Application Name	Virtual Parasite Project
Application Area	Computational biology and medicine, biomedical simulation, physics
Keywords	Chagas disease, T. cruzi, parasitology, Virtual Parasite Project, in silico laboratory, hierarchical modeling and simulation
Project/Dept. Affiliation	Center for the Study of Biological Complexity
Value of grids to this application	Absolutely necessary in order to be able to carry out the large amount of calculations needed and to have access to the large amount of memory and disk space needed to generate the simulations.
Originating institution	Virginia Commonwealth University
Contact (s) Name, Email	Tarynn M. Witten, PhD, FGSA, FCSBC tmwitten@vcu.edu
Participating sites	Virginia Commonwealth University, Center for the Study of Biological Complexity
General description	**VCU View** A Researcher's Quest for a Cure *Tracking a deadly parasite through the Virtual Parasite Project* ***Image #1, 2, 3 and 4*** ***Inside the world of the Virtual Parasite Project. Image courtesy of Tarynn Witten, Ph.D./VCU.*** By Sathya Achia-Abraham and Sara Hall University News Services June, XX 2007 At first glance, it would seem the Virtual Parasite Project is like your modern day video game. Virginia Commonwealth University researchers are entering into a virtual world and using a host of tools and test tubes, however, their goals are greater than a mission to find a gold ring or defeating some Master Cyborg Villain. Here the adventure is of real consequence, and the quest is for a cure. Led by Tarynn Witten, Ph.D., FGSA senior fellow and director of research and development at the Center for the Study of Biological Complexity at VCU, the team is gaining a deeper understanding of *Trypanosoma cruzi*, the deadly parasite at the root of Chagas' disease, which kills some 50,000 people each year. "The Virtual Parasite Project provides a working environment for our researchers in the form of a virtual or *in silico* laboratory. The laboratory is in the computer and that's where the researchers perform their experiments," Witten explained. "We want to gather more biological data on *T. cruzi* and find out more about how it functions. The goal is to move toward developing therapeutic strategies – or even a cure for infections

	caused by *T. cruzi*," she said. The parasite is found mainly in rural, poverty-stricken areas of Latin America, and is transmitted to animals and humans through insect vectors. The parasite alone does not cause Chagas' disease, however, once it gains passage into the bloodstream, through say an open wound or break in the skin; it can develop into Chagas' Disease. The infectious disease wreaks havoc on the body - affecting the nervous system, digestive system, and the heart. The disease is fatal and by the time it's diagnosed, it's incurable. Two of the three drugs available for treatment have been taken off the market because they are extremely toxic. Therefore, the need for alternative therapies is critical. That's where Witten and her team comes in. For more than 30 years, Witten has created mathematical and computer models of how living things work. A leader in her field, Witten was determined to create a model that had never before been designed in the virtual world. While a number of virtual models already exist for understanding the heart, human anatomy, biomechanics and genomics, none existed for the investigation of parasites. That model was uncharted territory, and Witten sprung to action. The VPP is housed in the Center for the Study of Biological Complexity at VCU, and allows researchers to select the parameters they would like to specifically test. For example, what would happen if gravity was turned off? Could the parasites swim? Would they know where they are? How would they react? Would the parasites still swim downward toward the host cells, as they do now? "We attempt to design the models as realistically as possible and use the best known biological data for computing. We'll see if they match up and if they don't we try to understand why," Witten said. "For example, is it because we don't have enough biological data? Or is it because the models of *T.cruzi* aren't good enough?" After just five years, the VPP has already unlocked one of *T. cruzi*'s secrets. Witten's team made an important discovery that has led to a patent application for a potential therapeutic intervention against the parasite. The team observed the parasites swimming around in the test tube and noticed that they did not collide with each other. They hypothesized that the parasites must sense each other's electromagnetic field. To test their theory, the team placed nanoballs with electric charges to the solution. They then put the

	parasites in the solution with the host cells at different concentrations to produce different electric field strengths and see whether or not the parasites would bind to each other. They discovered that the more electric fields present in the environment, the less likely the parasites were to bind to each other – which typically results in chaos and infection. “Our findings may one day lead to a potential therapeutic intervention. If we put biologically inactive, or inert vesicles into a human that are highly charged, we could theoretically slow it’s progression and the infection enough so that another therapy may work at a lower dose,” Witten said. “This work was based on a theory we had -- nobody knew any of this before. Creating the model actually led to an unknown biological result and new, critical information about this parasite,” she added. The focus of the current research at the VPP is *T. cruzi,* chosen because VCU has expertise in this area and the best biological data for use in the computational modeling. However, Witten has plans to expand its use and offer the VPP as a resource to researchers studying other organisms. Researchers would have an opportunity to create their own experimental *in silico* environments, input biological data into the computer program and perform necessary simulations. To run experiments and make predictions in the virtual world, Witten’s team is comprised of diverse expertise including biologists, microbiologists, physicists and mathematicians. Since the creation of the VPP, more than 35 experts, undergraduate, doctoral, and master’s students have worked on the project. “It’s generating not just research, but degrees. It has a broad student impact now,” she said. The VPP is the first of its kind involving an integrated environment that allows researchers to actually put videos, audios, simulations, and code all in the article for the user to read and work at interactively. [This sentence is out of place in that it seems to refer to my Academic Intersections journal work and not to the VPP. The VPP is the first of its kind involving the ability for researchers to expand the code to allow them to simulate their own individual parasites. But the 1st part of the previous sentence refers to the journal Academic Intersections (of which I am on the editorial board) and not to the VPP.] “It’s truly at the bleeding edge of how to do what we call, multi-scale modeling. It is an example of a computationally intense and mathematically difficult model,” Witten said of the VPP. And the

	computer-science world has taken notice. Sun MicroSystems has awarded the VPP access to its national grid of over 100,000 nodes (cpu's) and an Academic Educational Grant to purchase additional equipment. Apple Computing has also paid attention to the project, as has IBM. In November 2007, the VPP will be highlighted at a deep computing booth at IBM's national/international Super Computing 2007 meeting. Additionally, VCU received a Deep Computing award from IBM for the VPP based on the intense computing capabilities, the amount of data and the amount of computation involved. Witten and her group are collaborating with a number of universities to optimize the speed of the VPP to make it even faster. Witten's next goal is to develop the VPP into a national center for parasitic modeling and simulation. The work at the VPP is supported by awards from the Center for the Study of Biological Complexity, Apple, IBM and Sun MicroSystems. For more information visit: http://www.vcu.edu/csbc/vpp/index.html
Anticipated system requirements for SURAgrid nodes running this application	As much of everything as we can get
Anticipated non-system requirements for SURAgrid nodes running this application	Graphics and data analysis at VCU.
Grid focus (data sharing, computation, access to unique resources, collaboration)	Computation, access to resources not available at local institution, collaboration
Network dependencies (bandwidth, latency, multicast, other)	None
Expected frequency of application run (one-time, occasional, monthly, weekly, daily…)	Daily but certainly weekly with multiple users accessing system
Estimated start date for application run	Immediate
Describe expected application invocation mechanism (by user submitting job, programmatically by some event or timing…)	
Is this application open to others to use with their own data or revisions?	Currently the application is open through a CVS repository and collaborative research only. It is not available for general public use at this time.

Additional comments	