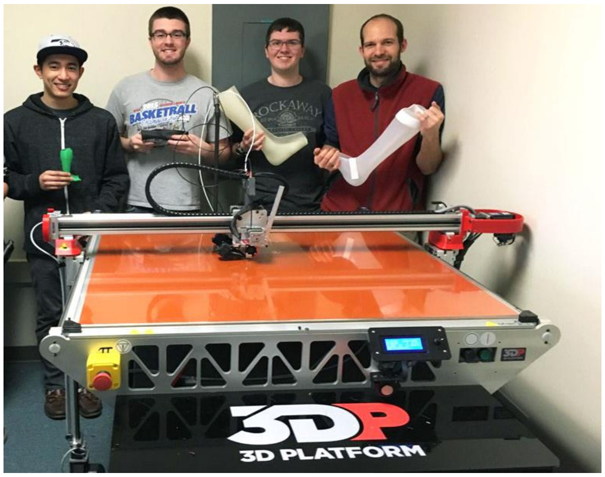
Transforming Ankle Foot Orthosis (AFO) with 3D Printing



The Gonzaga University 3D Printing AFO Project team. [Image Source: Gonzaga University]

Prosthetics and orthotics are necessary for a variety of patients, but the current manufacturing process of these medical devices are time-consuming and costly for both patients and hospitals. Thanks to the large-format 3D printing technology enabled by 3D Platform (www.3dplatform.com), and research effort by students at Gonzaga University (www.gonzaga.edu), patients can soon expect high-quality 3D printed orthotics that are affordable and produced within an optimized timeframe.

Traditional Ankle Foot Orthosis (AFO) is Costly

An Ankle Foot Orthosis (AFO) is a brace that is designed to treat foot and ankle disorders in children. AFO provides a stable base of support for a child's lower extremities, thus allowing a child to develop the process of walking and balancing. The current process of fabricating an AFO involves several steps including scanning, molding, vacuum heat forming, and form and fitting. This process takes up to four weeks and costs around $2,000 for most patients.

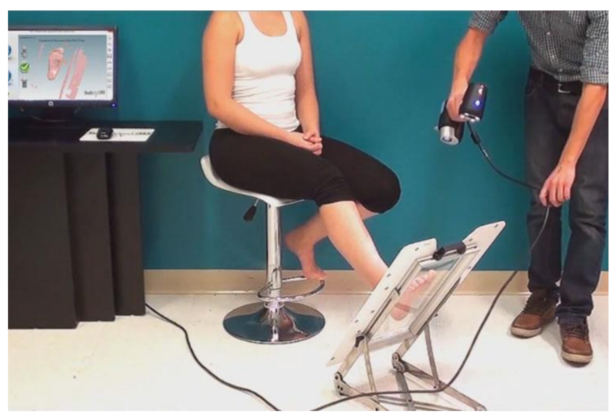
Traditional Ankle Foot Orthosis (AFO) are Costly [Image Source: Gonzaga University]

In late 2015, a group of Gonzaga University students researched and developed a 3D-printed, rapid prototyping process for fabricating AFO. The main goals were to improve the AFO design process while cutting costs and decreasing the production time. The top priority for Gonzaga University researchers was to "create a simple 3D printed AFO with the best composition and geometry to meet strength and comfort requirements for patients."

3D Printing High-quality, Affordable AFO

First, researchers used a 3D scanner to collect a patient's ankle and foot measurements, then a 3D model was designed for 3D printing the AFO. In addition to 3D printing the AFO design, researchers tested several types of 3D printing materials (including PLA, Polypropylene, Carbon Fiber PLA, PETG, and Nylon) to help determine optimal materials for 3D-printed AFOs.

"We want to 3D print large braces (up to 18 inches), and we need to print with a variety of materials as we research the best design for the braces," says McKenzie Horner, one of the researchers at Gonzaga University.



Researchers used a 3D scanner to collect a patient's ankle and foot measurements. [Image Source: Gonzaga University]

“3D Platform provided a versatile, large-format 3D printer that helped us with our materials research and AFO printing,” said McKenzie Horner. ‘We were able to immediately print a full-scale proof of concept, and the open platform software capabilities allowed us to prepare a print from a doctor’s 3D scan of a patient’s leg.”

A New Era for 3D Printed AFO

Multiple Material Choices

After extensive testing on the selected 3D printing materials’ tensile strength (Mpa), fatigue rating, printability, and repeatability, researchers identified that PLA and PETG are the most optimal choices for use of 3D printing AFO. Both materials met the strength and functionality requirements while minimizing the material cost.

4 Weeks vs 2 Days

Researchers cut down production time from up to four weeks to two days by 3D printing AFOs. The set-up of the 3D model took a matter of minutes. The actual 3D printing took up to 16 hours on a larger model, cutting production from a few weeks to a matter of hours.

Significant Lower Cost AFO

3D printing AFO also reduces the cost of materials and labor. Unlike the traditional heat molding process that has excess material wasted after trimming away from the leg hole, 3D printing only uses the required material.

Researchers at Gonzaga University will continue to explore the possibilities of 3D printing AFO with more materials, and patients can soon expect high-quality 3D printed orthosis that are affordable and produced within an optimized timeframe.

Material	Modulus (MPa)	Score	Tensile Strength (MPa)	Score	Fatigue Result	Score	Printability/Repeatability	Score	Cost (per kg)	Score	Overall Score
Solid PP	1507.72	---	20.04	---	infinite	---	N/A	---	$14.00	---	---
PLA	3930.26	4	42.66	5	13080	4	No warping, sticks to bed well, layers stick very well to each other, fast print speed, very repeatable	5 (tie)	$27.00	5	4.6
CFPLA	6501.44	5	39.52	4	2620	3	No warping, sticks to bed well, layers do not stick together well, medium print speed, difficult to load, not repeatable (inconclusive)	2	$66.00	2	3.2
3DP PP	1316.54	2	16.89	1	N/A		Lots of warping, does not stick to bed, layers stick together reasonably well, very slow print speed, not repeatable	1	$50.00	3	1.75
PETG	2269.70	3	34.14	3 (tie)	400000	5	No warping, sticks to bed well, layers stick very well to each other, fast print speed, very repeatable	5 (tie)	$48.00	4	4
PCTPE Nylon	73.04	1	34.79	3 (tie)	N/A		Requires baking before and/or after printing	3	$83.79 ($38.00 per pound)	1	2

Gonzaga University researchers identified PLA and PETG as the most optimal choices to use for 3D printing AFOs.