

The Power of Modelica

A Conversation With Professor Luigi Vanfretti



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Luigi Vanfretti

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Please tell us about yourself.

My name is Luigi Vanfretti and I'm an Associate Professor in the Department of Electrical, Computer and Systems Engineering at Rensselaer Polytechnic Institute (RPI). I also conduct research at my lab, ALSETLab, where my primary focus is electrical power grids. I use simulation technology extensively in my research.

What made you incorporate system simulation into your research?

We pretty much rely almost entirely on system simulation at this point because of three main factors. First, it's extremely costly to do experiments on the real grid. Simulation technology is much more cost-effective, even for an academic program, and yields accurate results. Second, most of our research involves critical infrastructure. Third, simulation allows us to conduct our experiments in a safe environment where we can also reproduce experiments. Simulation is key for the advancement of technology, especially in my area of expertise.

Of all the other system modeling and simulation languages, how did you come across Modelica?

I started to hear a lot about Modelica's multi-domain modeling properties in 2003 when I tried to get my hands on Modelica-based technology. Unfortunately, it wasn't as accessible at the time. I continued to use MATLAB and Simulink until 2011 when I got the opportunity to explore Modelica for power systems in the EU-funded FP7 iTesla project¹. I haven't looked back since. It really is the future for system modeling and simulation. The most innovative companies are using this technology; for example, Tesla has been starting to list Modelica on job posting under "preferred skills." I use those postings to attract students to my new class "Modeling and Simulation for Cyber-Physical Systems."

What does Modelica-based technology allow you to do that you couldn't do before?

When you need to go from low-level research to developing technology at technology readiness levels 3 and beyond, you're lost without Modelica. Simulink models break constantly. Most of the time I can't move my non-Modelica models into other, more domain specific, environments without having to recreate the models entirely. >>

¹<https://cordis.europa.eu/project/rcn/101320/factsheet/en>



Modelica allows for both scalable and reproducible modeling, and, because of its harmony with the Functional Mock-up Interface, it doesn't prohibit us from using general purpose tools for more specialized tasks, such as estimation and optimization. Once I figured out how to use Modelica for power and grid simulation, I was no longer bound to domain specific tools. Let's also not forget that the cost-effectiveness is superior here. I have the peace of mind to know my Modelica models will withstand the test of time and can be deployed in any environment at a fraction of the price of an enterprise level tool license.

What has helped you learn and succeed in Modelica technology thus far?

Modelon courses are the key ingredient for my success with Modelica. I took two courses - the Introduction to Modelica and Controls in Modelica - back when I was in Sweden exploring Modelica. The Modelon experts that lead training courses teach at the same level or even better than most academic faculty in my opinion. Our level of productivity went from taking 80 hours to do something to 2 hours for the same task.

How would you describe Modelon Training?

Modelon's training style is hands-on and no nonsense. In fact, I've been fortunate to take Modelon courses early in my career as I've adopted Modelon's training style into my own teaching. Modelon Instructors really know how to guide students into learning instead of making them hit a wall, which is especially common when learning a new language. Once I started taking the courses, I saw this evolution of going from not knowing what

to do to being fully efficient in the language. It opened a new opportunity to do research on things I could not have done like multi-domain modeling and system identification.

Let's talk about some of the Modelon products you've utilized. How have those helped you?

Digital twins has been the talk of the town in the systems modeling world. I believe the real power of digital twins is having the physical models integrated with sensor data. That's something that is possible to achieve with off-the-shelf Modelon solutions like their library and FMI tools. In fact, we've used FMI Toolbox for MATLAB/Simulink extensively, both in my research and in teaching students in my classes. I've even built a model calibration tool called RaPIId² that uses Modelon's FMI Toolbox to allow the import of models as FMUs. The libraries are great not just for modeling, but to show my students the examples and comprehensive components that come in the libraries we have. Currently I use Electric Power Library, Fuel Cell Library, and Hydro Power Library. I can't wait to try the other libraries soon!

What's next for you?

We're looking at being able to use the OPTIMICA Compiler Toolkit to remedy our steady-state problems. We're especially looking forward to using it for large scale simulations and for improved prototyping. That and exploring new libraries to further attract students into the world of modeling and simulation, a pre-requisite for the digital age!

²⁾ <https://github.com/alsetlab/rapid>