HHS*ignite* (beta)

Proposal for Funding

1. Project Title (limited to 140 characters)

Working title: "The NIH 3D Printing Exchange: a virtual collection of biomedical 3D printing files and tutorials"

2. Requested HHS*ignite* (beta) Funding Amount

$ 10,000

3. Certification of Approval

Project Lead's Approving Supervisor: Yentram Huyen, Ph.D., Chief, Bioinformatics and Computational Biosciences Branch, Office of Cyber Infrastructure and Computational Biology, National Institute of Allergy and Infectious Diseases

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4. Executive Summary

3D printing technology is widely used in industry to build prototypes, but only recently has it become mainstream. There are a number of online resources for 3D prints, but there is a paucity of scientific models, and the expertise required to generate and validate such models remains a barrier. We will fill this gap by creating an online portal where researchers and educators can download biomedical structure files that can be printed on a desktop 3D printer or via a 3D printing service provider. They will also find 3D modeling tutorials and educational material to accompany each print. HHS*ignite* (beta) support is necessary to realize the full potential of this project: a comprehensive, open-source, accessible, and interactive website for searching and browsing biomedical 3D prints.

5. Your HHSignite (beta) Team

Project Lead Name: Darrell Hurt, Ph.D. Op/StaffDiv: NIAID/NIH (FTE)
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Team Members (Max of up to 7 additional team members)

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6. List the Secretarial Priorities that this proposal directly supports.

This project aligns with Secretary Sebelius' priorities to:

Put children and youth on the path for successful futures
Accelerate the process of scientific discovery to improve patient care

7. Identify the category that this proposal falls into

This proposal falls into the category of Communications.

8. Identify any additional funds or resources being brought to this project to supplement HHSignite (beta) funding and support.

Supplemental resources include existing software expertise, software development resources, and workstation and server infrastructure. The NIAID team will also make available the Z510 3D printer currently in use by our group, purchased in 2007.

Project Description (Max 2 pages)

3D printing permits the direct fabrication of unique and complicated objects in a layer-by-layer manner. Its use has been validated across many industries over the past decade and more recently is reaching mainstream users through service providers, both online and in brick-and-mortar stores. Greater affordability of 3D printers has led to adoption of their use in homes, offices, and schools. Tangible models built by 3D printers have proven of great worth in classroom-based instruction and biomedical research and communication, but there is much unrealized potential. Even though the technology is now easily accessible, most researchers and lay people have little to no experience using the software required to create digital models. Furthermore, there is a paucity of readily available scientifically relevant digital models that are compatible with 3D printers.

To fill this gap, we aim to create the NIH 3D Printing Exchange, an open, comprehensive, and interactive website for searching, browsing, downloading, and sharing biomedical 3D print files. Our team members from NIAID, NICHD, and NLM collectively already have more than 100 ready-to-print models to populate this proposed database. These models were created by biomedical illustrators or directly from experimental data and medical images.

The content is directed toward three user demographics: (1) primary and secondary school educators looking for hands-on teaching aids, such as cells and sub-cellular compartments, larger anatomical features, and molecular structures such as DNA; (2) scientific or clinical researchers and investigators seeking specialized models to visualize existing problems and spark ideas leading to new discoveries; and (3) speakers looking for new ways to engage an audience. High-level executives at NIH have already used hundreds of NIAID-produced prints at domestic and international talks.

Users will be able to search this content and print the files with their own 3D printer, or they may use one of the many low-cost service providers. Although each 3D printer uses its own unique software, only a few open-source file formats serve as the *de facto* interchange standards, which simplifies the database architecture required for our library. However, we want to build a flexible schema to manage metadata attached to the models and be prepared to accommodate new file types. To promote expansion, we will allow users to request new models and submit their own files for inclusion in the library. In addition to ready-to-print 3D files, we will include relevant news and information about 3D printing technology in science and education. Users will have access to educational material for use in the classroom and interactive viewers for previewing virtual 3D prints on screen. The website will also feature tutorials on creating digital models for 3D printers and a discussion forum for questions and answers on 3D printing, scientific models, or modeling software. We hope that by creating an environment for sharing files and ideas, we will encourage collaboration among researchers and educators, which will facilitate innovation and open science and ultimately improve patient care and teaching methods.

Support from HHS*ignite* (beta) will provide us with the necessary resources to realize the full potential of this project. Of the funding, we estimate $4,000 for a high-end desktop 3D printer, the CubeX Trio, and $2,500 for Magics (Materialise, Inc.), software specially designed to validate 3D print models. The remainder of the funding will be used to purchase printer consumables. HHS*ignite* resources may also be used to assist in exploring the many alternative features that could be included in the website, and to provide support for meeting HHS internet

standards and 508 compliance, and possibly in creating new educational material and raising awareness of the website.

In the first stage of this project, team members will design a database schema, and the NICHD group will develop a website for searching and browsing 3D printable files through a polished, intuitive interface. Next, members from each institute will upload their existing 3D printer-compatible files to the repository, which will be housed in the NIAID computing infrastructure. We will use the new printer alongside our current 3D printing resources to experiment with new ways of designing digital models that are durable, functional, and informative, and we will brainstorm to develop new ways to print useful research and teaching aides, such as experimental apparatuses or models with moving parts that demonstrate biological processes and molecular interactions. We will also print, validate and refine user-contributed files, and make notes about post-processing steps to accompany the models. The NIAID group already has a number of instructional videos ready to upload, and the team will work together to create additional material, especially for non-specialist users and educators.

The major milestone in this initiative is to launch the pilot site, either to the NIH community alone, or to the general public. We will advertise through communication outlets at NIH and HHS and through social media. We estimate a four- to six-week pilot phase, during which we will elicit feedback from users. We hope the high-profile nature of HHS*ignite* (beta) will help to draw a substantial number of site visitors. In the final stage of the project, we will implement a formal strategy for maintenance of the site and all team members will contribute to adding new material in the future. In the long-term, and dependent on the success of this pilot, we aim to publish a paper about the NIH 3D Printing Exchange in a scientific journal.

This project aligns with the mission of NIH to foster biomedical research, and has the potential to be a long-term "flagship" NIH resource for global public use. This is particularly relevant as the technology is advancing to allow for 3D printing of human tissues and organs, a development expected to have a significant impact on medicine. There is also immense opportunity for extensive collaboration with industry or other areas of government. For example, during the pilot phase, we may engage the 3D Medical Applications Center at the Walter Reed National Military Medical Center. Furthermore, the NIH 3D Printing Exchange will place HHS in a group of federal agencies already invested in 3D printing, including the Departments of Defense, Energy, and Commerce, the National Science Foundation, and NASA. We foresee that, over time, our model for creating a specialized repository of validated, 3D-printable files could be copied or expanded to include any of these agencies, and more. For the duration of the HHS*ignite* (beta) phase, we have outlined goals that are attainable within the six-month timeframe, but that also involve a portable, scalable framework to accommodate future additions and modifications, and that could be moved to a cloud computing environment, if desired.

This promising initiative is fully in line with the missions of NIH, HHS, and the federal government at large. The NIH 3D Printing Exchange supports missions set forth by HHS and the White House to promote Science, Technology, Engineering, and Mathematics (STEM) education. It will keep NIH and HHS ahead of this emerging technology, which is in line with their interests to promote research leading to new and improved treatments for patient care. We hope we can look forward to participating in HHS*ignite* (beta) and bringing to fruition our plan for a successful and sustainable 3D printing resource for biomedical researchers, educators, and administrators.