

Dr. Carlo daCunha

Each issue of the ¡MIRA! Minute highlight a ¡MIRA! faculty member and learn more about them, their research, and their journey. This issue our faculty highlight is Dr. Carlo daCunha, Assistant Professor, in the NAU School of Informatics, Computing and Cyber Systems.



¡MIRA!: Can you briefly describe your research interests and focus?

CC: My research is multifaceted and interdisciplinary but always intertwined with electronics and statistical mechanics. One focus is on in materia intelligence, where I am investigating defect engineering in semiconductor oxides to create novel neuromorphic devices that mimic the behavior of biological neurons. Another focus is on the study of collective systems where I develop physics per analogiam. For example, I am studying how humans and animals evolved to coordinate and then I use these results to inform the other branches of my research. Connecting everything together is an investigation on robotics, where I investigate how to use the neuromorphic devices I create to give robots a brain and use bio-inspired algorithms to make robots work collectively towards a common goal.

¡MIRA!: What made you decide to pursue your major and career?

CC: I love this question because it brings so many good memories. It was the 80s and electronics was revolutionizing our lives. Computers were entering our homes, video games were being developed, and then we would see VCRs, headphones, and many other inventions. As a kid I was mesmerized and wanted to understand how all that worked.

I remember one day when my dad bought a transistor radio just to see it disassembled in all its parts by me the next day. I then started to study electronics on my own and choosing electrical engineering for my undergrad was the natural choice. However, electronics had been developed in the US but I was in Brazil. Moving to West Virginia to study electronics was only natural. There, I studied gallium nitride, which had recently been used to create blue LEDs. But the electronics I was more interested in was here in the west. I then moved to Arizona to study the physics of electronic devices and ended up studying the flow of electrons in quantum effect devices, which bloomed into the field of quantum technology only more recently.

¡MIRA!: Could you tell us about the individuals who have influenced your journey to where you are now?

CC: There are three people who strongly influenced me. One would expect a physics teacher but the first to influence me was a math teacher I had in high school called Vicente Gaeta. His approach to tackle abstract concepts using humor is a trait that I absorbed into my own methodology today. I was then an undergraduate in electrical engineering but was taking modern physics. Professor Pedro Grande discussing introductory quantum mechanics twisted my brain. That made me realize that there was more to electronics than just circuits. He made me curious about what was inside the transistors! Finally, there is my PhD advisor and friend, professor David Ferry. Even before starting my PhD I remember thinking: "Oh man! One day I want to be just like him and I want to make my contribution to this field just like he's doing!". I am not just like him yet, but I am still trying.

¡MIRA!: What recommendations do you have for students who are pursuing a STEM degree, particularly in your area of expertise?

CC: There is a recommendation I give to my own children: don't be sidetracked by the easy stuff. Technology has provided us with so many amazing things that have even changed society itself! We create technology

and technology shapes us. It is very easy today to look at the waves on the surface of an ocean of innovation, however what is really interesting is not the waves, but what is below them, making them appear. To understand this, you will need to go deep, and it might not be an easy journey. You will need to be resilient, develop good analytical skills, learn how to be as flexible as steel and as hard as rubber, but I guarantee you that the prize you will find is worth all the journey!

¡MIRA!: What are your interests or hobbies outside of your research endeavors?

CC: I still love the old days of electronics. I am currently working, as a hobby, on emulators for the old MSX and Amiga computers. I also love music and I play my electric bass on a daily basis. I also love horse riding, but having time to do it all has become really challenging.

¡MIRA!: What do you like most about your job?

CC: Innovation! In research, we are not bound to reproduce what already exists. We are innovators, shaping the future and preparing the next generation to follow our steps and move society forward. Not many things excite me more than that “that’s weird” moment and seeing my students creating and innovating with me.

¡MIRA: How would you like to see your field and STEM change/develop over the next decade?

Electronics is changing fast! Twenty years ago, I was using discrete components on a protoboard. Today, it is gone. Electronics has become software. There are software description languages for hardware and there are software packages for simulating devices. We don’t see humans inside semiconductor fabs anymore. It was all taken by robots and the engineers program codes that the robots execute. However, although electronics is going in the direction of software, I see STEM as a whole blurring boundaries. Artificial intelligence was initially developed by psychologists, but some of the pioneers were physicists, and it is now a field of computer science. The lessons we learn by studying biological systems find applications in the financial market and they also power robots. I have degrees in electrical engineering, but I work as a physicist in a school of informatics. All sciences appear to be converging and I believe this trend will only continue. That old view of a scientist who only does one thing is dying. I would love to live in a future where we do synthetic biology using principles of self-assembly learned by examining societies to create novel devices that make our lives easier, less laborious, and more creative.

¡MIRA!: Are there any additional thoughts you would like to share with the MIRA community—be it words of inspiration, advice, or cautionary insights?

CC: Students: Don’t be afraid to change! Question everything! Hit science hard with your contribution! And on top of everything else: always be ethical!



Pictured: Petra Schaumburg (NAU), Cassie Petit (NAU), Carlo da Cunha, Andy Wang (dean of CEIAS/NAU), and Viacheslav Fofanov (director of SICCS/NAU) at Micron Technology in Boise, ID 2024.