure. Appreciate it.