

Metal Printing – An Advancement of Additive Manufacturing Resources at the University of Florida

Proposer: Dr. Abdol Chini, Professor and Associate Dean of College of Design, Construction and Planning
chini@ufl.edu 331 Architecture, 1480 Inner Rd, Gainesville, FL 32611 (352) 294-1407 Fax: (352) 392-7266

Sponsoring Organization: Infinity Fab Lab - College of Design, Construction and Planning and College of the Arts

Purpose and Specific Objectives: This proposal is a call for the advancement of instructional technology in the field of digital fabrication, here at the University of Florida; specifically, **3D Printing of metal materials** for the first time at the University of Florida and in the greater North Florida region.

Additive manufacturing, or “3D Printing” as it is best known, is one of the fastest growing industries in the world and developments through studies in materials sciences is making an impact in almost all industries, from engineering, architecture and the arts, to medical devices, prosthetics, entrepreneurship, and much more. In this growth, new processes for making and new materials are continually available. Metal is the newest emergence in 3D printing materials, allowing for the creation of objects on-the-fly with elements such as stainless steel, aluminum, titanium and more. For years the Infinity Fab Lab has been continually requested for this material availability and now this technology is available in a small form-factor that is completely safe and affordable to use.

We continue to offer internships and courses run through the Fab Lab and we feel that having hands-on experience with the most up-to-date technology will increase the student’s chances of success in the job market. We are also looking forward to coming through for faculty who have requested this technology. We have the experience and expertise to support the University mission of teaching and research and we are here to serve. However, we know that to remain a *preeminent digital fabrication research and learning laboratory* and to best serve the University, we must stay on the cutting edge of technology, so that our researchers, our teachers, our staff and our students, have the fullest potential to research, make and invent, uninhibited.

To meet our mission of supporting the people of the University of Florida in the pursuit of knowledge through advancing the additive manufacturing resource offerings of the Infinity Fab lab, we have crafted this Tech Fee Proposal with the intentions of acquiring one new piece of equipment and it’s supporting devices, the **Markforged Metal X 3D Printing System**. We have researched many options in this technology, fielded multiple demonstrations from different makers of metal printers, and the Metal X has risen to the top as the most high-quality, affordable option that will be accessible and sustainable for the long-term.



The Markforged Metal X 3D Metal Printing System

In it’s 4th generation of existence, we feel this compact, concise unit, has worked through many of the issues seen in the past in the area of metal printing, and is ready to go to work at supporting making, learning and research.

With this technology, average cost savings are 1/100th the cost of traditional manufacturing methods.

As part of this proposal, we will create a *Metal Printing Pilot Program*. This program is intended to test the uses of the printer and to spread awareness across campus, of this new tool on campus. We will send invites to every college unit on campus and ask for project submittals, for a chance to be 1 of 6 individuals or groups to get the opportunity to use the printer with an included budget of up to \$500 in materials and unlimited support in their development over a 2 month timeframe.

Specific measurable objectives will include:

- Multiple iterations, as is a benefit to 3D printing.
- Case studies of cost/time savings compared to other manufacturing techniques.
- A synopsis of what they learned and how this particular tool can be utilized elsewhere on campus

Impact/Benefit: The Infinity Fab Lab and the resources within are open to ALL faculty, staff and students at the University of Florida. We serve 20-30 courses and thousands of individuals each year from the Colleges of Engineering, Arts, Design, Construction and Planning, Warrington College of Business, Shands/UF Health, Anthropology, Museum Studies, Health Science, Anesthesiology, Radiology, Neuroscience, Marine Biology, Computer Science, the Vet School, the McKnight Brain Institute and many more.

The Lab is in it's second year of partnership with UF Housing's Infinity Hall and it's 308 residents, as well as Innovation Academy, bringing the program's 407 students through the lab, each with 2 weeks of hands on learning and making experience. The Warrington College of Business' Entrepreneurship and Innovation Center has added an Infinity Fab Lab *iterative making experience* to their list of required objectives in their minor program. The lab sponsors the P.K. Youngge Robotics team, as well as the Eastside Urban Farmer's market. The President's office teamed up with the College of the Arts and Fab Lab to produce this year's laser-cut Christmas cards and the University Communications department worked with the Infinity Fab Lab to produce laser-engraved coasters as gifts as they hosted last year's SEC Communication gathering.

The Fab Lab provides the most sophisticated digital fabrication technology and expertise on campus to aid in making tangible outcomes efficiently and successfully in a personal and hands-on way. This grant, if awarded, will ensure to our community full access to 21st century industry standard digital fabrication and rapid prototyping tools required to fulfill their research and realize their concepts to their fullest potential. We wish to continue as the lab to turn to for fabrication of the highest standards and greatest ease. The Metal X greatly accelerates innovation, delivering metal parts overnight using a new technology at a fraction of the cost.

Category	Cost
Typical Machined Cost	\$3,247.48
Markforged Printed Cost	\$45.93
Savings	99%

The Metal X is up to 10x less expensive than alternative metal additive manufacturing technologies – and up to 100x less than traditional fabrication technologies like machining or casting.

But what really qualifies this as a responsible investment in the University of Florida community of students, faculty and staff? Who will this REALLY serve? Can the price of this equipment really be justified? Based on 10 years of experience in investing in tools of the future, now, to create success in the long run, we think so.

At the Infinity Fab Lab, we have focused on a two-part approach how we serve the campus. The first part is in being the people you can come to with a problem or idea, and we are here with the expertise to help solve it and provide resources to create it. The second part is to be visionaries. We seek to find the tools of tomorrow and make them standard in our process today. In doing this, we create solutions for problems not yet even thought of. We want to continue to be the place on our University of Florida campus that provides a wide range of versatile resources to create and think up new things, simply because the tool now is within grasp. With this all being said, we foresee uses of the equipment that haven't even arisen yet, simply because the tool didn't exist yet. It is this mindset, of being truly on the cutting edge and allowing for growth of new possibility, that makes UF a *Research One University*. At the Fab Lab, it is our promise to be the people who stay up-to-date on industry standard equipment, which in turn supports the existing campus community and attracts scholars and researchers from all over, to the University of Florida and furthers the feats of human kind all-over.

Ex. 2 years ago, the University of Florida really wanted to recruit two students from high school who were engineering wizards and had won the national robotics competition all 4 years of their high school career. It was their visit to the Fab Lab, and our invitation to intern here, which convinced them to come to UF, even over other choices such as MIT and Pratt. Both Cross and Michael did intern at the Fab Lab, gained experience on advanced fabrication tools, and in only their first year of college, got accepted as interns at Tesla, due to their experience in the Fab Lab. This is similar to many other stories we have been told by interns, where their experience in this kind of advanced lab, not only advanced them as people, but it also allowed for growth into companies such as Tesla, GE, Kohler, and many more.

9 years ago we bought an advanced resin 3D printer. It was very advanced and expensive, \$120k. We didn't know who all would use it, but today it is our most highly used printer by Engineering, McKnight Brain Institute, Art, College of Dentistry, and more. We are confident that the many people who have requested to use the printer, will have the demand to make it worth the investment.

Case Study: The nuclear reactor on campus often makes their own custom parts for the reactor as they are doing research. They also often use the Fab Lab because of our rapid turn-around times and ability to create along with them when they are mid-project. They have asked for metal parts, but only ones that a 3D printer can create. We are excited to give them this ability.

Other use case scenarios based on conversations with departments around campus of whom we serve:

- Architecture/furniture design courses explore new components of building construction that can be tested in real time without further post processing.
- Art department will utilize the technology to create metal objects without the dangers inherent to students working in the metal shop/foundry.
- Harn Museum and Florida Museum of Natural History re-creation of metal objects to complete restoration of pieces no longer made today.
- Allows for the development of objects ready to use in Interior Design courses. (from hinges to robust one off furniture components.
- Music department can create/re-create parts once hand-made for irreplaceable instruments
- Engineering – Mechanical/Aerospace to create pieces for their Design, Build, Fly team, for the Gator Motorsport rally car, and for endless components in research being done by PhD students in labs throughout all the colleges in Engineering.
- Warrington College of Business and the Entrepreneurship and Innovation Center to develop new products by students needing metal fabrication without the need to pay an average of \$8k per mold and minimum runs of hundreds of parts. Ex: The Cocovana Coconut Twist opener - this project the student developed

over the course of the last 4 years while studying at UF. When Sheldon first came to the lab, he was looking for a way to develop the product, but we could not help him. Eventually he spent hundreds of hours on prototypes and thousands of dollars, to create something that could've been 3D printed in metal in a matter of hours and saved him that time and money.

Sustainability: This proposal will provide technology that requires a small amount of recurring resources in order to run the Markforged Metal X 3D Metal printing system. The College of Arts and College of Design, Construction and Planning will be responsible for maintenance, upkeep, and replacement of all items funded by this grant, as it has with all current technologies, valued at almost \$1,000,000. The Fab Lab has had a working, self-sustaining model for the last 9 years where operational costs for new equipment are built in from the start.

We have a two-fold plan for sustainability which has served everyone well. We work from a model where we operate at a deficit for UF staff, faculty and other students, and then make it up by charging for our services with some built-in profit to businesses outside of the university and let this subsidize the University of Florida researchers and creatives. This model has worked well to simply operate at break-even for the last seven years and provide for the most opportunity possible to the people at the University of Florida.

Timeline: August 2018: Purchase of all noted equipment. Vendors have been fielded and are aware of the possibility of our order.

October-November 2018: Arrival of Metal X and supporting equipment such as the sintering oven which takes 1-2 months to manufacture from the date of our order.

January 2018: All technology in place and operational. Training will have commenced and students/faculty may now begin to utilize this for research and creation. An Open House will follow to showcase this state-of-the-art piece of equipment to the University.

Budget: We have researched all the offerings of additive manufacturing with metal printing technology today and chosen the Markforged Metal X 3D metal printer to add to the University's resources and services without any duplication of services or infrastructure at the University of Florida. By the end of this project, the Fab Lab and University at large will have gained a new piece of technology and we at the Infinity Fab Lab will be capable of providing resources and expertise to deliver it.

We have been watching the costs of these printers for the last 5 years as they have come to market and we feel this is the lowest cost that a printer of this level of quality will get to in the foreseeable future. After consideration of the feedback from the committee, we have revised the budget for this project to include only the absolute minimum of materials necessary to get up and running with the printer. This will give us a starting point to work through experimentation and implementation and begin working with researchers and scholars across campus.

BUDGET

Markforged Metal X 3D Metal Printing System, Starter Materials, Post-Processing Equipment & Support	\$177,990
Installation of 3D Metal Printing System and Sintering Oven	\$10,000
Budget Total:	\$187,990