Interdisciplinary Team Assessment for Translational Application of Advanced 3-D Printing Technology

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DISCLOSURES

No financial disclosures

No conflicts of interest

Brand name devices and equipment will be discussed

CASE HISTORY

- Dx with Charcot-Marie-Tooth in 2012 at age 60
- 2018- using fitted carbon fiber spiral AFOs with custom foot inserts, occ use of cane
- 2022- progressive weakness and sensory loss
  - Bilat foot global weakness 1/5
  - Significant bilateral thenar atrophy, intrinsic hand muscle weakness, + Froment's sign, decreased grip strength
  - Profound sensory deficit including proprioception
  - Widened base of support during gait with poor foot placement

INTERVENTION AND OUTCOME

Converted from Carbon fiber AFOs to custom molded thermoplastic hinged AFOs

Provided increased needed ankle support

Stabilized gait

Reduced falls

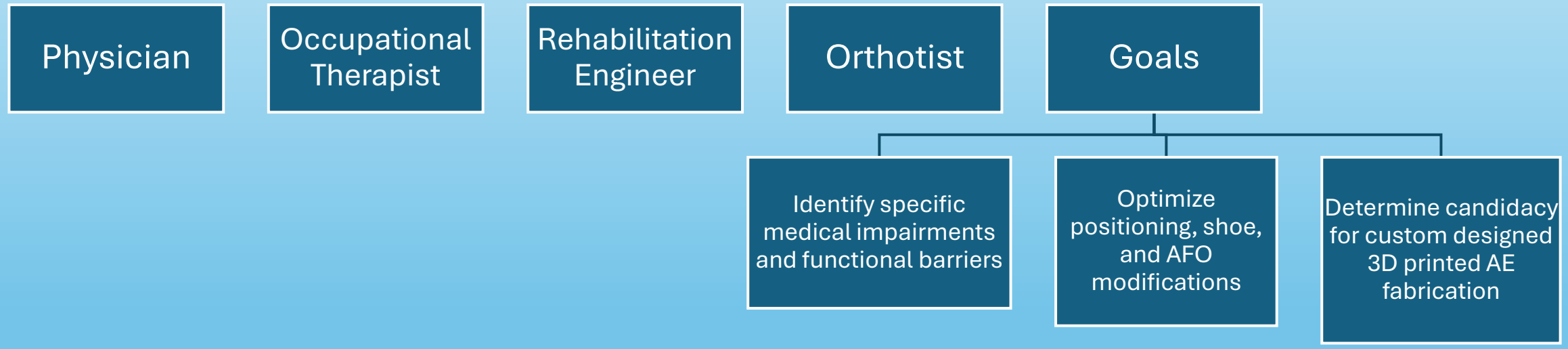
PROBLEM- unable to donn in reasonable time.

45 minutes- not practicable

Rendered him home bound

“I’d like to know if this design (DAFO) is right for me. I want to take it on/off without being discouraged and this will impact my ability to get out in the community.”

INTER-DISCIPLINARY ASSESSMENT



OT EVALUATION

Marked decreased prehension and pinch strength	Could not pull on AFO
Marked decreased grip and intrinsic strength	
Decreased functional and protective sensation in fingers to SWMF	Could not feel shoelaces- needed visual feedback
Deformity development	Trigger fingers Claw hand
Activity Analysis	

POSITIONING

- Stable sitting surface
- Optimal seat height
  - Keep knee at 90 degree during donning
- Optimal floor surface
- Solutions:
  - Bench style seat
  - Height to allow foot on floor
  - Found 6-legged stool
- DAFO kept at maximal opening (120 deg) with dressing stick

SHOE MODIFICATIONS

Needed wide toe box- New Balance

Widened shoelace holes with leather punch

Added Velcro to tongue and shoe tip to hold in place

Did not need different lace style

ORTHOSIS MODIFICATIONS

- Calf strap moved medially to reduce shoulder strain
- Added thermoplastic piece to calf strap to improve grasp
- Replaced D-ring with Velcro closure
- Removed dorsal strap- too restrictive

DEVICE FABRICATION CRITERIA

- No commercially available option
- Patient willing to participate in fabrication process
- Patient motivated to use the device
- Patient with sufficient cognition to learn to use it
- **CURRENTLY DEVICES ARE PROVIDED FREE OF CHARGE**

DEVICE FABRICATION PROCESS

Determine barriers that remain after positioning, shoe, and orthosis modifications have been optimized

Inter-D team discuss with patient barriers a separate AE could solve

Trial and error: Angle of donning surface, Prevent toe curling, Prevent shoe counter collapse, Stabilize shoe

Mock-ups created

Donning Process

Concerns

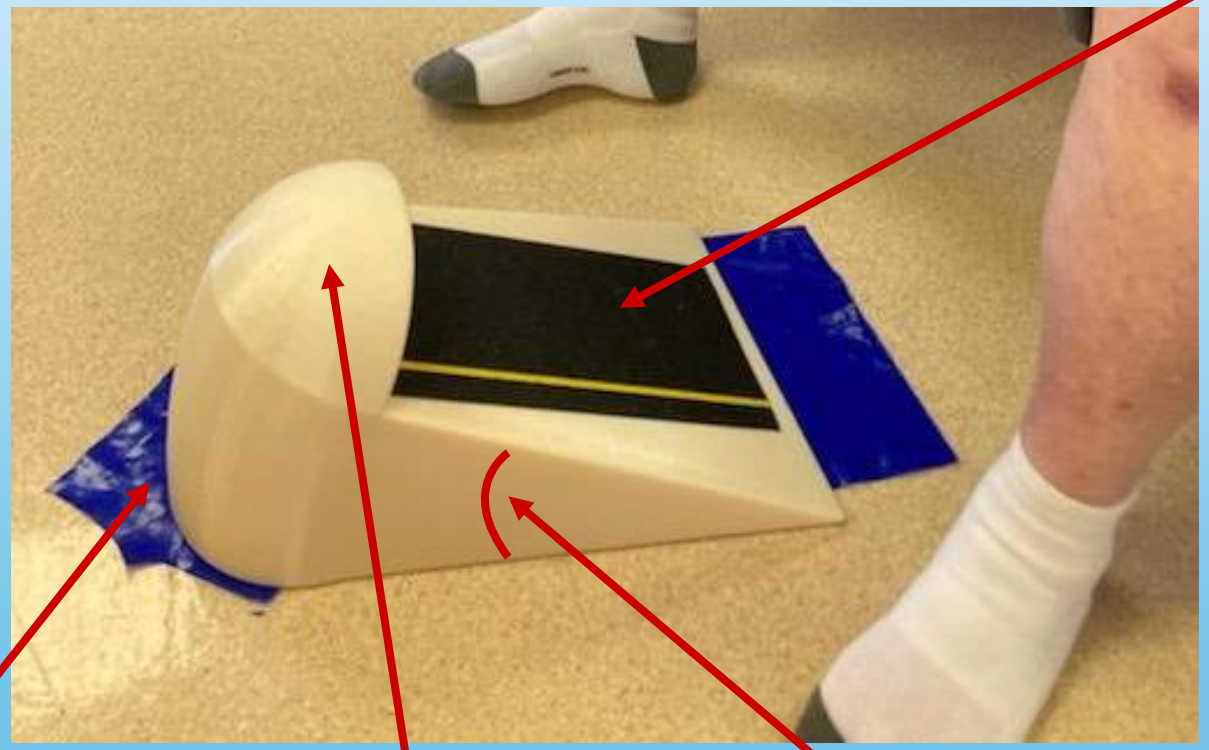
Lever Arm

Skidding

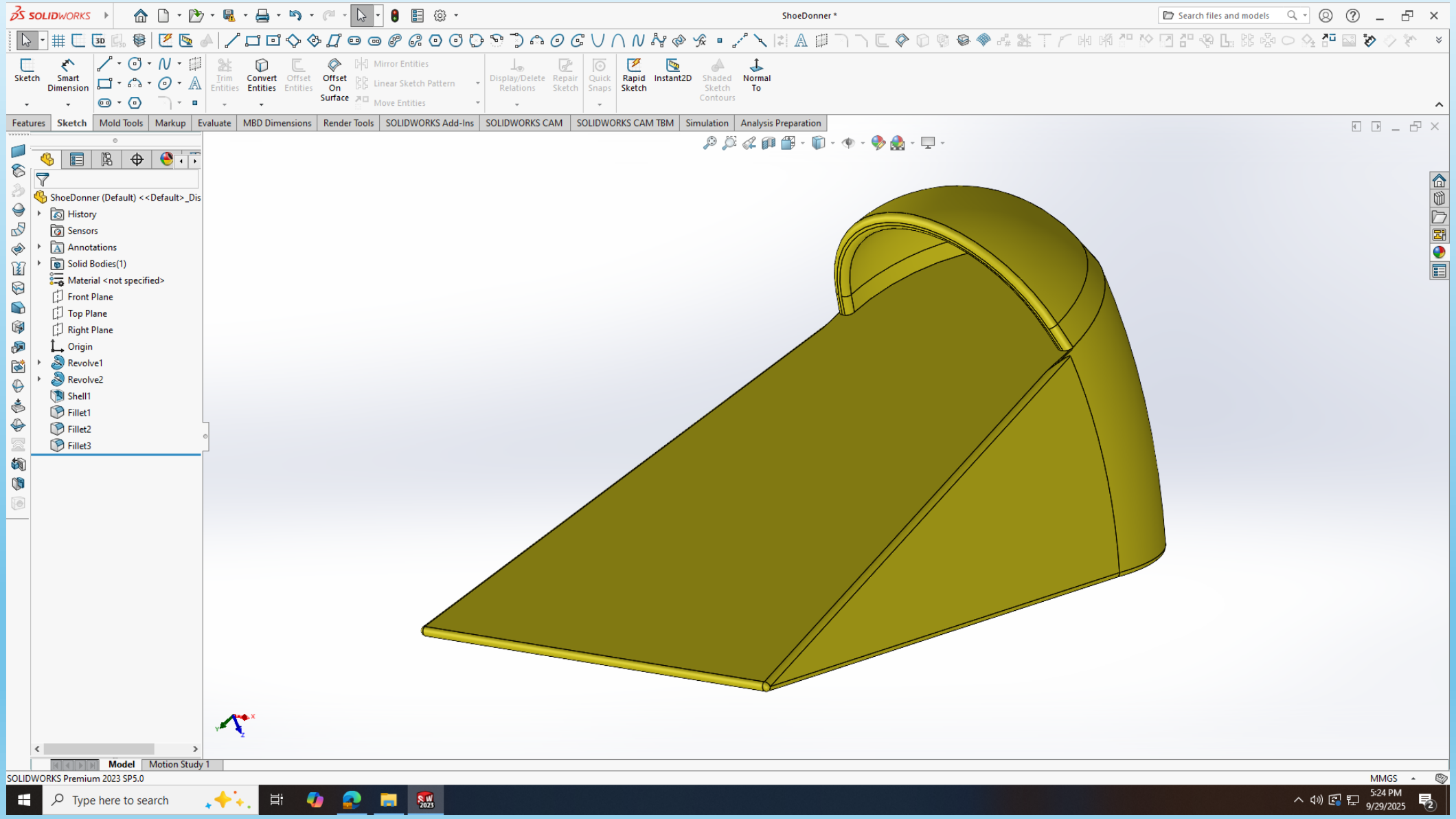
Shoe Movement / Rocking

Accessible Position / Orientation

Design Considerations



Solidworks 2023



3D Printing

Stratasys FORTUS 450mc

FDM

Filament Canisters
- Engineering Materials
  - Model / Support

Large Build Volume

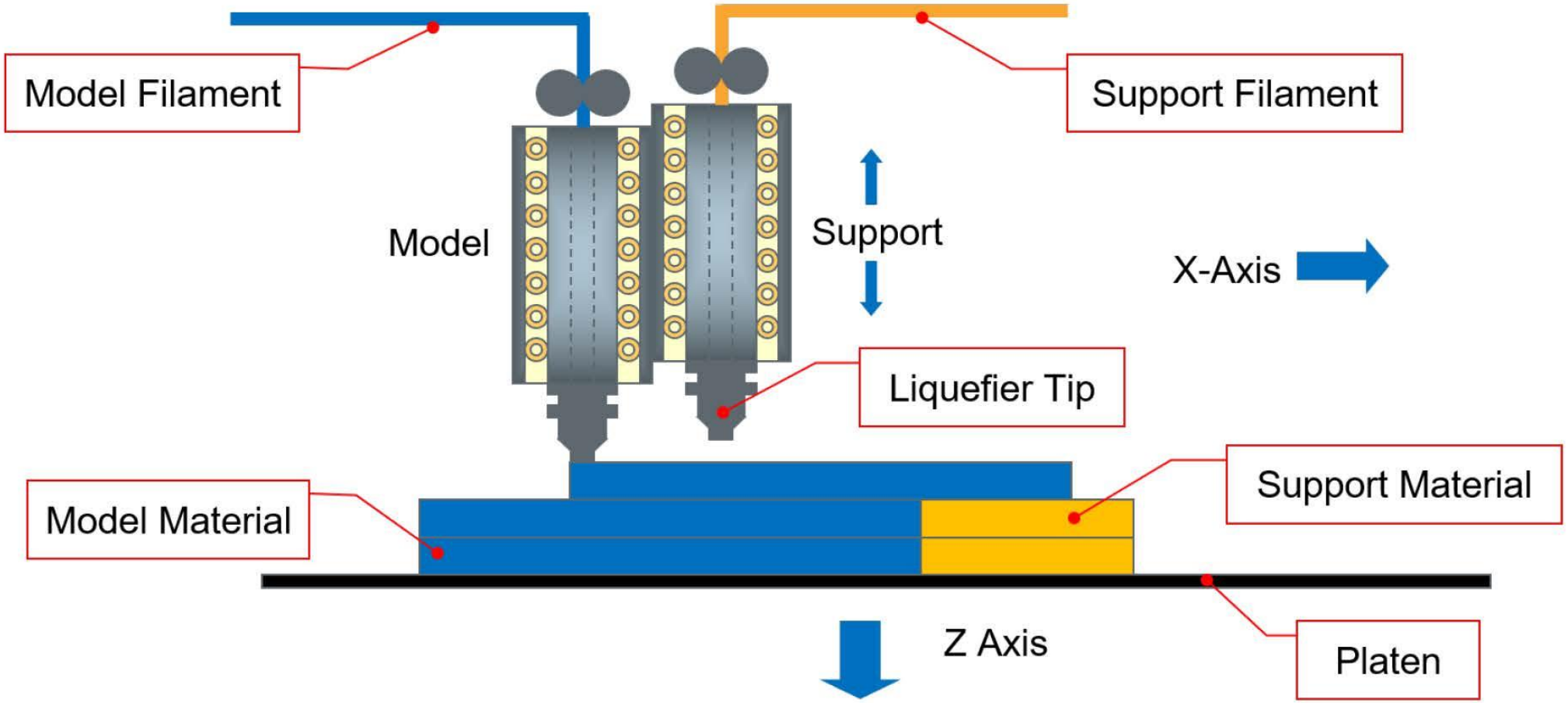
Heated Build Volume

Accurate +- 0.005 inch

Insight Software

FDM Technology

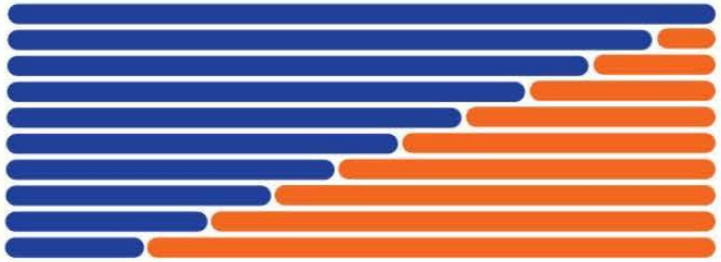
How it works



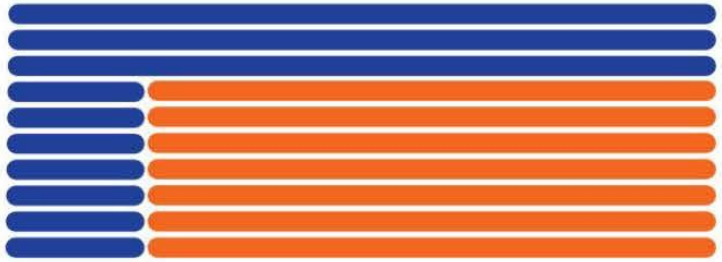
FDM Technology

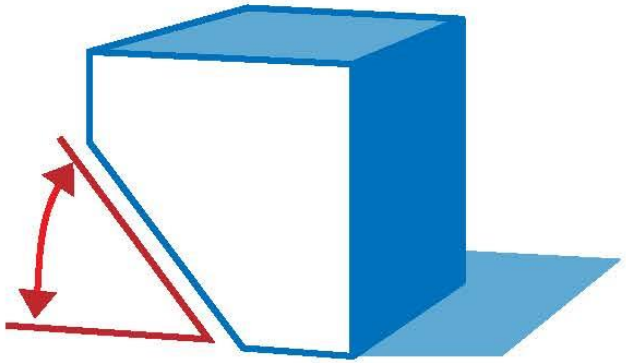
Support Material

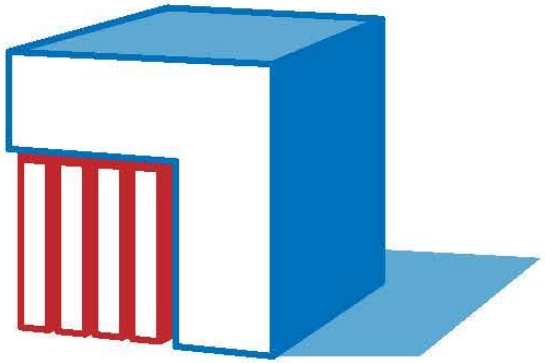
<45° needs support



Overhangs need support







Model Material

Support Material

Donning Videos

OUTCOMES

- Donning time reduced from 45 minutes per foot to less than 60 seconds
- Now accesses community at will
- No loss of needed stability provided by orthosis with modifications
- Adaptive equipment device is durable

“I can’t believe how easily my foot slides into the shoe compared to how much struggle I had before. I was struggling for 45 minutes and still didn’t get my foot in the shoe. I’m starting not to hate these as much.”

Thank You!

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