Building Scientific Communities Online

HUBzero® is an open-source software platform used to create web sites or "hubs" for scientific collaboration, research, and education. It has a unique combination of capabilities that support science and engineering. A little like YouTube.com, HUBzero allows people to upload content and "publish" to a wide audience, but instead of being restricted to short video clips, it handles datasets, analysis tools, and other kinds of scientific content. In that respect, HUBzero is a little like MIT's OpenCourseWare, but it also integrates the content with collaboration capabilities. A little like Google Groups, HUBzero lets people work together in a private space where they can share documents and send messages to one another. A little like Askville on Amazon.com, HUBzero lets people ask questions and post responses, but about scientific concepts instead of products.

Perhaps the most interesting feature of HUBzero is the way it handles simulation and modeling programs, or "tools." A little like SourceForge.net, HUBzero allows researchers to work collaboratively on the source code of their simulation programs and share those programs with the community. But instead of sharing only by offering source code bundles to download, HUBzero also offers live *published* programs available for use instantly and entirely within an ordinary web browser. The simulation engines run start to finish on computational resources selected for that hub. Computationally demanding runs can be dispatched to remote computing resources in a way that is completely transparent to users. Tools are driven by friendly graphical user interfaces (GUIs) that enable end-to-end operation of the simulation process encompassing set-up, execution, and data visualization. Many GUIs are built using HUBzero's Rappture toolkit, which lets researchers compare simulation results from multiple runs and ask "What if?" questions. In effect, each hub powered by HUBzero is an "app store" for a scientific community connected to a cloud of resources for app execution, complete with a library of training materials and other collaboration features to support app use.

HUBzero was created by Purdue University and the National Science Foundation (NSF)-funded Network for Computational Nanotechnology (NCN) to power their web site at nanoHUB.org. Since 2002, the community using nanoHUB.org has grown from a thousand users at Purdue to more than 400,000 visitors each year from 172 countries worldwide. In 2011, some 10,800 users accessed more than 230 nanotechnology simulation tools and launched 390,000 simulation runs. Collectively, they spent 9,500 days interacting with the tools and visualizing results within their browser window. During the same time period, a larger audience of 195,000 users viewed seminars, accessed teaching materials, and downloaded podcasts from nanoHUB.org.

All resources on nanoHUB.org are presented in a scholarly fashion with title, authors, abstract, and archival citation information. To date, there are more than 710 citations in academic literature to nanoHUB.org and the tools, seminars, and other resources published there. Also to date, 379 courses at 131 institutions of higher education have used nanoHUB.org resources. The citations in research journals and the documented use in classrooms is evidence that nanoHUB.org resources aid both research and education.

HUBzero was released as open source software in April 2010, and today, it powers 40 web sites with a combined audience of 600,000 visitors each year. One of these, NEES.org, connects 14 research institutions with practicing engineers in the NSF Network for Earthquake Engineering Simulation (NEES), a $105M project focused on preventing damage from seismic disasters; they use the HUBzero platform not only for simulation, but also for experimental data collection, and for education/outreach activities. In the healthcare area, the Cancer Care Engineering hub at cceHUB.org combines a database of blood samples from cancer patients with statistical data mining techniques in order to explore more effective treatments and prevention strategies for many types of cancer. The pharmaHUB.org site serves the pharmaceutical manufacturing community by maintaining an excipients knowledge base and 20 simulation tools for various manufacturing processes. Other hubs span a variety of scientific areas including biofuels, manufacturing, electric vehicles, climate change, water quality, volcanology, and microelectromechanical systems.

How Hubs Connect Communities

① A scientist named Hugh creates software for scientific modeling and uploads it to a hub to share with colleagues, much as he would share a video on YouTube. Other scientists and engineers can use the tool and rate or comment on it.

② Another researcher, Sue, runs her data on the new software tool using a simple Web interface. The demanding computations are done using cloud computing, and are automatically farmed out to available computers across the nation. Sue's data is sent to supercomputers connected to the TeraGrid, Open Science Grid, or DiaGrid, and she receives her results within minutes.

③ Sue has questions about her results, so she asks the community of scientists on the hub what they think about the finding.

④ A third researcher, Drew, posts a possible answer to Sue's question. Then, other scientists vote "thumbs up" or "thumbs down" on whether they agree with Drew's answer. Drew and the other scientists participate by voting on the best answer, all receiving hub points for their efforts.

⑤ Sue also has an idea for a new feature for the software tool, so she adds her idea to a wish list for the software on the hub. Because this is a feature she realty wants, she offers a bounty of 200 of her hub points for the feature.

⑥ Hugh and Sue decide to collaborate on their next project, which is successful, so they write a research paper and give a presentation at a conference. They post the presentation slides on the hub and then track how many users view the materials.

⑦ Drew enjoys the presentation and uses some of the slides in his class to explain this new area of research to his students. He creates a homework assignment in which his students use Hugh's simulation tool to investigate the phenomena, and then Drew posts the assignment on the hub for other educators to use.
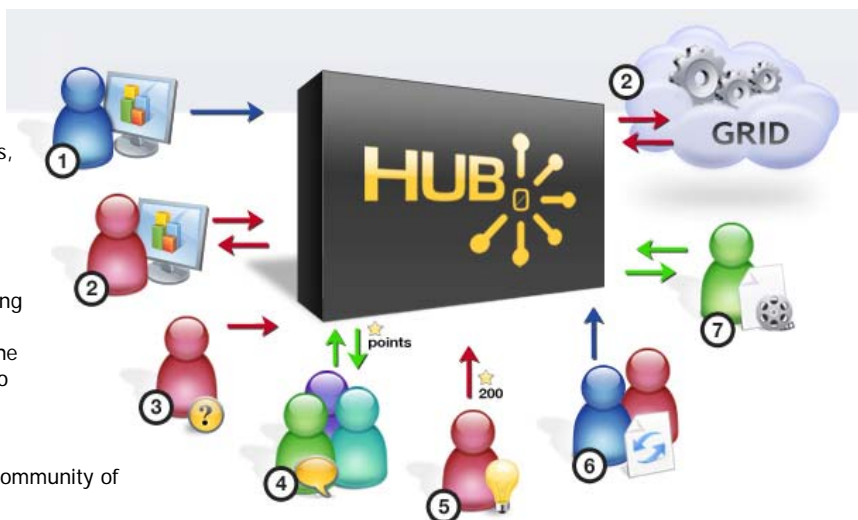
Watch it on YouTube
zy4GwV5KCf8

Acknowledgments

More Information

▸ Visit the HUBzero web site: http://hubzero.org

▸ Videos on YouTube:

Features	How Hubs Work	Symposium	Simulation Tools	nanoHUB-U
vtNUeZQjxGI	zy4GwV5KCf8	h5YEYJ-YXFw	FgfGOEpZEOw	7eFtlbBAl9c

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