Tanya Domi: Hi, this is Tanya Domi. Welcome to the Thought Project, recorded at the Graduate Center of the City University of New York, fostering groundbreaking research and scholarship in the arts, social sciences, and sciences. In this space, we talk with faculty and doctoral students about the big thinking and big ideas generating cutting edge research, informing New Yorkers and the world.

STEM-related job creation grew three times the rate of other jobs during the first decade of the 21st Century, and it's estimated that nearly two and a half million STEM positions are currently unfilled. What's more, New York State has the third largest technology sector in the country, and employment in New York City's science and technology sector increased by 57% between 2010 and 2016. Exploiting the inherent opportunities that come with the growth of STEM industries is a major goal of the city's mayor and the governor and the Graduate Center's role in preparing the next generation of scientists and advancing the discoveries that fuel the industry is increasingly important.

Over the past decade, the Graduate Center has taken several strategic steps to expand its footprint in STEM education and innovation locally and on the worldwide stage. Here today, to speak with us about the present and future of STEM education and research at the Graduate Center is Josh Brumberg, dean of the sciences. Welcome to the Thought Project, Dean Brumberg.

Josh Brumberg: Oh, my pleasure to be here.

Tanya Domi: In addition to having an active lab, yourself, you are the dean of sciences at the Graduate Center. Can you talk a bit about expanding the role of the science programs as described in the GC's strategic plan, that was issued in 2017, and the expansion of the programs and how that relates to the overall institution's mission.

Josh Brumberg: The sciences for many years were almost an afterthought at the Graduate Center, which was really known for its humanities, social sciences, and the arts, and one of the tasks that now outgoing President Chase Robinson asked me to do is to try to raise the visibility of the sciences at the Graduate Center. We've done that through a variety of ways, but one of the challenges has always been, that the science, the really interesting science is done at the laboratories throughout the CUNYverse. How do we integrate those scientists that are part of our doctoral programs into the community of the Graduate Center? We've done that through having targeted discussions, workshops, conferences that bring together scientists throughout CUNY to raise the visibility within the building.

Transformation happened two years ago when CUNY decided to move the Advanced Science Research Center from the central office to under the Graduate Center's umbrella. For the first time since the inception of the Graduate Center in 1961, we now have the ability to hire faculty to do bench work in a state of the art, 200,000 square foot facility. Over the last two years,

we've built our central line faculty, not only in the experimental sciences, which is one half of the scientific equation, but we've also been able to hire two theoreticians, one a mathematician, one a biophysicist here at the Graduate Center.

What we're hoping to now do is to use this as a catalyst to increase the visibility of science at the Graduate Center, increase the visibility of science at CUNY as a whole, and also through the ASRC become a resource for CUNY scientists system-wide just like the Graduate Center is considered a resource for the social science and humanities' faculties.

Tanya Domi: Not only has that been accomplished, but, in addition, master's programs have been added in in the last few years that have science-based focus. For example, the cognitive neuroscience master's program, data analysis and visualization, and it's also expanded to include data science. These are some of the hottest topics in popular culture and actually, operating in the workplace today in America.

Josh Brumberg: Yeah, so the Graduate Center has been known for years for its doctoral degrees. Even I didn't know that we've been awarding master's degrees since the early 1980s. When I came as the dean of science three years ago, we had no MS degrees, masters of science. As you noted, we now have four: data science, data analytics, cognitive neuroscience, and a quantitative methods in the social sciences.

These serve several purposes. One, it allows us to diversify our student body even further which is consistent with one of the missions of the Graduate Center. Second, it provides a useful credential for the marketplace, tools for analytics. Handling data, visualizing data is important not only in science, but it's also important in marketing, in the financial industry, in the communication's industry, and we're providing the students with the training which they can go on and work in those industries. We have a few more master's program in the works.

Of course, one other thing we're trying to do is to use this, the cognitive neuroscience would be a good example, as a stepping stone to Ph.D. programs. Many undergraduate students might not have the research experience necessary to get into a top-flight doctoral program, and these master's programs expand our portfolio and allow us to interface with another great population of students.

Tanya Domi: The strategic plan also said that the GC would work to remove barriers among the sciences and between sciences and the humanities, social science, and the arts. How have you pursued this effort as the dean of the sciences? This is pretty interesting, actually.

Josh Brumberg: Right. Several examples actually come to mind. One just concluded this morning that we're recording the podcast is that we hosted a two and a half day meeting with a group of academics from Sao Palo, Brazil sponsored by their federal state granting agency called the [inaudible 00:06:45], is a Portuguese acronym. What we did is we brought together two Brazilian scholars and two scholars from the Graduate Center across a wide range of fields, so physics, neuroscience, structural biology. We also include the humanities, social inequality. We also did media. We had a big round table about fake news, about U.S.-Brazilian interactions, about the impact of environment on gentrification of neighborhoods and how that, in turn, is affecting resiliency.

Try to creating these interdisciplinary conferences is one way in which we try to engage both halves of the institution. The other one is, and it almost sounds trite, is actually happening tomorrow night from the day after we're recording this podcast, where I have Lev Manovich, who's a professor of computer science but really well-versed in cultural analytics and aesthetic. He's leading a round table discussion about how artificial intelligence impacts everyday life. Lev is one of the forefronts of using digital technology to understand the arts. He was one of the, to go back to your previous questions, one of the founders of the digital visualization analytics master's program. So, it all works together.

We've been creating, actually, interactions with the Center for Humanities here, Keith Wilson and I. We helped put on a public event about a month ago about the hundredth anniversary of the Spanish Influenza. We had an author who wrote a book about it and then we had a scientist who modeled the impact of the influenza. This was integrated into a larger, cultural events in New York City called 'Germ City' where there was an exhibit at the Museum of the City of New York at the Tenement Museum and we actually hosted a conference on virology. Try to bring together-

Tanya Domi: That's pretty interesting.

Josh Brumberg: ... the cultural aspects along with the scientific aspects. The final point is with The Center for Humanities, they've created something here at the Graduate Center called the object library where you're bringing in different objects. I had our nanoscientist up at the Advanced Science Research Center manufacturer some little pyramids.

Tanya Domi: Oh, wow. That's interesting.

Josh Brumberg: If you go up there and look at them in the object library, it looks like an empty box.

Tanya Domi: Sure.

Josh Brumberg: But, if you magnify it 100,000 times, you see things that look like ziggurats.

We've been trying to find ways in which the-

Tanya Domi: To interact and-

Josh Brumberg: Exactly right.

Tanya Domi: ... intersect. I would also add I've done a lot a work with Lev. He's a guy that really leans forward is his area of scholarship and has done a lot of work, for example, taking pictures during the uprising of the Maidan in Kiev, Ukraine. He works across so many ideologies, so many disciplines. It's very exciting to see his work and how it's evolving as he pursues it here at the Graduate Center.

Josh Brumberg: Yeah, that's one of the things that I think he's a good example of how we try to create knowledge for the public good. A lot of, if not all of his work is available online. The thing I always point to is he had a project which he called 'Selfie City' which he looked at publicly available selfies in about a half-dozen cities around the world. Then, using facial analysis software, he then analyzed, well, which cities are happier, which cities are sadder.

A, it was very cute, but B, it was very visceral is that you immediately understood what he was doing and he really harnessed the power of big data to give us little snapshots of how cities respond and how that their responses matter as a function of seasonality or in current events that might be going on at that time.

Tanya Domi: Also, the differences in gender. I worked with him on that project and during that project, it was the Academy Awards and Ellen DeGeneres did a selfie when she was the host using a Samsung camera phone and it broke Twitter. Twitter crashed during the Oscars and that event intersected with his scholarship and his scholarship ended up on the pages of the Wall Street Journal, which is pretty, pretty cool.

Josh Brumberg: Yeah, really that's one of the things ... Two examples right there, Lev winding up in the Wall Street Journal and then through interactions with yourself and other members of the GC communications team, we're trying to get the word out that really world-class science happens at CUNY. I know in this very studio about a year ago, Rein Ulijn, the founding director of our nanoscience initiative, at the ASRC was on Science Friday talking about how they came up with a really ingenious way of synthesizing melanin in the laboratory which turned out to be a very tough chemical synthetic process.

We really are trying to get the word out that world-class science happens at CUNY and that you can come to CUNY and become a world-class scientist. One thing I mentioned this morning when I was talking to the Brazilian group that was visiting us, 11 Nobel Prize winners in the sciences have graduated from CUNY. All of those from the undergraduate, so I'm looking forward to one day

seeing a graduate of the Graduate Center walk across the city hall in Stockholm to receive the award from the king of Sweden.

Those are the large visions. You hinted back to the strategic plan. We don't put something that big in the strategic plan, but it's always in our mind that our students can go on to excellent and productive careers.

Tanya Domi: Sure, the aspiration. You, yourself, even if you are a dean with your administrative burdens, you are a neuroscientist in psychology, your research is focused on understanding the building blocks of the brain's cortical circuitry and specifically how sensory stimulation influences its development as an organ. What answers has your lab uncovered? What do they mean for the field of brain science and for addressing neurological diseases? That's a big order.

Josh Brumberg: That's a big order.

Tanya Domi: That's a big order.

Josh Brumberg: There's a little unpacking to do. What I mean by building blocks, the best analogy I always do is kids playing with alphabet blocks, so they learn 'A', the ah sound, 'B' is the be sound. Then, as they develop, they grow bigger, they know they can spell words, cat, top, bag, all the three-letter words and then it expands.

When I first opened my lab when I came to Queens College and the Graduate Center in 2002, we used studies to define what was the three-dimensional morphology of neurons. What were the basic building blocks? 'Cause that's what I mean by that. Then, we asked ... The question is, how does environmental experience impact their structure and function? We use in a mouse model. Any New Yorker listening to this have seen rodents in the parks, hopefully, not in their apartments, certainly in the subway system.

Tanya Domi: Subway for sure.

Josh Brumberg: If they watch them carefully, they'll notice that they use their whiskers to interact with their environment. In fact, their whiskers are as sensitive as our fingertips in determining textures. We can manipulate their experience by, for instance, trimming their whiskers which is totally painless to the animal, equivalent to you getting a haircut. There's no sensory receptors there. Or, we can put more toys or running wheels in their cages so they are in an enriched environment.

What we've shown is that when you deprive the animals of their normal sensory experience, the morphology changes, the physiology changes, and the behavior changes. They can't, for instance, discriminate as well between a rough and a smooth texture. How is that related to human health, which is the bigger

question and that's how we get funding from the National Institutes of Health, is that unfortunately, this actually happened in a human population.

One thing that became apparent in the fall of the Soviet Union in the mid-90s is that there were institutional orphanages in countries like Bulgaria and Romania-

Tanya Domi: Romania, yes.

Josh Brumberg: It's a tragic story. International adoption agencies rushed in and placed these children largely in affluent families in the United Kingdom. The parents couldn't understand why their children were not developing "normally". Then, there was more research that's akin to the story of fetal alcohol syndrome-

Tanya Domi: Syndrome.

Josh Brumberg: ... diagnosis here in the United States. They then realized that these infants were raised in cribs in some cases until the age of four and five, and really had no sensory experience. That resulted in deformations of their brain. We don't know if there was changes at the cellular level because we can't take those samples, but if you do an MRI, we know structurally they're different. If we measured their electrical activity, we know that's different. If we look at their neurochemical activity, we know that's different and we know the behavior and IQ.

We know for sure that sensory deprivation is important. You hear this. New mothers are always told to stroke their babies-

Tanya Domi: Their babies, yeah.

Josh Brumberg: ... and they're physiological reasons to that. We think there's important feedback mechanisms. We're trying to then see if, for instance, enrichment following a period of sensory deprivation can ameliorate some of the effects. It does appear to have an effect, but it turns out that the brain is much more immutable early on in development.

If you do the sensory deprivation from birth, the impacts are quite long-lasting. If you do the sensory deprivation later in life, the impacts are much subtler to not at all depending on what you're assaying.

Tanya Domi: I see.

Josh Brumberg: When we do deprivation followed by enrichment, we have an effect, but you have to allow the enrichment to last much longer because the rate at which-

Tanya Domi: To mitigate ...

Josh Brumberg: Exactly. The rate at which the brain can reshape itself later in life is slowed down. We're actually studying one of the things we think is putting the brakes on this rearrangement and that's really where my lab is focusing right now is that if we can remove these brakes, can we reopen what is called the critical period is the neuroscientific term, and therefore allow for recovery.

Not only would this be important in developmental disorders like we discussed, but also in what they call acquired disorders like for instance a stroke or some sort of trauma to the brain. It's very hard for the neurons to regenerate and that's because there's inhibitors to the regeneration all around them. The idea is if we can help remove that, that will reopen this critical period and allow them to recover better. There's some evidence from other labs that suggests this may, in fact, be the case.

Tanya Domi: Your research actually has a connection as I'm looking at the news cycle right now. One of the great criticisms is the child separation policy down on the border in children are not being touched in these ICE facilities. Actually, the staff is being told not to touch the children. There seems to be quite a bit of outrage by pediatrics association, doctors, psychologists. There's a lot of outrage about this right now.

Josh Brumberg: Right. The lack of touch and the impact, I think, it's not entirely known. I do think it's better. I think the bigger fear is the stress, that you are stressing out these children and I think there's no doubt about that.

Tanya Domi: I see.

Josh Brumberg: That is then a setup for subsequent health effects. We've seen that in communities that are marginalized that are constantly under stress. And, stress can come from many different functions. It could come from economic stress. It could come from food scarcity. It could come from trauma, abusive stress. It appears in many cases that ultimately it impacts the same cellular mechanisms and then that sets up-

Tanya Domi: That chain ...

Josh Brumberg: ... a chain of events and more often than not, the outcome is quite poor.

Tanya Domi: Your working lab is at Queens?

Josh Brumberg: Yeah, my laboratory-

Tanya Domi: Your lab is at ...

Josh Brumberg: ... at Queens College, which is what I like to say, part of the CUNYverse. I must say, this is a special Wednesday coming here for the podcast. Usually,

Wednesday is the one day that I spend the day in Queens working with my lab. I'm in touch with them all the time via phone, text, Skype. It's really-

Tanya Domi: It's all-consuming.

Josh Brumberg: It's all-consuming and I really have a great respect for the people in my lab. I always felt I was very lucky to have a great mentors as an undergraduate and a graduate student as they were always there. As you mentioned, I have a lot of administrative duties and I'm mindful on the impact that has on my mentoring and the ability to help my students.

One of the things I'm very proud of is now we've had over 40 students from my labs since coming in 2002 that have gone on to graduate or professional school, so medical school, dental school.

Tanya Domi: That's a great record.

Josh Brumberg: That's something I'm really proud of.

Tanya Domi: We mentioned earlier discussion about when the GC absorbed the Advanced Science Research Center, this incredible facility uptown with five research initiatives. Can you tell our listeners a little bit more about the ASRC and how you envision it elevating GC sciences overall?

Josh Brumberg: It's the Advanced Science Research Center. It's really a state-of-the-art building that really was implemented and designed to create interdisciplinary interactions between the five core areas within the building, environmental science, nanoscience, structural biology, neuroscience, and photonics. Environment science is quite obvious what that is. We talk about water scarcity. We talk about environmental interactions, pollution. Neuroscience is the study of the brain and really one of the focuses there is how does the environment impact the brain. We discussed a little bit of that from my own research perspective but they look at things, for instance, like epigenetics, the idea that your brain can affect the way in which your genes produce different RNAs which then produce different proteins which then have different effects.

Structural biology looks at the three-dimensional structures of proteins and based on that, infers how these proteins might be working and has implications on not only the brain but also cancer. Photonics is the study of light and the light transmission. Light can be used to manipulate neural activity. It could be used to manipulate cellular activity. So, that's a natural interaction. Eventually, nanoscience, which its focus is on bionano, the idea that you can develop biological materials at microscale that could help, for instance, in cancer treatment.

In addition to those research efforts but equally aligned, we have 17 core facilities. These are facilities for not only the researchers within the building, but

researchers throughout CUNY and throughout the metropolitan area where they can come in for a fee and, for instance, use New York City's largest clean room for the manufacturing of devices or materials at the nanoscale, which is 10 to the minus nine, so 0.0, nine of those and then a one to give you how small we're talking about. We have high-level imaging if you want to be able to see those things, a magnetic resonance imaging, MRI, center which will be training some of our cognitive neuroscience master's students. So, you begin to see the integration.

Tanya Domi: In partnership with the brainchild-

Josh Brumberg: The Child Mind.

Tanya Domi: Brain ... Yeah.

Josh Brumberg: The Child Mind Institute.

Tanya Domi: Institute, yes.

Josh Brumberg: We have a partnership with them. We have partnerships with a variety of companies that come and use our facilities. I think the ASRC provides one, a nexus and where collaborations can go across, what we call vertical collaborations 'cause each one of those initiatives is on a different floor, number one. Number two, we have several programs that promote scientists from throughout the CUNYverse coming to the ASRC to use the facilities, interact with the research faculty there. And, then third, it allows us to collaborate with academic partners like Columbia, NYU, Mount Sinai, New York Structural Biology Center, but also allows it to interact with nonprofit groups. You mentioned the Child Mind Institute, but also private industry that want to come in and use our facilities.

Tanya Domi: That's a pretty incredible facility. Rein actually indicated when we were talking at one point, he said, "This is the only facility like it in the world." This is truly unique as a unique place in the research of really what you would call new, forward-leaning, scientific research.

Josh Brumberg: Yeah, a lot of universities have attempted to do what we're attempting to do, is to create these interdisciplinary environments, but typically what they do is they hire someone into the physics department who is in a building over here. They hire someone to the neuroscience department which might be at the medical school two miles away. Then, you have the issue of geography which here at CUNY we're used to, number one, but number two, we've now hired all of them under one roof.

From my own experience and talking to many other scientists, you collaborate with the people you meet in the tea room, if we were in England, Rein Ulijn coming from Scotland, or the water cooler here in America or wherever we

might be. These interactions ... And, we've actually created a forum which we call Science Fridays, a play off Super Science Fridays that we do so we don't rip off the NPR show that's recorded here, where we have essentially snacks. Each week is sponsored by a different initiative and they come and talk about their science and possible ways they can interact or they want to get help on a question from the other scientists in the building.

Tanya Domi: I just have drawn a symmetry here. ASRC is our uptown campus, but it's likewise here at the GC. It's one building and you see interdisciplinary work in ways that you just don't see on a classic, spread-out campus like Syracuse, a place like that. I think that's really unique to this graduate, doctoral research environment. I think it's very exciting.

Josh Brumberg: Yeah, I totally agree with that. Interdisciplinarity is baked into the Graduate Center and it's baked into the ASRC. I think that's one of the reasons why the central office made the decision to move the ASRC under the GC's umbrella. I think that's great. I agree from the graduate student perspective to be able to be trained in this interdisciplinary environment using cutting-edge tools will really put them a step ahead of the competition when they go for post-doctoral positions or industry positions at the time of graduation.

Tanya Domi: Last thing I wanted to bring up, which is very exciting. A recent grant that was issued to the Graduate Center, the Clare Boothe Luce Fellowship Grant of $249,400 to supplement five graduate fellowships for women in mathematics and computer science programs. How did this come about and what was the ... Obviously, what was the intent behind this? To advance women, clearly, but more to the point, how do you contextualize this in the overall mission?

Josh Brumberg: Well, I put this in really lockstep with one of the goals of the Graduate Center is the idea of diversifying the professoriate and making it more inclusive. There's a lot of discussion these days about increasing representation from underrepresented groups. We've made some strides there. Our chemistry program actually won an award from the American Chemical Society for advancing diversity in the chemical sciences and it's something that we're really working on.

When you look at issues in science, especially in what they call the quantitative fields, engineering, which we don't have, mathematics, physics, computer science, the number of females in those fields are relatively low, less than 30%, which typically graduate programs are about 18 the 20%. Frankly, that's what the Graduate Center is. We saw this opportunity through the Clare Boothe Luce Fellowship Program to perhaps get additional funds which we were fortunately successful to get with the help of Hellen Koh here in our development office.

We can use those funds to help recruit top-quality, female graduate students, but the other thing that we're putting in from our side is we're creating a mentoring environment. We're identifying faculty members in computer science

and mathematics, female faculty, that can be resources to not only the Clare Boothe Luce fellows, but to female graduate students throughout those programs and try to create spaces where they can talk about issues that might be pertinent to them while, myself for example, as a male faculty member, it might not be something that I'm even aware about.

To create an environment where they feel included, they feel welcome, I think, will hopefully, allow us to recruit not only these Luce fellows but more female graduate students into our programs.

Tanya Domi: That's terrific. Thanks for joining us today, Dean Brumberg. We'll have you back to give us an update.

Josh Brumberg: I look forward to that and if you're listening this season, I wish, Tanya, you and all the listeners a very happy holidays and a healthy new year.

Tanya Domi: Thank you very much. Thanks for tuning to the Thought Project and thanks to today's guest, Dean Joshua Brumberg of the Graduate Center at CUNY.

The Thought Project is brought to you with production engineering and technical assistance by Sarah Fishman. I'm Tanya Domi. Tune in next week.