2015 Technology Fee Full Proposal

Title: New Functionality for UF Libraries' 3D Printing Services

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Sponsoring Organization: George A. Smathers Libraries

Purpose and Specific Objectives: To expand the UF Libraries' 3D printing services, we propose the purchase of multi-color printers and a fleet of small 3D printers that will circulate to students.

Multicolor 3D Printers:

We propose the acquisition of four dual-extruder Fusion F306 printers that can 3D print models using two colors of plastic filament. Although similar to the one-color Fusion printers we currently operate, the proposed printers will feature a second extruder nozzle for two-color printing. Two-color printing will increase the range of 3D models that the libraries will be available to print providing students with more flexibility in creating their designs. (See Figure 1)

Figure 1. Image of single-extruder Fusion F306 (dual-extrusion is similar) and 2-color 3D models.

Additionally, we are requesting a Mcor Iris full-color 3D printer that uses paper, printer ink, and glue to create photo-realistic 3D models (See Figure 2). These 3D models will be created by inkjet printing sheets of paper, then automated cutting and gluing sheet to sheet to build intricate 3D models. This will be the only type of 3D printer, at the Libraries, that prints in the full spectrum of colors. These resulting 3D models are remarkably strong. Another benefit of the proposed printer is that the supplies will be considerably cheaper than other types of 3D printers since the major consumables are standard printer paper, white craft glue, printer ink, and cutting blades. Mcor informs its customers that print costs are 1/10 the cost of plastic 3D printing and we plan to pass along those savings to students. It also does not release toxic fumes, unlike most 3D printers, making it suitable for the general library environment. This proposed printer will be the first full-color paper-based 3D printer at UF.

Figure 2. Examples of full-color 3D printed models from the Mcor Iris paper-based printer. For more images, see http://mcortechnologies.com/3d-printers/iris/

3D Printers for Student Circulation:

UF students can currently submit 3D models to be printed in three library branches, however students are missing the educational opportunity to learn *how* to 3D print, including using the processing software and by directly operating the printer. We propose the acquisition of 10 portable 3D Printrbot Simple Metal printers (Figure 3). Each will come with a carrying case to be either used in-library, home, or in a classroom. These small printers have a footprint of 18" x 17" x 13", build volume of 6" x 6" x 6", and weigh 16 lbs. The proposed printers will be made available to students who will check them out and also receive a roll of white filament. Students will be able to use this filament or purchase additional filament and different filament colors at the UF bookstore or at an off campus location (e.g. Best Buy).

Figure 3. Printrbot Simple Metal portable 3D printer, filament, and carrying case.

Impact/Benefit: The Smathers Libraries' 3D service, created by a Technology Fee award in 2013, offers 3D printing in Marston Science Library, the Education Library, and the Health Science Center Library, serving the undergraduate and graduate student populations across all disciplines. Since the service began in April 2014, the Libraries have assisted 1,635 patrons with printing, totaling 322 pounds of plastic and 360 days of print time. Approximately 62% of users were undergraduates, followed by 17% graduate students. Installation of 3D printers in the Libraries has been well received as demonstrated by the usage data for 2014 and 2015. The usage increased by 87% percent between 2015 and 2014 (Figure 4) and is expected to increase further in 2016. The Libraries continue to provide students with the least expensive option for 3D printing on campus, charging only $0.15 per gram of filament used.

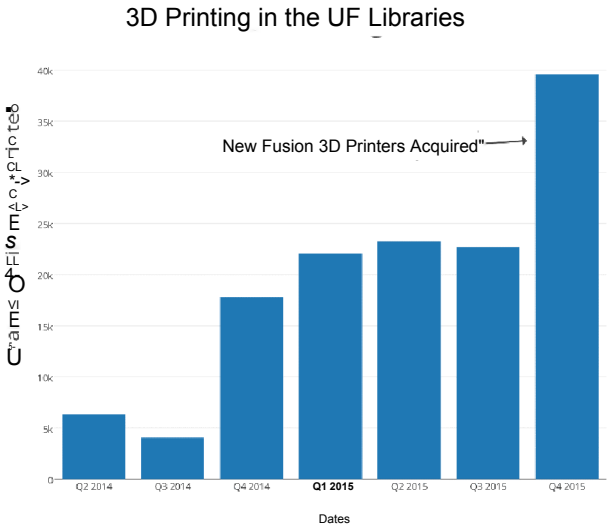

Figure 4. 3D Printing Usage in the UF Libraries.

University libraries serve as a central space for all disciplines and thus are uniquely suited to make fabrication/visualization technology available. Usage of the Libraries is extremely high, especially Marston Science Library with 1.4 million visitors in 2015, providing significant promotion of our 3D services. Many UF faculty are

incorporating 3D printing into their curriculum, including courses in engineering, architecture, the arts, and the health sciences. Since April 2014, we have printed models for at least 522 class assignments (32%).

The benefit of funding the purchase of the proposed 3D printers is that these printers will allow students to stay abreast of the latest technology and will allow the Libraries to meet the increasing student demand for access to 3D printing technology.

The proposed dual-extruder Fusion F306 printers are the next generation of the Libraries' current printers and will meet the needs of students who require multiple colors in a 3D model with the material strength of PLA. AUF student organization, Generational Relief in Prosthetics (GRiP) designs and manufactures 3D printed assistive devices for children and adults with upper limb differences all throughout the nation. They focus on the empowerment of the recipients, and the delivery of STEM education in the community.

"Marston Science Library and their 3D printers have been integral to GRiP UF's success over the past year. Their already strong force of printers produce almost 100% of our club's prosthetics and assistive devices, and have helped us deliver 10 devices thus far to kids in need. Adding a dual extruded head would not only allow us to increase the complexity of the designs, but also produce more colorful and high quality prosthetics that encourage our recipients to higher level of self-confidence. " ~Jessica Bergau, GRiP president and undergraduate engineering student

The proposed Mcor Iris full-color 3D printer that uses paper will meet the needs of student majors such as architecture and fine arts, in addition to science and engineering majors, who require the ability to create photo-realistic 3D models. The only type of 3D printer that prints in the full spectrum of colors, it prints 3D models using inkjet printing sheets of paper, automated cutting and gluing sheet to sheet to build intricate 3D models. Because it uses paper and water based adhesive, the full-color printer is eco-friendly, clean, safe, and offers low operating costs.

"This printer would highly benefit my thesis, in which I am conducting a facial reconstruction of an Egyptian mummy by 3D printing the skull from CTscans. Once the reconstruction is done, I can create a realistic representation with color using 3D modeling computer software, which I could then print on the full-color 3D printer for museum exhibit purposes." ~Elizabeth Bouton, graduate student in the College of the Arts

Finally, by funding the proposed fleet of small 3D Printrbot Simple Metal printers that the Libraries will circulate, the students will benefit by the educational opportunity of learning *how* to 3D print small objects, *how* to use and manipulate the processing software, and *how* to operate and troubleshoot 3D printers. These proposed printers will be checked out to students on a 3-day loan and will come with a spool of white filament. Students will be able to use that filament or purchase additional filament and different colors at the UF bookstore or at an off campus location (e.g. Best Buy). Knowing how to 3D print is a skill that can be highlighted by students seeking employment.

"Having a hands on experience with 3D printers has been a rewarding experience for students. Allowing them to use the printers and make mistakes has been a vital tool in teaching design for 3D printing. The PrintrBot Simple is a rigid, compact and simplistic design that is ideal for transportation. " ~John Loeffler, mechanical engineering graduate student

3D printing offers the innovative opportunity to create a physical copy of a 3D digital model, essential for rapid prototyping of a concept. This technology is common now in engineering firms, health care, and in architecture and fine arts. 3D print is a marketable skill that students can learn and add to their resumes. 3D printing provides students from all disciplines with a tangible realization of their creative vision. It is imperative for students to be able to explore and become familiar with the latest innovations in this key technology to foster creativity, visualize multi-dimensional objects, and prepare for future careers.

Sustainability: This proposed 3D equipment will be sustained by the Libraries' 3D funding model, supported by printing charges and labor provided by library staff. This model has been in effect since April 2014 and has proved sufficient for supporting printer repairs and materials.

Timeline: Start date: 7/1/16; end date: 6/30/17. Upon approval of this proposal, the 3D printers described above will be ordered. Once the printers are received, set-up, and tested, they will be ready for use.

Task	Timeframe
Order 1 Mcor Iris 3D printer	Upon receipt of funds
Order 4 Dual Extruder Fusion F306 printers	Upon receipt of funds
Order 10 Printrbot Simple Metal printerswith 10 carrying cases	Upon receipt of funds
Order 100 rolls of filament	Upon receipt of funds
Begin Printrbot checkout	Within 45 days of receipt of funds
Dual Extruder Fusion F306 printer start-ups	Within 60 days of receipt of funds
Mcor Iris 3D printer start-up	Within 90 days of receipt of funds

Budget Narrative: The budget for this proposal includes the cost of the printers and shipping. In addition, for the portable printers to be checked out to the students, a carrying case for each Printrbot is included in the budget. To get the students started on using the Printrbots, these printers will be checked out to students on a 3-day loan and will come with a spool of filament for their use. One hundred rolls of filament are included in the budget.

Budget

Technology	Price/item	Qty	Total
Mcor Iris 3D Printer (with educational discount)	$50,790	1	$50,790
Shipping	$500	1	$500
Dual Extruder Fusion F306	$4975	4	$19,900
Shipping	$405	1	$405
Printrbot Simple Metal	$599	10	$5990
Pelican 1620 Case	$220	10	$2200
Filament for printers (1 year supply)	$20	100	$2000
TOTAL			$81,785