Title: 3D Print Lab in the UF Libraries

Proposer: Sara Gonzalez (Marston Science Library (MSL)), Amy Buhler (MSL), Denise Bennett (MSL), Tara Cataldo (MSL), Michael Howell (MSL), Margeaux Johnson (MSL), Vernon Kisling (MSL), Michelle Leonard (MSL), Ann Lindell (Architecture & Fine Arts (AFA)) , Valrie Minson (MSL), Cliff Richmond (Health Sciences Center Library (HSCL)), Melody Royster (MSL)

Sponsoring Organization: UF Libraries

Purpose and Specific Objectives:

Purpose: **To acquire 3D printing and scanning equipment in the Marston Science Library (MSL) and the Health Science Center Library (HSCL) for use by all UF students and faculty.**

Introduction: 3D printing technology has existed for several decades but the technology has matured to the point that print costs are no longer a barrier for educational initiatives. 3D printing offers the innovative opportunity to quickly 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.   It is imperative for students to be able to explore and become familiar with this key technology to foster creativity, visualize multi-dimensional objects, and prepare for future careers. To see examples of 3D print objects, visit www.thingiverse.com .

University libraries serve as a central space for all disciplines and thus are uniquely suited to make visualization technology available. Recently, several academic university libraries, such as North Carolina State, University of Nevada at Reno, and Dalhousie University, have installed 3D printing and scanner equipment, resulting in high usage and interest by both students and faculty. The UF Libraries has experience and a proven history of providing information and computing resources for general student use and the acquisition of 3D printers/scanners will further expand MSL and HSCL's ability to serve the undergraduate and graduate student populations, across all disciplines. We anticipate faculty usage as well, especially for instructional purposes.

Description: MSL will house 1 medium- and 1 lower-resolution printers, and a 3D digital scanner. HSCL will host a medium resolution 3D printer and 3D digital scanner. Each scanner will be connected to a workstation plus large monitor to create and edit scanned models. A student assistant (20 hrs/week) will be employed to assist with the printing in MSL.

Patrons will deliver a 3D object file to the MSL or HSCL service desk to be assisted by a librarian in selecting the appropriate print resolution, material type, and to place it in the print queue, handled by a workstation connected to the printers. Students will be expected to create the 3D object file themselves either by using the library 3D scanner or by using UF computing labs' 3D modeling software.

The current printers being considered are the Stratasys UPrint SE+ and the lower resolution Makerbot Replicator 2. The proposed 3D scanner is NextEngine 3D Scanner HD and is capable of 400 DPI resolution, .005" dimensional accuracy, and a 22.5" x 16.75" field size. 3D technology is a rapidly evolving field and we will re-evaluate equipment before purchase.

Instruction is an important component to introducing this technology so we will offer workshops and online tutorials to teach new users how to create and modify 3D models. These workshops and training will be held in coordination with the staff of the Fab Lab so that students will learn not only 3D modeling skills but also the range of fabrication opportunities available at UF.

Existing Infrastructure: There are several 3D printers located in various faculty labs on campus and recently the A^2 Fab Lab opened its production equipment to the UF community with a membership cost. The Fab Lab has 2 very high-resolution 3D printers, laser cutters, scanners and a router. This proposal **does not** duplicate their existing 3D print services but rather **complements** the Fab Lab by offering entry-level lower resolution 3D printing for

students who want to explore 3D printing for either class or personal use. Students who seek high resolution, production quality printing will be referred to the A^2 Fab Lab.

Impact/Benefit:

The impact of these resources is potentially enormous since the 3D printers and scanners will be available for use by the **entire UF community**. Based off our preliminary queries to departments, we anticipate that engineering students will find it particularly useful, impacting almost **5000 undergraduates and almost 3000 graduate students**. The equipment will also be highly visible to students, centrally located in the Marston Science and Health Science Center Libraries. Both libraries have a high level of traffic, with over 705,000 students visiting MSL in 2012.

Students need the ability to create 3D models to rapidly turn an idea into a physical prototype. 3D printing also enables students to print out a representation of a concept (such as a molecule) and, by examining it tactilely rather than a 2D representation on a monitor, gain a better understanding of the object. Some potential uses at UF include:

- *Anthropology*: Replication of artifacts, skeletons

Figure 1: Artifact Replicas from 3D images printed in the 3D printer in the LSU Digital Imaging and Visualization in Archaeology (DIVA) lab, as well as the original artifact. (Photo courtesy H McKillop, Anthropology News, 2/6/2013)

- *Architecture:* Production of physical models of architectural structures

- *Biological Sciences:* Reconstruction of extinct organisms/fossils, production of genetic structures. Professor Monika Oli teaches MCB 2000L (**800 students/semester**) and plans to use the 3D resources for her instruction:

  "I am a faculty in Microbiology and Cell Science teaching microbiology labs. Over the last year I have been planning to use a 3d printer for several of our projects, but have not had the opportunity to work with someone who could help me with this. There are several projects I want to use the printer for with my students. 1. I want to produce 3D models of bacteria, parasites and viruses and study sub cellular organelles. This will be used for the class and also for rotating exhibit in our building. 2. I am spearheading a project where I combine art and microbiology and am interested to use the printer for more abstract - educational art - projects, which in turn can be used for outreach and K-12 education. We have over 800 students per semester and the 3D printer would be a great way to introduce students to current and cutting-edge- technology which is used in so many fields."

Figure 2: Molecules, printed using Replicator (http://www.blog.csc.mrc.ac.uk/?p=184)

- *Chemical Sciences:* Production of molecular structures to better visualize interactions and complexities; production of custom lab equipment for specialized experiments.

- *Civil and Coastal & Mechanical Engineering:* Print structures to be tested inside UF's wind tunnel; replicate lab equipment or mechanical parts, prototyping of custom pieces for undergraduate/graduate projects

- *Geography/Geospatial Sciences:* Visualization of GIS and topographical data; modeling of watersheds

Figure 3: 0.6 x 0.9 meter scale model of Seattle (http://www.rapidtoday.com/GIS-3D-Printing.html)

- *Industrial & Systems Engineering*: Dr. Keith Stanfill, director of the Integrated Product & Process Design Program, stated that *"Our IPPD teams would be heavy users of this service"* (**125 students enrolled/semester**).

- *Health Sciences:* Visualization of anatomical models; production of custom research equipment. The six HSC colleges represent 6,900 students and approximately 1,129 residents.
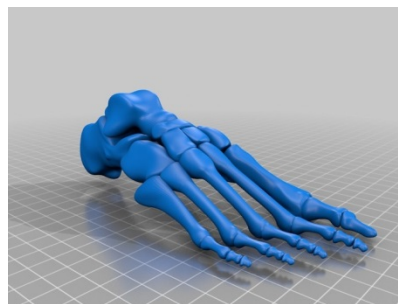

Figure 4: Anatomic Human Foot Model (http://www.thingiverse.com/thing:22628)

As students become more familiar with the technology, we anticipate the discovery of uses across all departments and disciplines. The UF Libraries have a librarian liaison for every UF department and we will reach out to instructors to better integrate this technology into their coursework.

Sustainability:

The recurring costs will be sustained through print charges based upon the materials used. Replacement costs will be based upon expected lifespan of equipment, annual maintenance and repairs. We are projecting usage based upon statistics at other academic libraries and the feedback from UF course instructors. We are estimating 500 print jobs/semester for each printer of size 15 g (Replicator 2) and 2 in^3 (UPrint SE+).

Assuming a 3 year lifespan, annual maintenance costs (after the 1 year service plan) of $300/printer and using current prices for plastic, we will need to charge $0.25/gr and $7.10/$in^3$ to sustain the 3D printers. For reference, a standard 2x4 Lego brick would cost $0.63 on the Replicator 2 or $2.09 on the higher resolution UPrint SE+ printer. Print charges will be evaluated semi-annually in order to address fluctuation in material costs and activity.

Timeline:

August 2013	Funding awarded 3D printers, scanners, monitors, computers ordered Signage, online tutorials created
September 2013	Equipment received, installed in MSL and HSCL Staff trained in equipment usage Student hired to assist in printing and maintenance of equipment
October 2013	3D printing and scanning services begin Workshops held and outreach to students and instructors begin
Ongoing	Statistics on printer and scanner usage kept

Technology Fee Full Proposal Template

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BUDGET

Equipment	Quantity	Cost per unit	Total Cost
UPrint SE+	2	$26,000	$52,000
Makerbot Replicator 2 (includes warranty, 1 yr plastic filament)	1	$3,525	$3,525
3D NextEngine Scanner	2	$2995	$5,990
MultiDrive (aid in 3D model creation)	2	$995	$1,990
ScanStudio HD Pro (expands processing to increase speed, higher detail)	2	$995	$1,990
RapidWorks (converts 3D scans to solid models)	2	$2995	$5,990
3 Year Extended Warranty	2	$295	$590
Workstations (Dell quote) OptiPlex 9010 Small Form Factor w/ Standard PSU, Windows 7 Professional, No Media, 64-bit, English	4	$742.70	$2970.80
Dell UltraSharp U2412M 24-inch Widescreen Monitors with Dell MDS14 Dual Monitor Stand	4	$739.49	$2957.96
NEC Large Monitor 46" E462 Full HD LCD Display with Tuner, Black	2	$684.88	$1369.76
TOTAL			**$79,373.52**

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