3D Printing Shoes for Production Manufacturing

D. Casey Kerrigan, M.D.

Chairman, OESH Shoes

www.OESHshoes.com

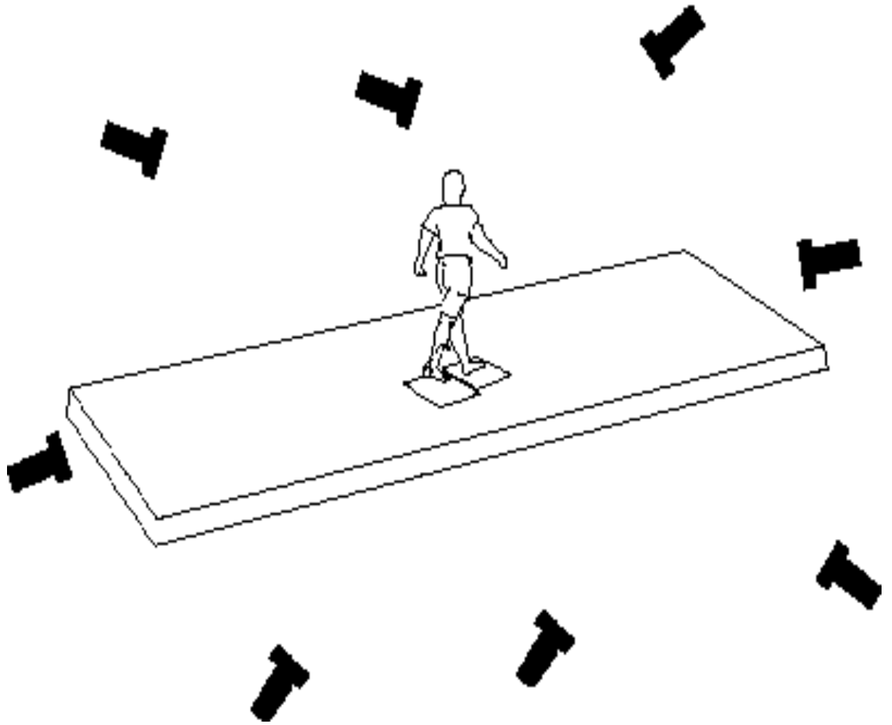
Class summary

I'll describe the advantages and challenges of using 3D printing for shoe manufacturing. I'll include how **OESH Shoes** is using a pellet-based extruding 3D print process not just for making prototypes, but for production manufacturing of shoe soles as well

Key learning objectives

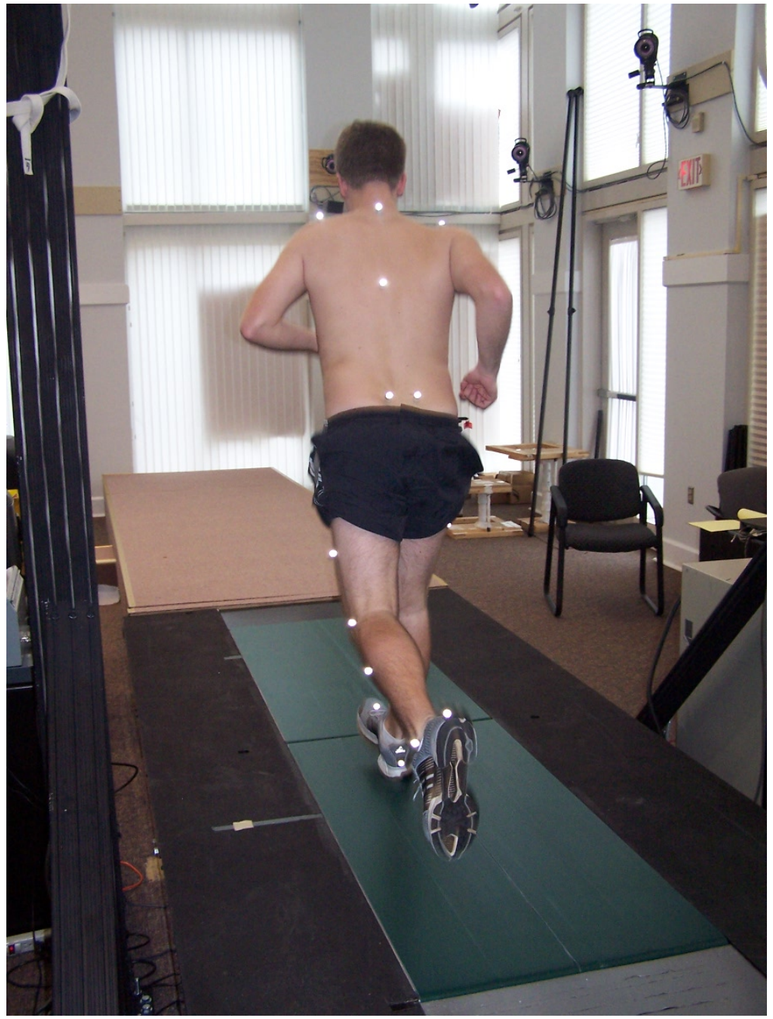
- Discover advantages of 3D printing for shoe manufacturing
- Understand challenges of 3D printing for shoe manufacturing
- Identify a means to overcome the challenges of 3D printing for shoe manufacturing
- Envision a future of 3D printing for shoe manufacturing

For 20 + years, I was funded by the U.S. National Institutes of Health to Study Gait (Walking and Running)…

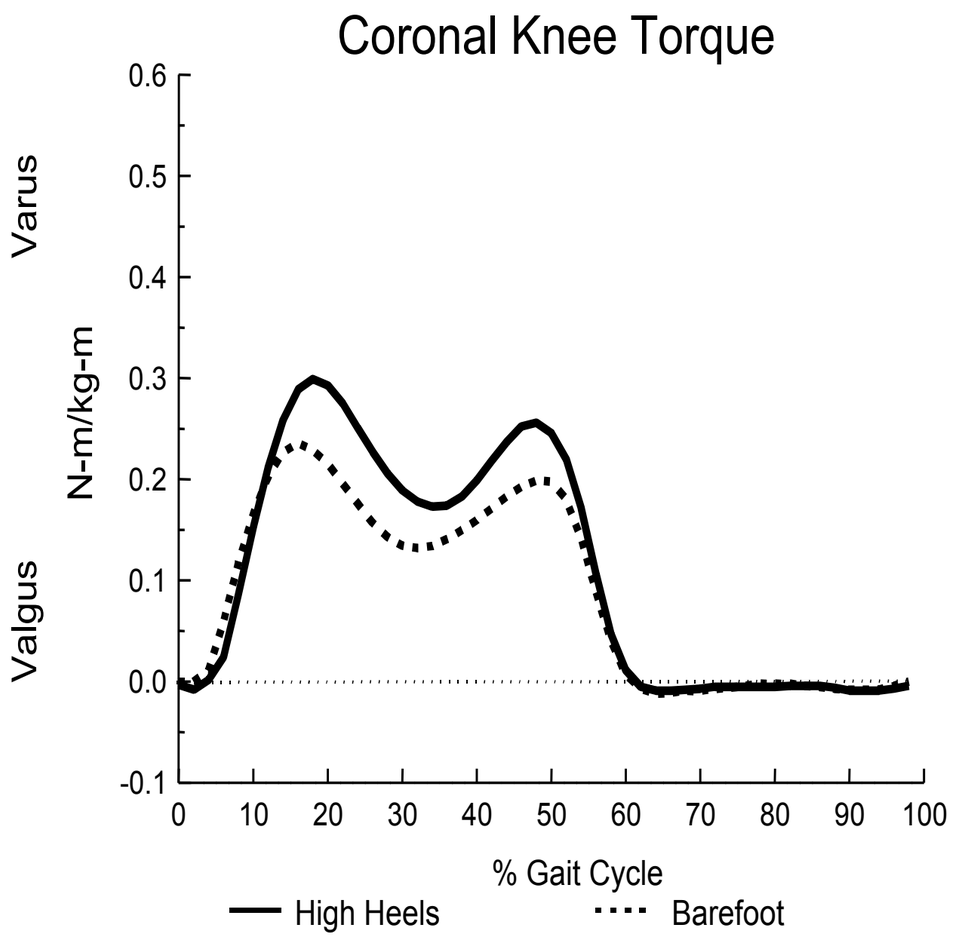


Including the effects of shoes on forces and loads not just in the foot but on the rest of the body

Walking, Running, Standing



My research team
and I studied
subjects of all ages



THE LANCET

Knee osteoarthritis and high-heeled shoes

D Casey Kerrigan, Mary K Todd, Patrick O Riley

Reprinted from THE LANCET Saturday 9 May 1998
Vol. 351 No. 9113 Pages 1399-1402

THE LANCET 42 BEDFORD SQUARE LONDON WC1B 3SL UK
655 AVENUE OF THE AMERICAS, NEW YORK, NY 10010 USA

THE NEW YORK TIMES
June 2, 1998

Study Links High Heels to Arthritis

By JANE BRODY

CLOTHES may or may not make the man, but high-heeled shoes almost certainly make a woman's knees susceptible to arthritis, a study in Boston has shown.

The findings suggest that the current trend of switching from dress shoes to sneakers to walk any distance may provide women with far more than temporary comfort.

It may help to save their knees from the crippling pain that accompanies osteoarthritis.

Women are twice as likely as men to develop osteoarthritis — the wear-and-tear type — in their knees, and three specialists in physical medicine at Harvard Medical School and Spaulding Rehabilitation Hospital suspected that walking about in high heels had something to do with this increased risk.

They knew beforehand that walking in high heels shifted the weight of the body toward the inner side of the knee joint, which is the area most susceptible to arthritic degeneration.

So the researchers, headed by Dr. D. Casey Kerrigan, put 20 healthy women who were used to wearing narrow high heels to a test.

They asked the women to walk at a comfortable speed both barefoot and in their own high heels and measured various anatomical changes, including the torque on their ankle and knee joints.

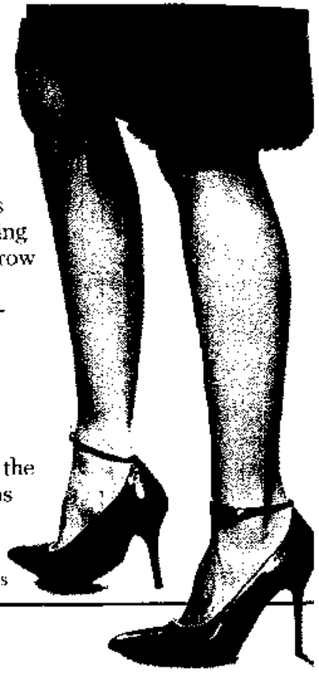
Just as the researchers thought, the knee took on a disproportionate amount of stress when the women walked in heels. This occurred largely because walking in heels resulted in less torque on the ankle, forcing the knees and, to a lesser extent, the hips to assume more of the stress of keeping the women stable and moving forward as they walked.

Their findings appeared last month in The Lancet.

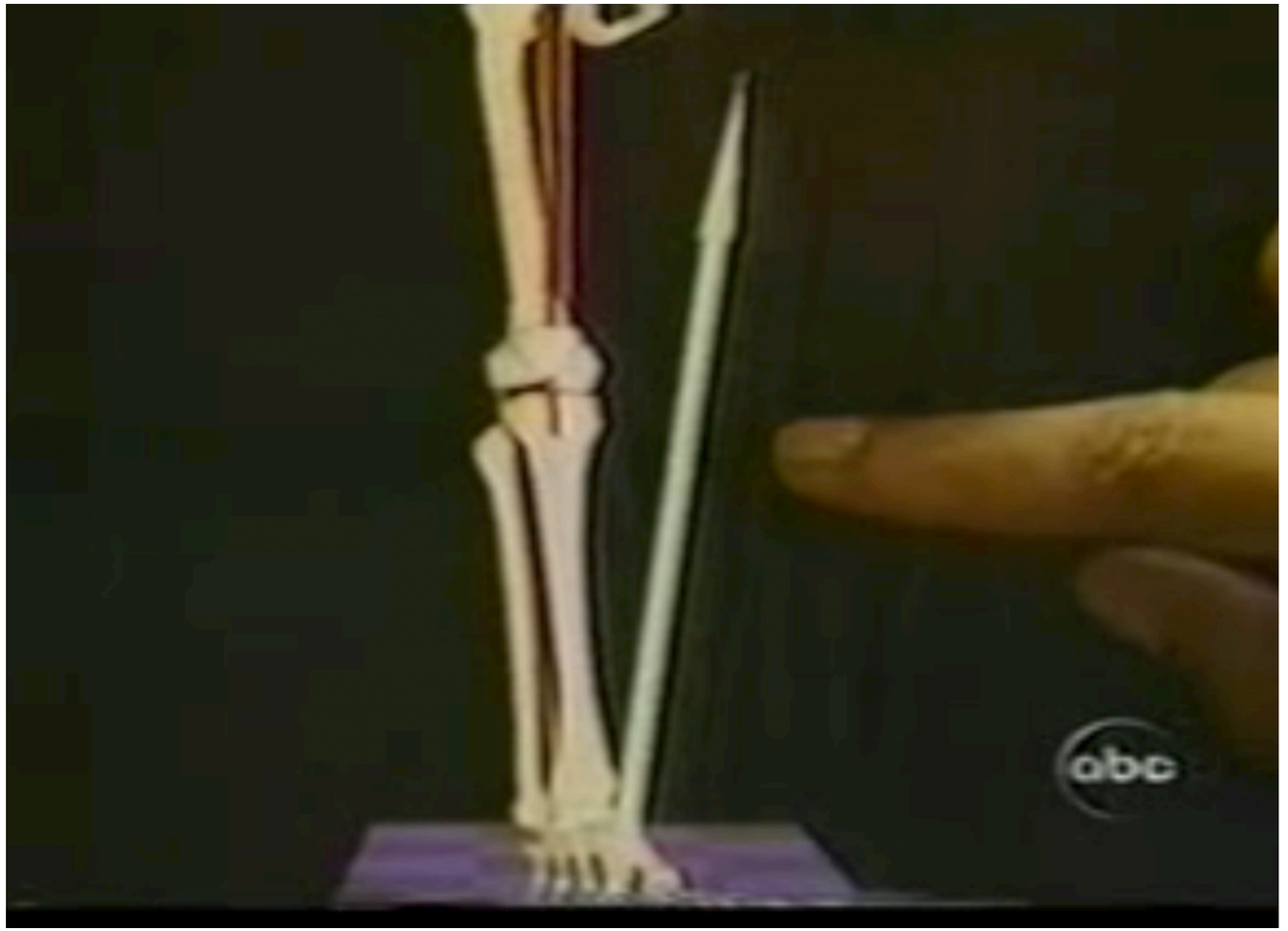
Heels Sock Knees

ARTHRITIC KNEES ARE TWICE AS COMMON IN women as in men, and a new study suggests that glamorous shoes are at least partly to blame. Harvard researchers attached markers to various parts of women's legs and videotaped them walking on a laboratory runway, both barefoot and in narrow two-and-a-half-inch heels. Then they compared the movements of the joints. When we walk barefoot, our body weight is shared by the inner and outer parts of the knee. But high heels shift the weight forward. The result, physiatrist D. Casey Kerrigan and her colleagues report in the May 9 Lancet, is an increase of at least 23 percent in the pressure on the center of the knee. Kerrigan says the resulting strain on the joints, muscles and tendons may lead to degenerative arthritis. Talk about well-heeled fashion victims.

STEPHEN WILLIAMS



ABC 20/20 Feature Presentation



…we published a bunch more studies on all different types of shoes and shoe modifications

Women's shoes and knee osteoarthritis

D Casey Kerrigan, Jennifer L Lelas, Mark E Karvosky

We assessed whether wearing wide-heeled shoes has a similar effect on knee torque to narrow-heeled shoes by measuring the joint torques of 20 healthy women during walking. Wearing wide-heeled shoes had a 30% greater effect on peak external knee flexor torque than walking barefoot. Walking with wide-heeled and narrow-heeled shoes increased peak knee varus torque by 26% and 22%, respectively. Our findings imply that wide-heeled shoes cause abnormal forces across the patellofemoral and medial compartments of the knee, which are the typical anatomical sites for degenerative joint changes.

Lancet 2001;357:1097-1098

Men's Shoes and Knee Joint Torques Relevant to the Development and Progression of Knee Osteoarthritis

D. CASEY KERRIGAN, MARK E. KARVOSKY, JENNIFER L. LELAS, and PATRICK O. RILEY

ABSTRACT. *Objective.* To determine if men's dress shoes and sneakers increase knee joint torques and play the same role in the development and/or progression of knee osteoarthritis (OA) as women's high-heeled dress shoes.

Methods. Three-dimensional data regarding lower extremity torques and motion were collected during walking in 22 healthy men while (1) wearing dress shoes, (2) wearing sneakers, and (3) barefoot. Data were plotted and qualitatively compared; major peak values were statistically compared between conditions.

Results. The external knee varus torque in early stance was slightly greater with the dress shoes and sneakers, but this slight increase can be explained by the faster walking speed with shoes. No significant increases were found in any other of the sagittal, coronal, or transverse knee torques when walking with dress shoes and sneakers compared to barefoot.

Conclusion. Men's dress shoes and sneakers do not significantly affect knee joint torques that may have relevance to the development and/or progression of knee OA. (J Rheumatol 2003;30:529–33)

The Influence of Arch Supports on Knee Torques Relevant to Knee Osteoarthritis

JASON R. FRANZ, JAY DICHARRY, PATRICK O. RILEY, KEITH JACKSON, ROBERT P. WILDER, and D. CASEY KERRIGAN

University of Virginia, Department of Physical Medicine and Rehabilitation, Charlottesville, VA

Original Research

The Effect of Running Shoes on Lower Extremity Joint Torques

D. Casey Kerrigan, MD, Jason R. Franz, MS, Geoffrey S. Keenan, MD, Jay Dicharry, MPT, Ugo Della Croce, PhD, Robert P. Wilder, MD

Objective: To determine the effect of modern-day running shoes on lower extremity joint torques during running.
Design: Two-condition experimental comparison.
Setting: A 3-dimensional motion analysis laboratory.
Participants: A total of 68 healthy young adult runners (37 women) who typically run in running shoes.
Methods: All subjects ran barefoot and in the same type of stability running footwear at a controlled running speed. Three-dimensional motion capture data were collected in synchrony with ground reaction force data from an instrumented treadmill for each of the 2 conditions.
Main Outcome Measurements: Peak 3-dimensional external joint torques at the hip, knee, and ankle as calculated through a full inverse dynamic model.
Results: Increased joint torques at the hip, knee, and ankle were observed with running shoes compared with running barefoot. Disproportionately large increases were observed in the hip internal rotation torque and in the knee flexion and knee varus torques. An average 54% increase in the hip internal rotation torque, a 36% increase in knee flexion torque, and a 38% increase in knee varus torque were measured when running in running shoes compared with barefoot.

Fitness on NBC NEWS.com

Running Shoes: Hazardous to Your Joints?

Study Shows Running Shoes Exert More Stress on Knees and Hips Than Running Barefoot

Font size: A A A

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By Kathleen Doheny
WebMD Health News

Reviewed by Louise Chang, MD

Jan. 7, 2010 -- Compared to running barefoot, running in conventional running shoes increases stress on the knee joints up to 38%, according to a new study.

"There is an increase in joint torque that may be detrimental," says D. Casey Kerrigan, MD, the lead author of the study, published in *PM&R: The Journal of Injury, Function and Rehabilitation.*

Joint torque is a measure of how much a force causes the joint to rotate.

But Kerrigan is not advocating that runners take up barefoot running -- just that her findings may be a reason to redesign running shoes. Kerrigan, formerly chairwoman and professor of physical medicine and rehabilitation at the University of Virginia, Charlottesville, now heads JKM Technologies and is designing a running shoe.

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- Running Shoes Hazardous To Your Joints

I published a lot more papers and presented around the world

Planted

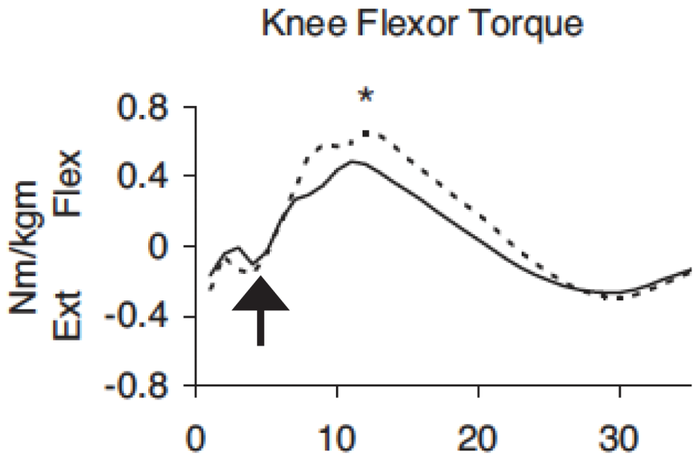
Impact

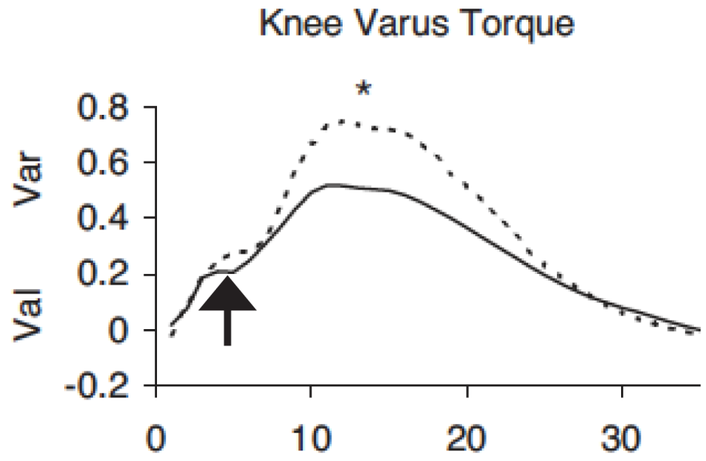
Impact

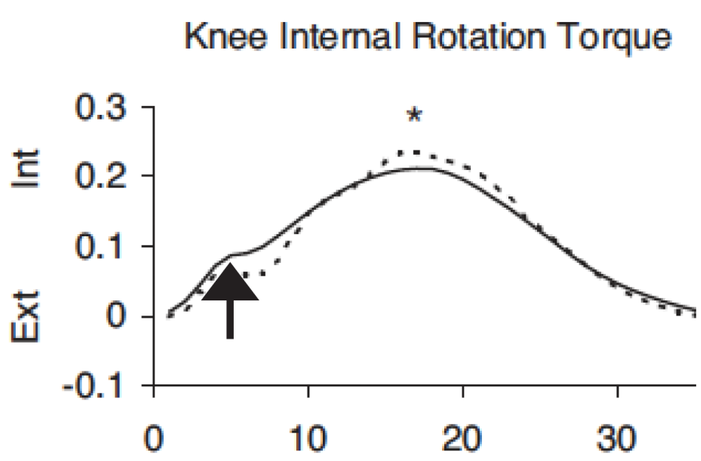
Planted

Shoe features that abnormally increase loads on joints

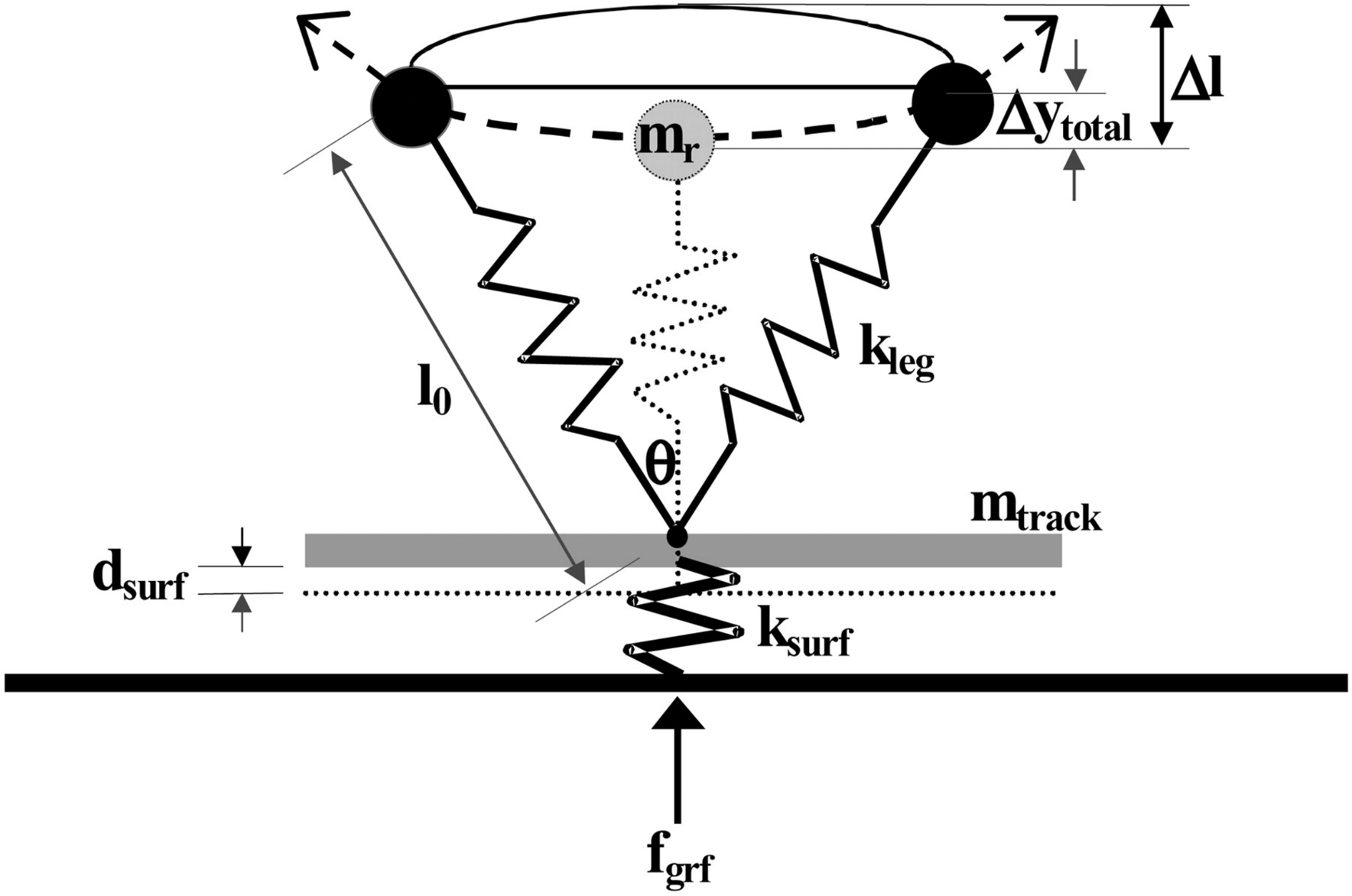
- Any elevation in the heel
- Any arch support
- Any side to side contouring (the typical shoe has a cradle running side to side







Loads on joints during running
Arrows point to “impact”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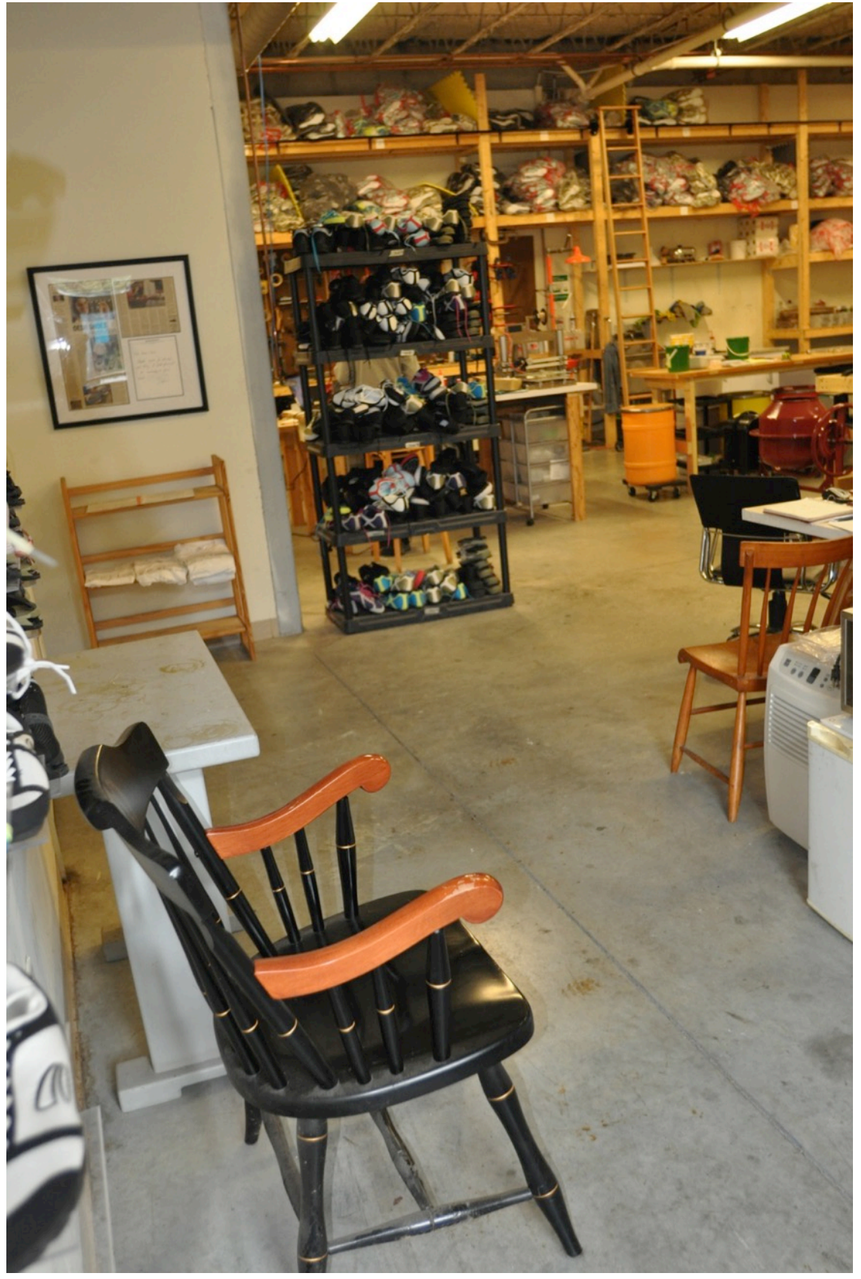

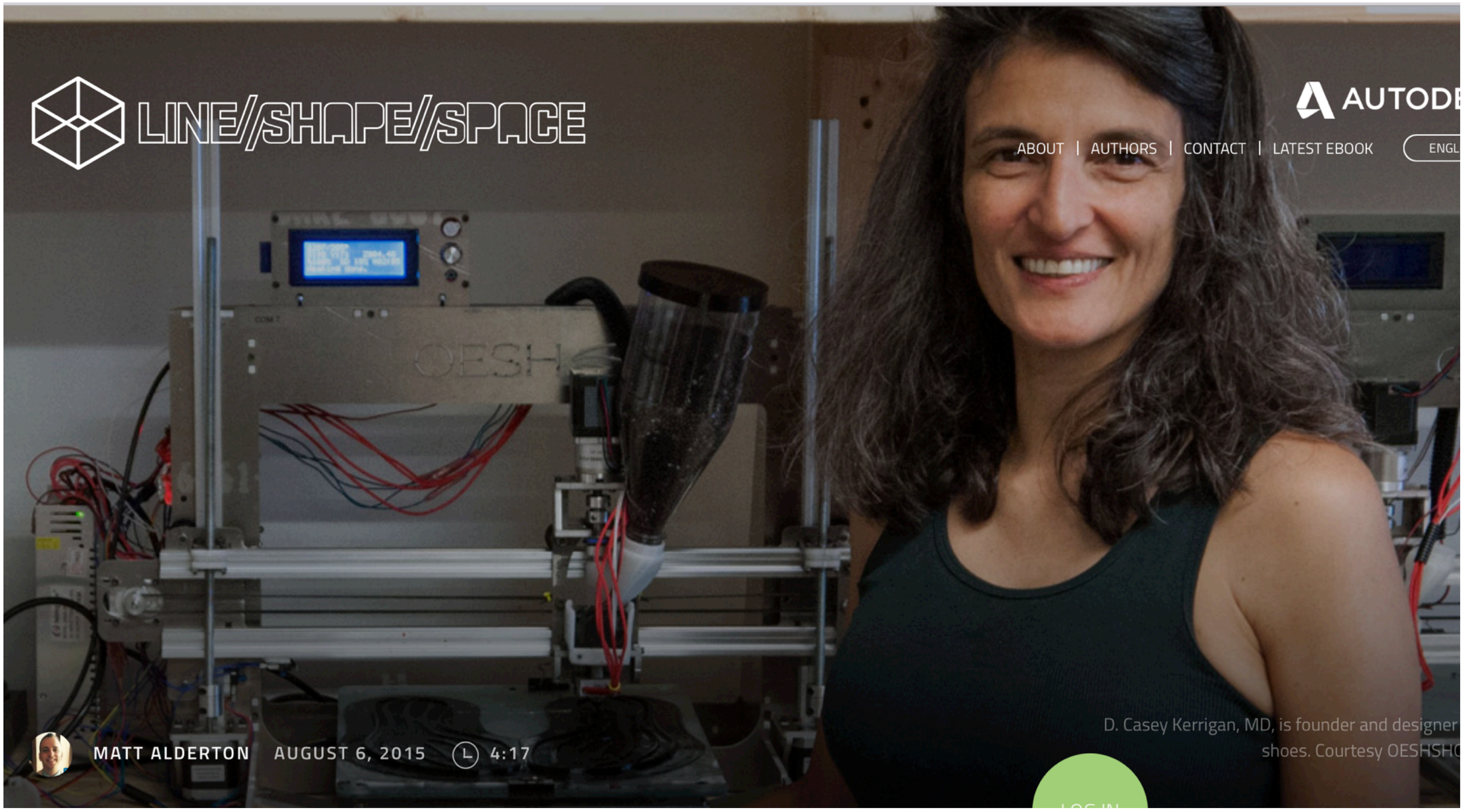
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MATT ALDERTON
AUGUST 6, 2015
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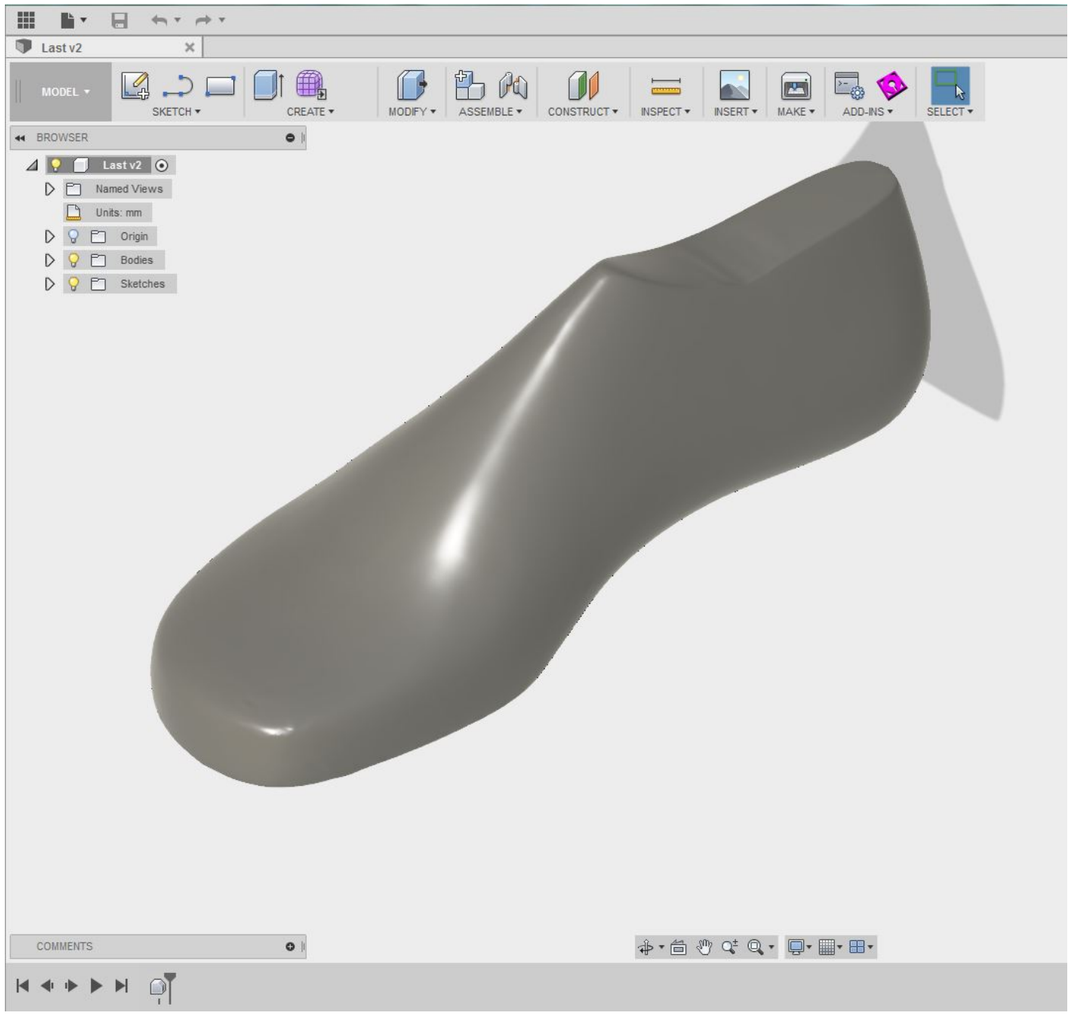
D. Casey Kerrigan, MD, is founder and designer
shoes. Courtesy OESHSHO

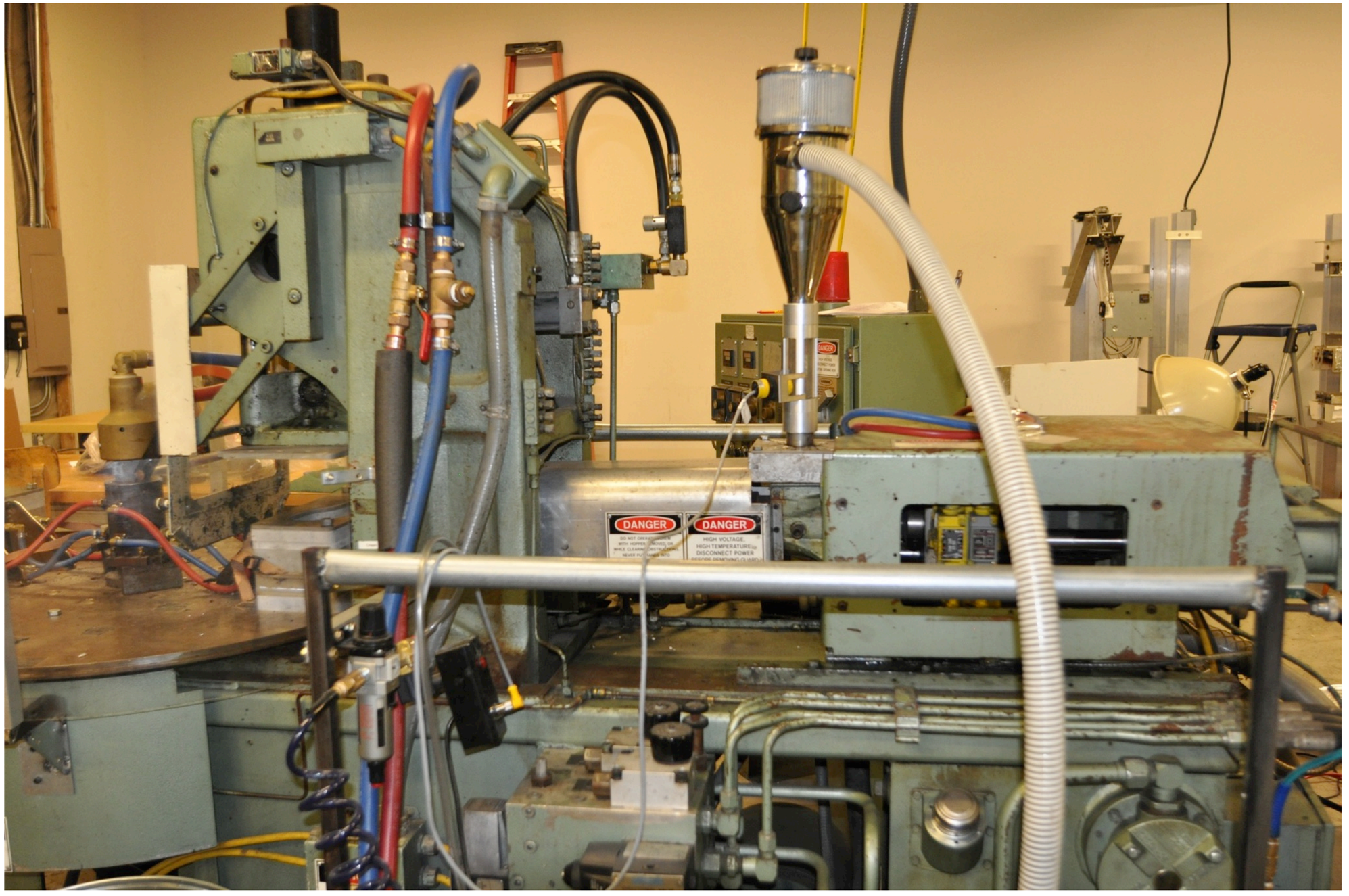
Last Design
and designing with the last



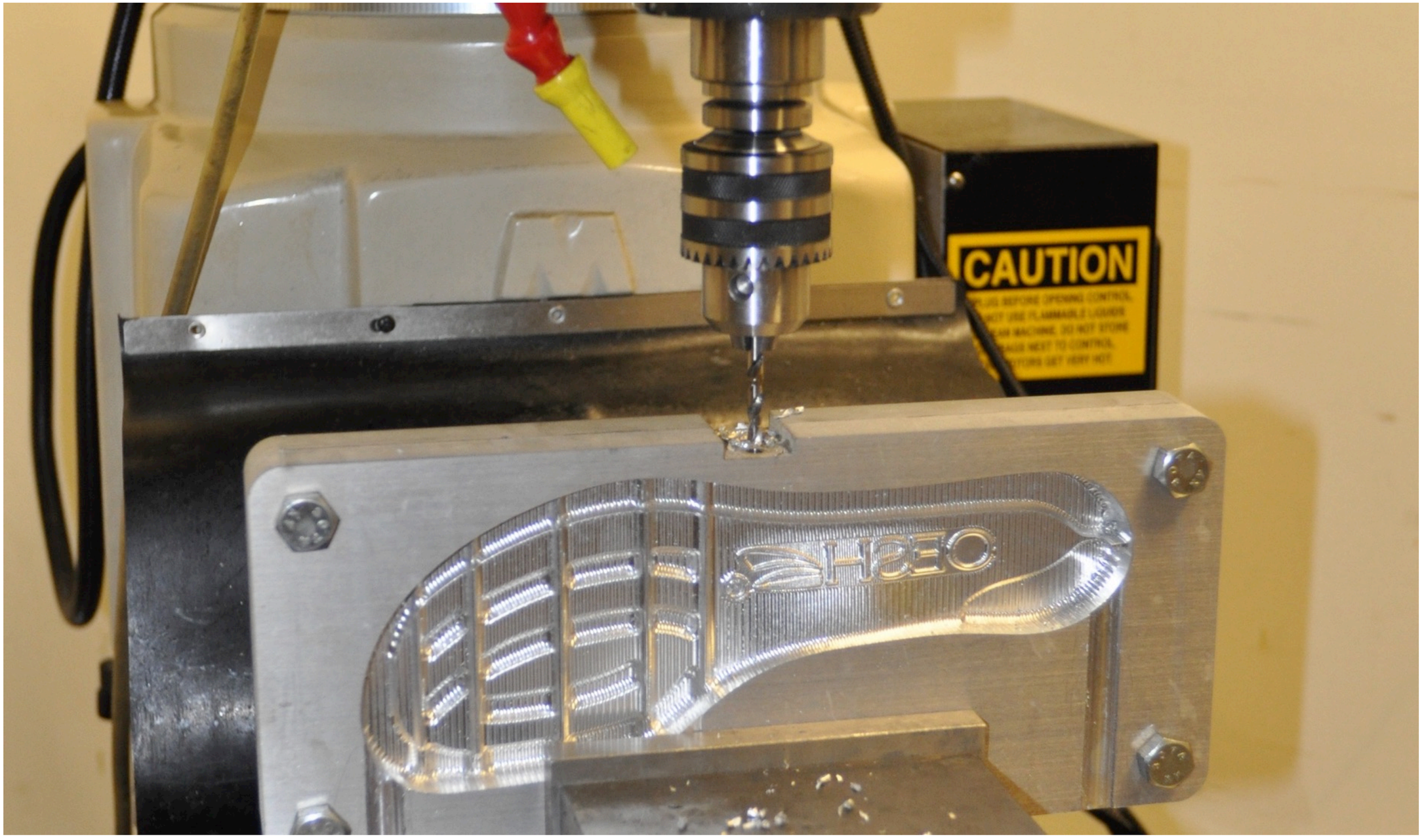
Traditional Footwear vs OESH Shoes


OESH

Thermoplastic elastomers are replacing conventional rubbers and steel in high performance springs used in railway rolling-stock buffers, draw gears and draft gears. German company DUREL is in the vanguard of this trend, manufacturing spring pads from rods and tubes supplied by Quadrant Engineering Plastic Products (Quadrant EPP) in Arnitel® thermoplastic polyether elastomer (TPEE) from DSM Engineering Plastics.


DANGER
DANGER
HIGH VOLTAGE.
HIGH TEMPERATURE.
DISCONNECT POWER


CNC SUPRA
CAUTION


CAUTION

IEEE PULSE
A MAGAZINE OF THE IEEE ENGINEERING IN MEDICINE AND BIOLOGY SOCIETY

March/April 2014

FEATURED

The Race to Build a Better Shoe

BIOMECHANISTS NOW KNOW HOW TO BUILD A HEALTHIER SHOE. SO WHY AREN'T SHOE COMPANIES MAKING THEM?

D. Casey Kerrigan | March 13, 2014 | 3 Comments

OESH

SHOP SHOE WELLNESS OESHERS SAY BLOG 0

PRODUCT CATEGORIES

- Sandal
  - Artemis
  - Athena
- Shoe
  - Elite
  - La Vida

La Vida v2.0 | Charcoal

$120.00

La Vida v2.0 | Deep Wisteria

$120.00

La Vida v2.0 | Fiji

$120.00

La Vida v2.0 | Oxford

$120.00

La Vida v2.0 | Rococco

$120.00

La Vida v2.0 | Saguaro

$120.00

La Vida v2.0 | White Sand

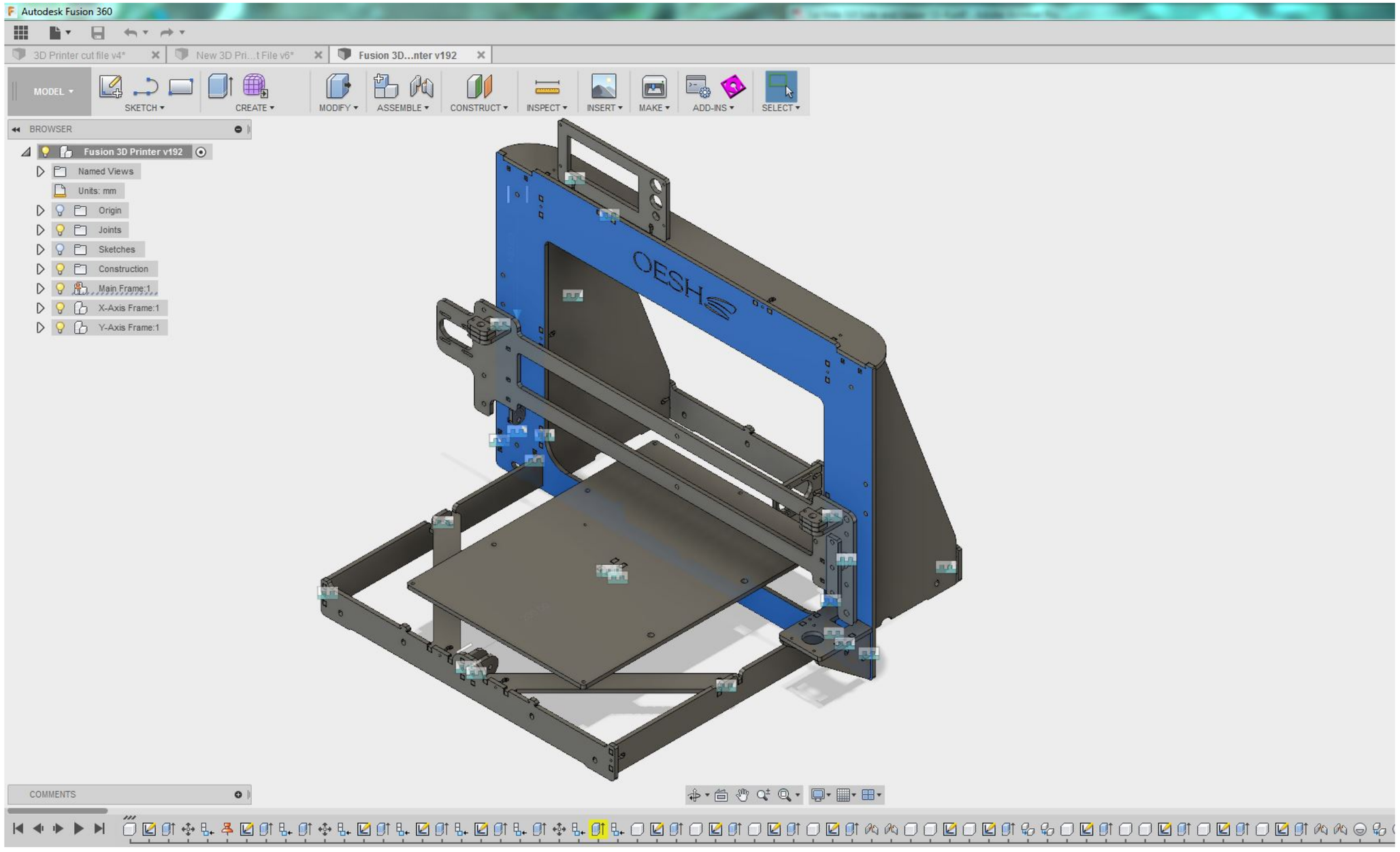
$120.00

Elite | Jet Black

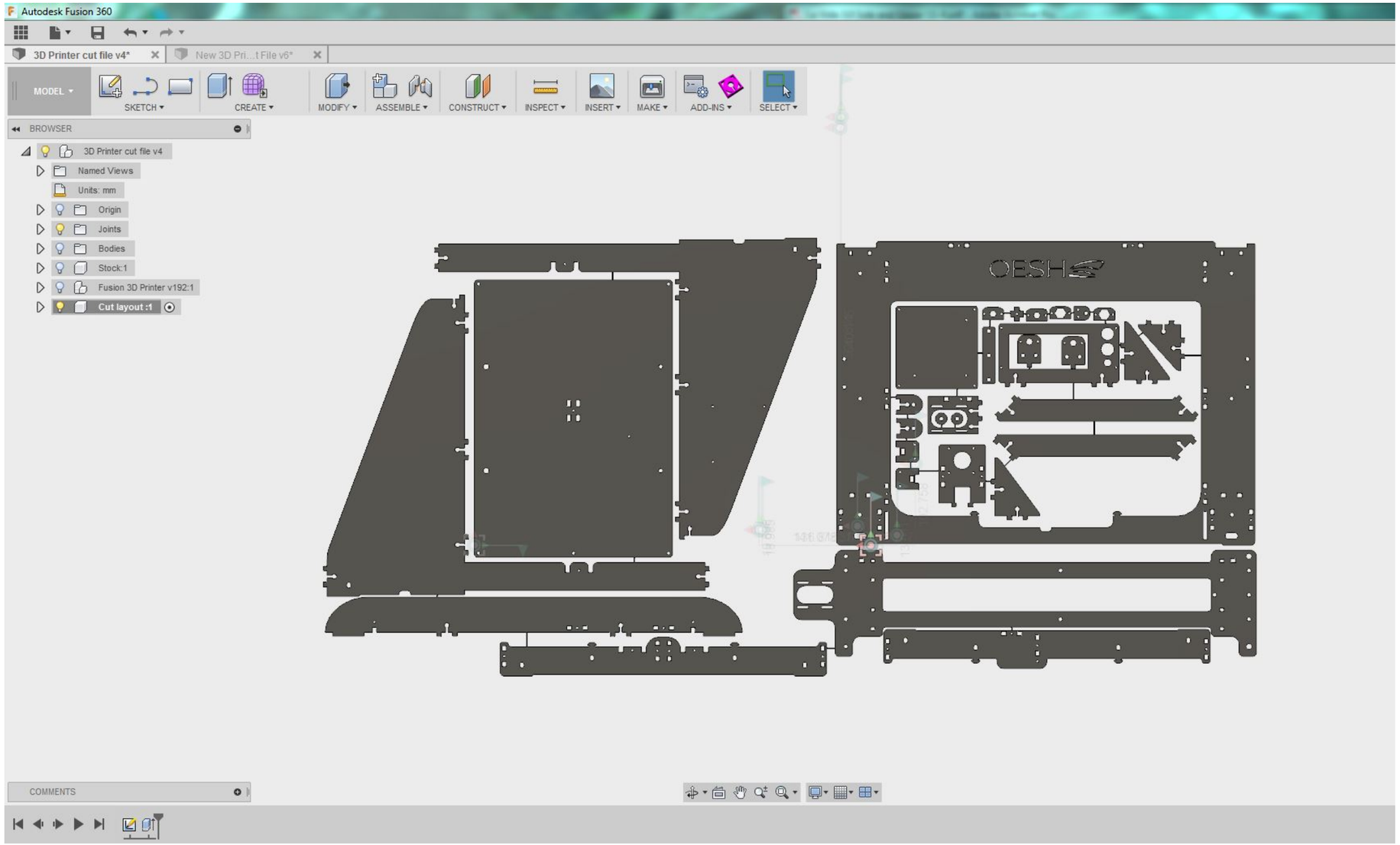
$160.00

OMAX Waterjet Technology Is Key to Healthier Soles

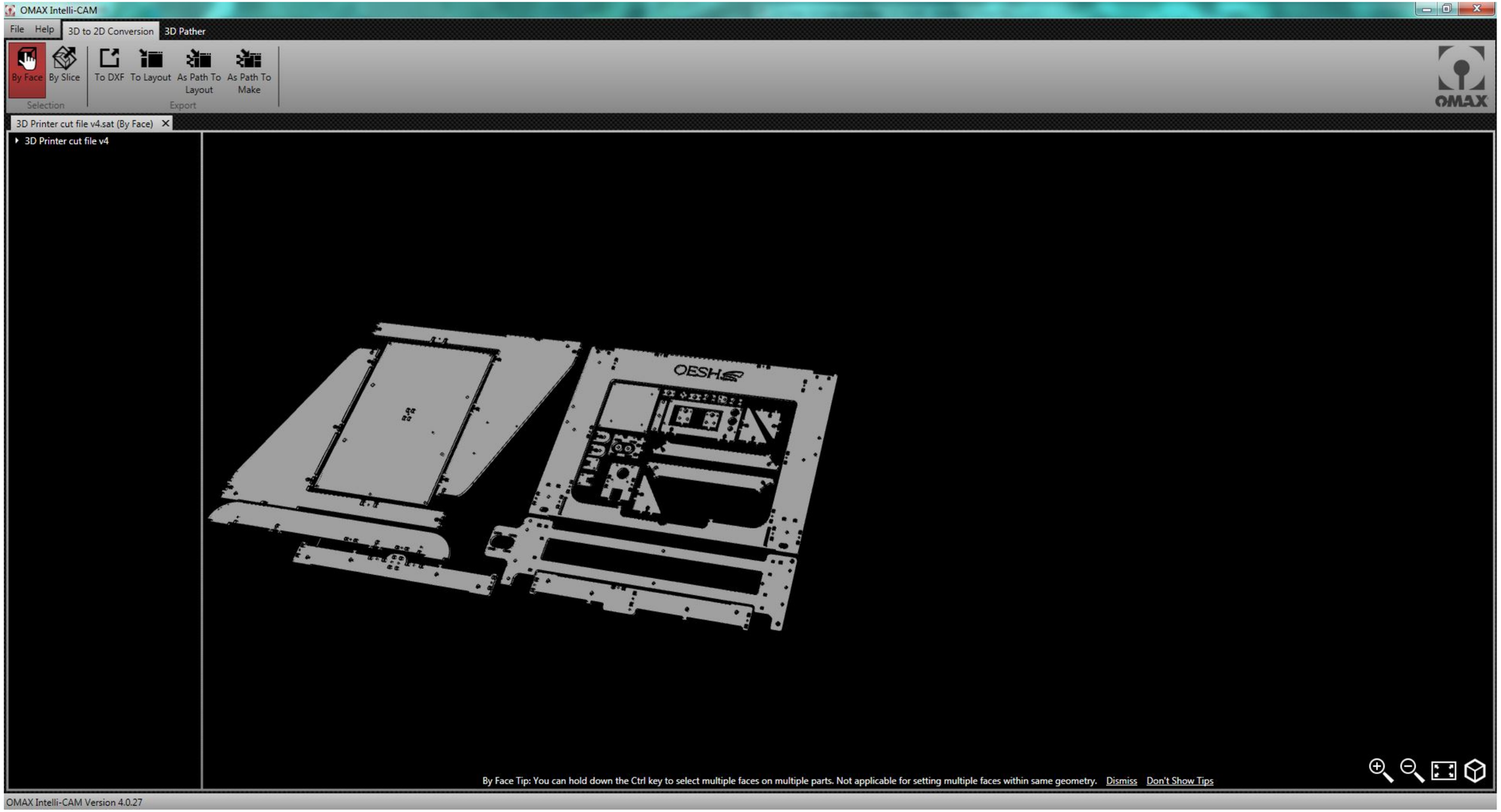
Customer Successes


Autodesk Fusion 360
3D Printer cut file v4*
New 3D Pri...t File v6*
Fusion 3D...nter v192
MODEL
SKETCH
CREATE
MODIFY
ASSEMBLE
CONSTRUCT
INSPECT
INSERT
MAKE
ADD-INS
SELECT
BROWSER
Fusion 3D Printer v192
Named Views
Units: mm
Origin
Joints
Sketches
Construction
Main Frame:1
X-Axis Frame:1
Y-Axis Frame:1
COMMENTS

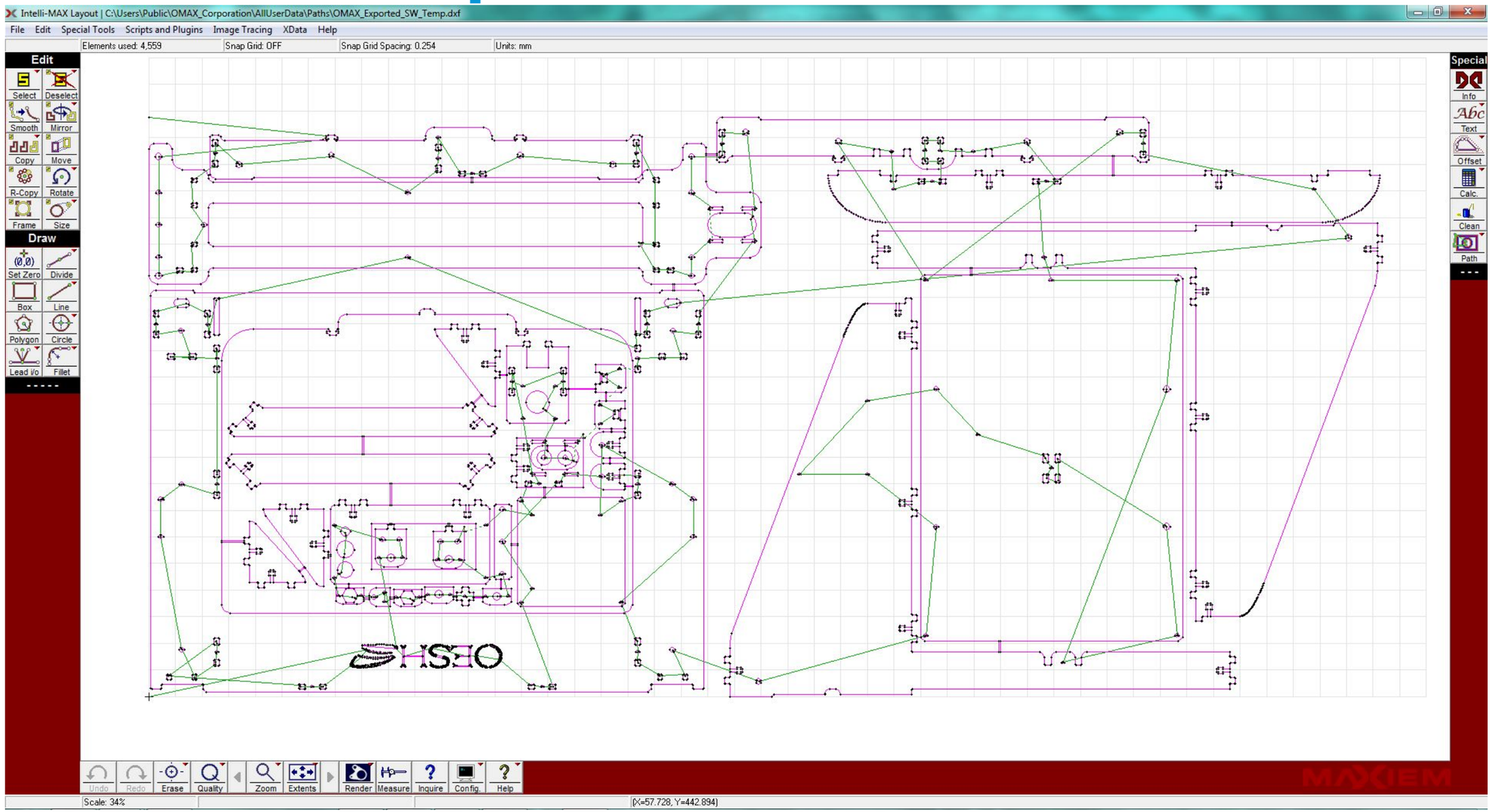
Laying out 3D Printer to cut



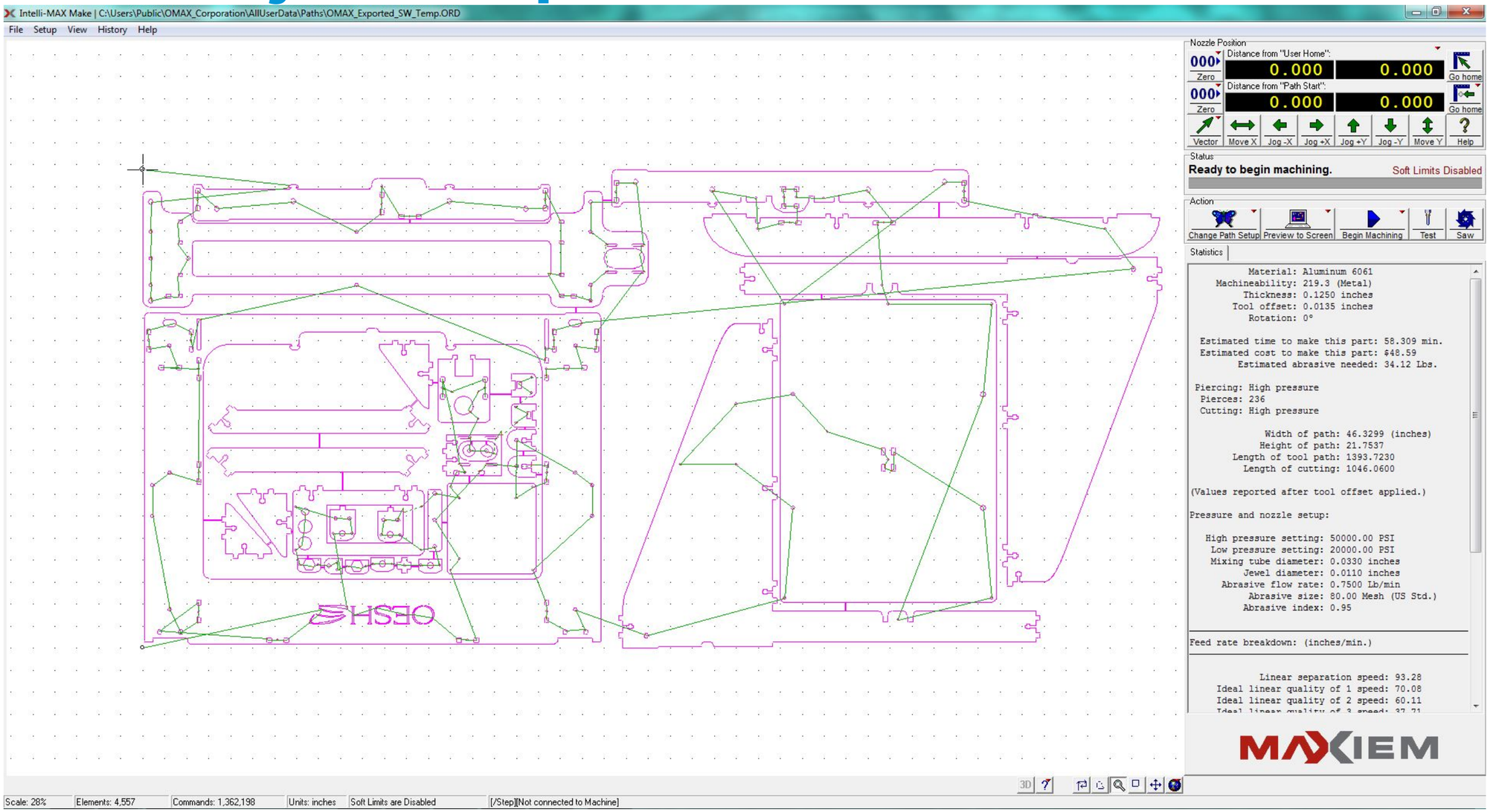
OMAX Intelli-CAM
Add-in for Fusion 360

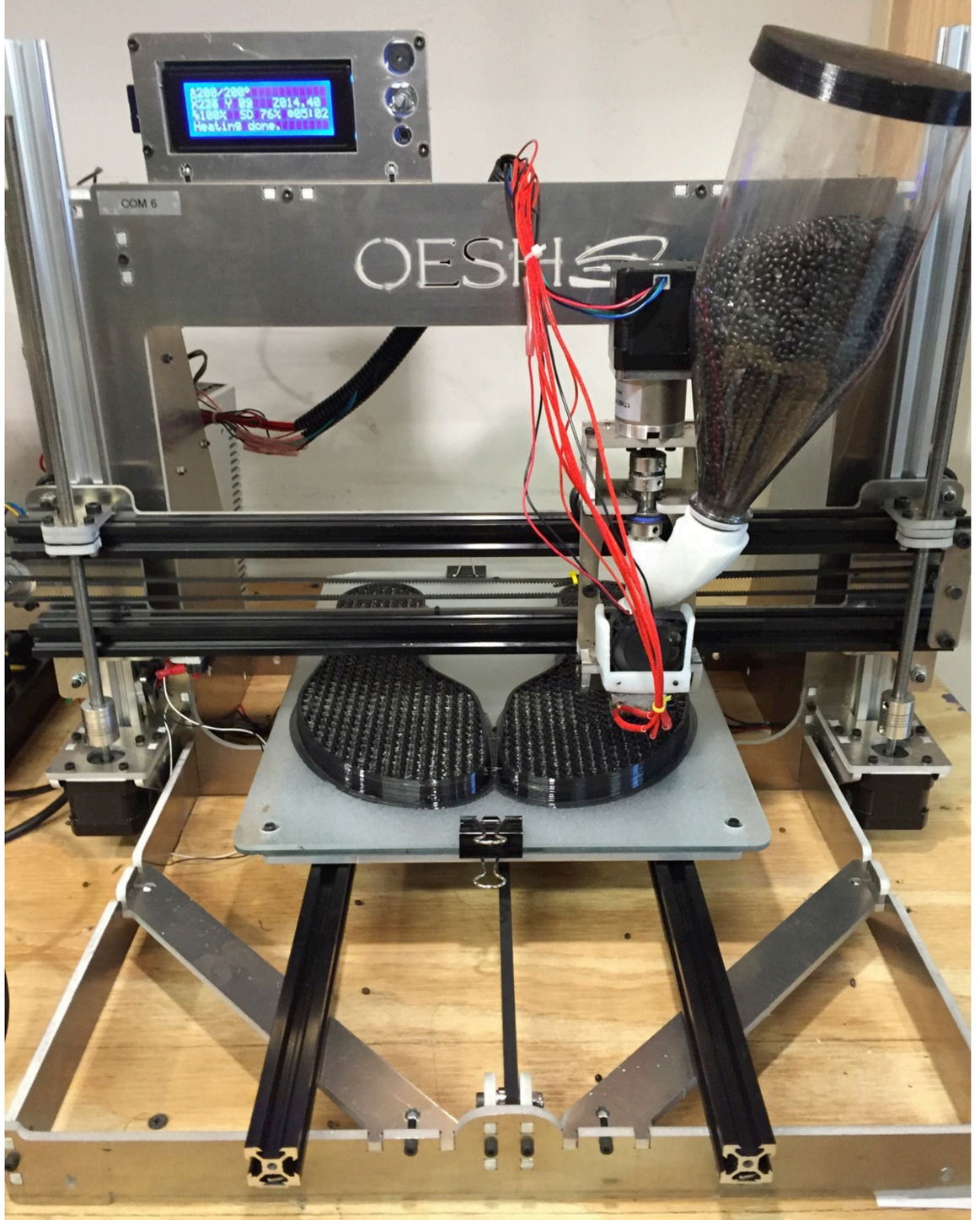


Intelli-MAX Layout to create tool paths



Intelli-MAX Make
to waterjet components

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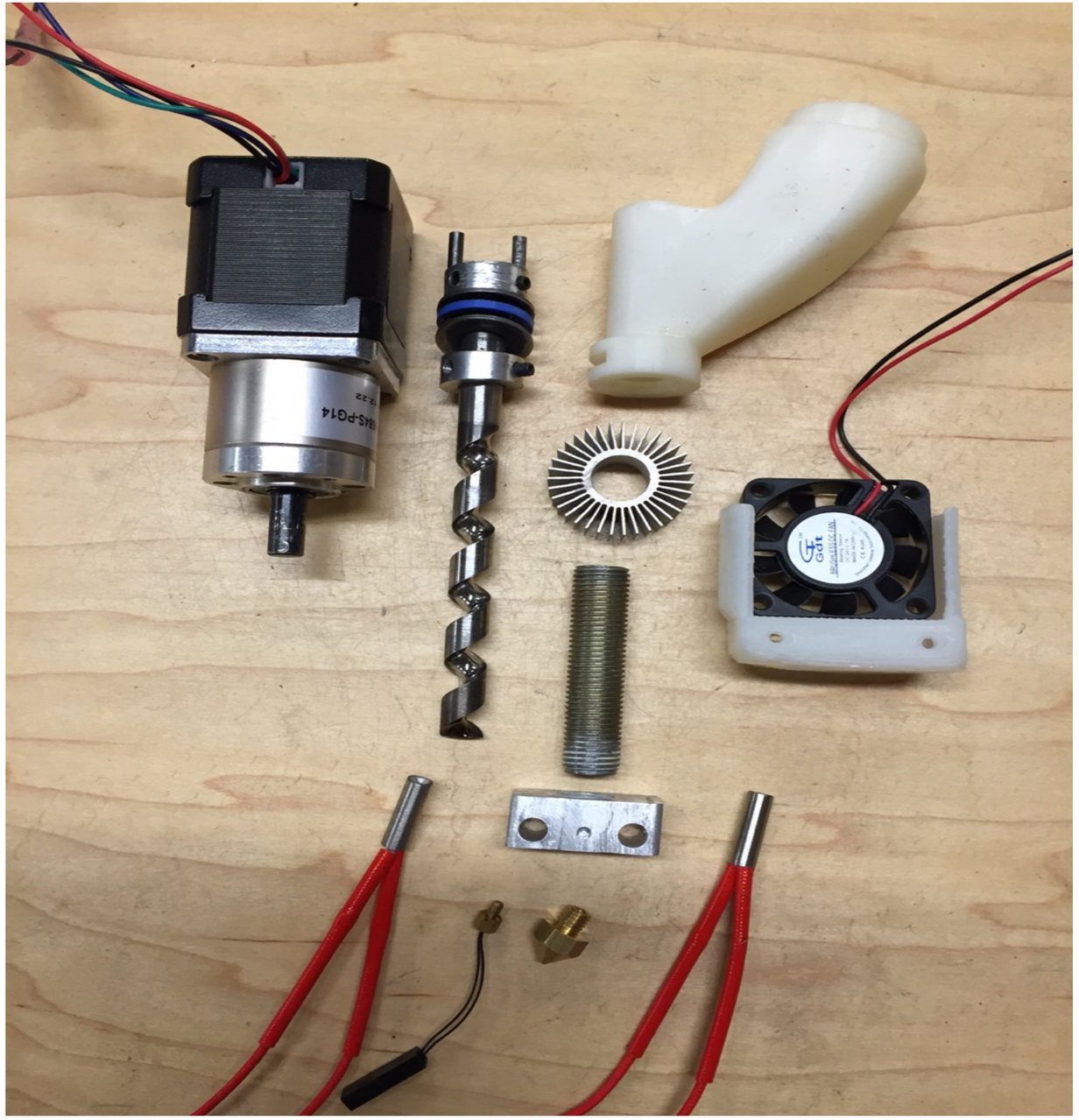
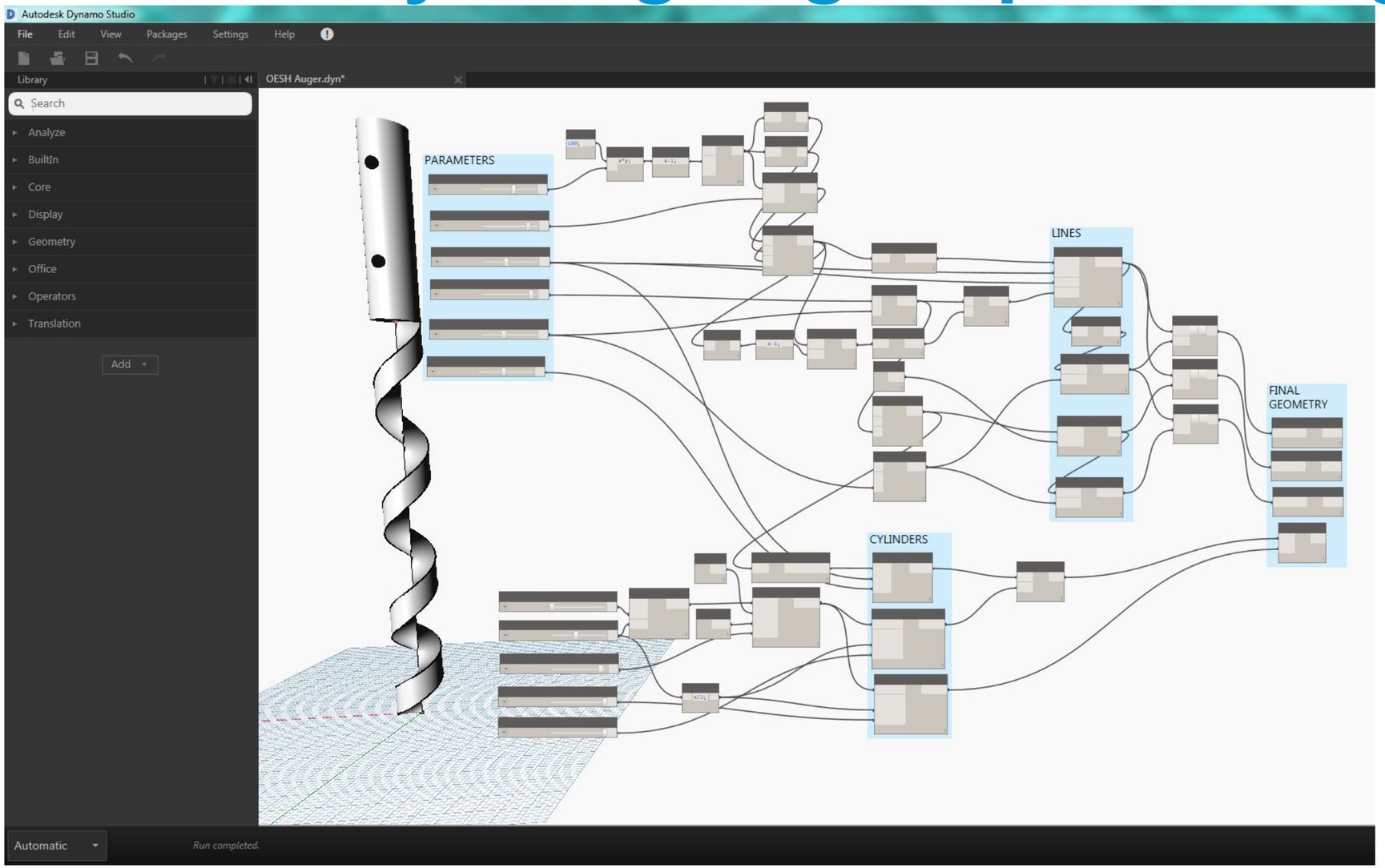
OESH

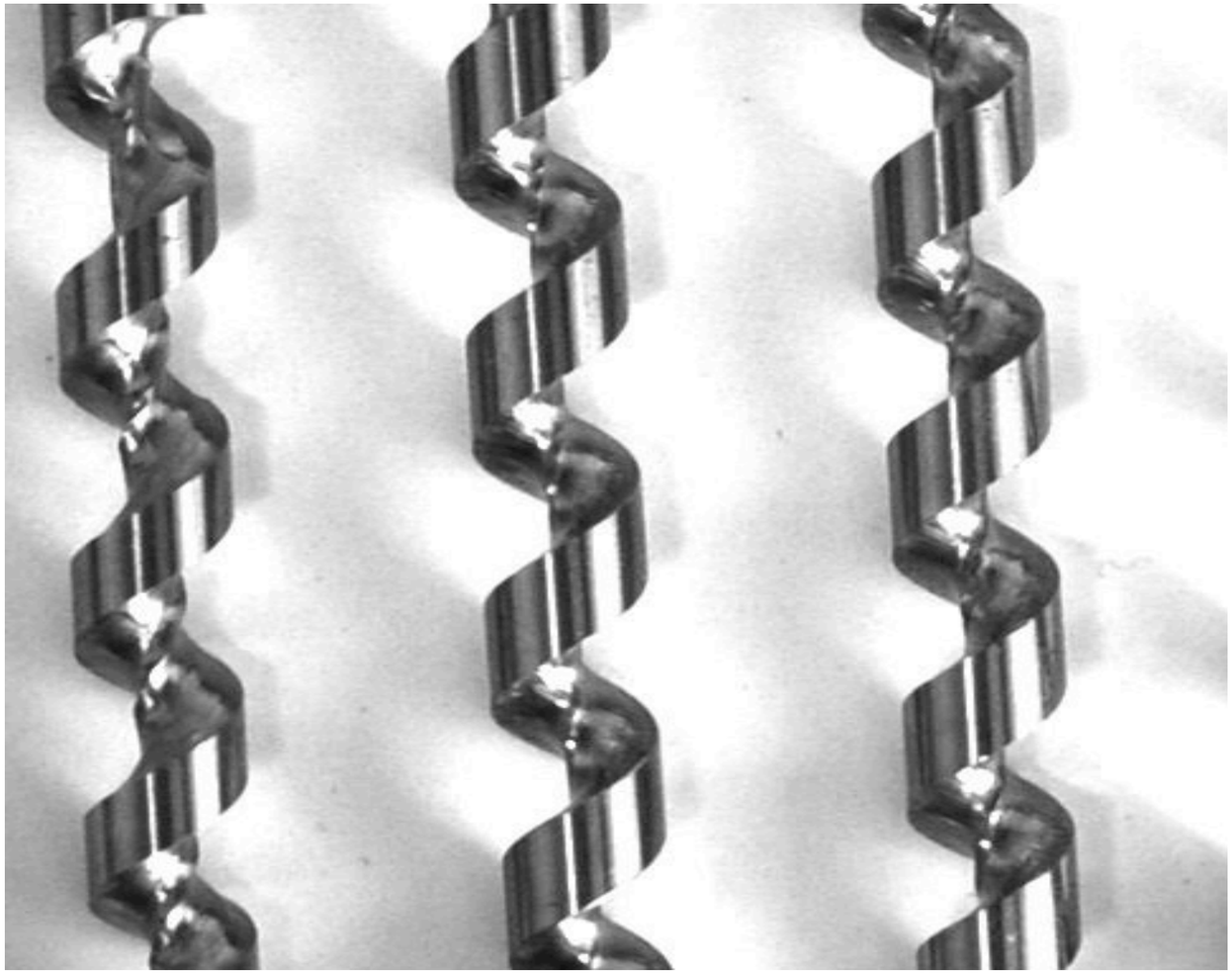


Dynamo Studio

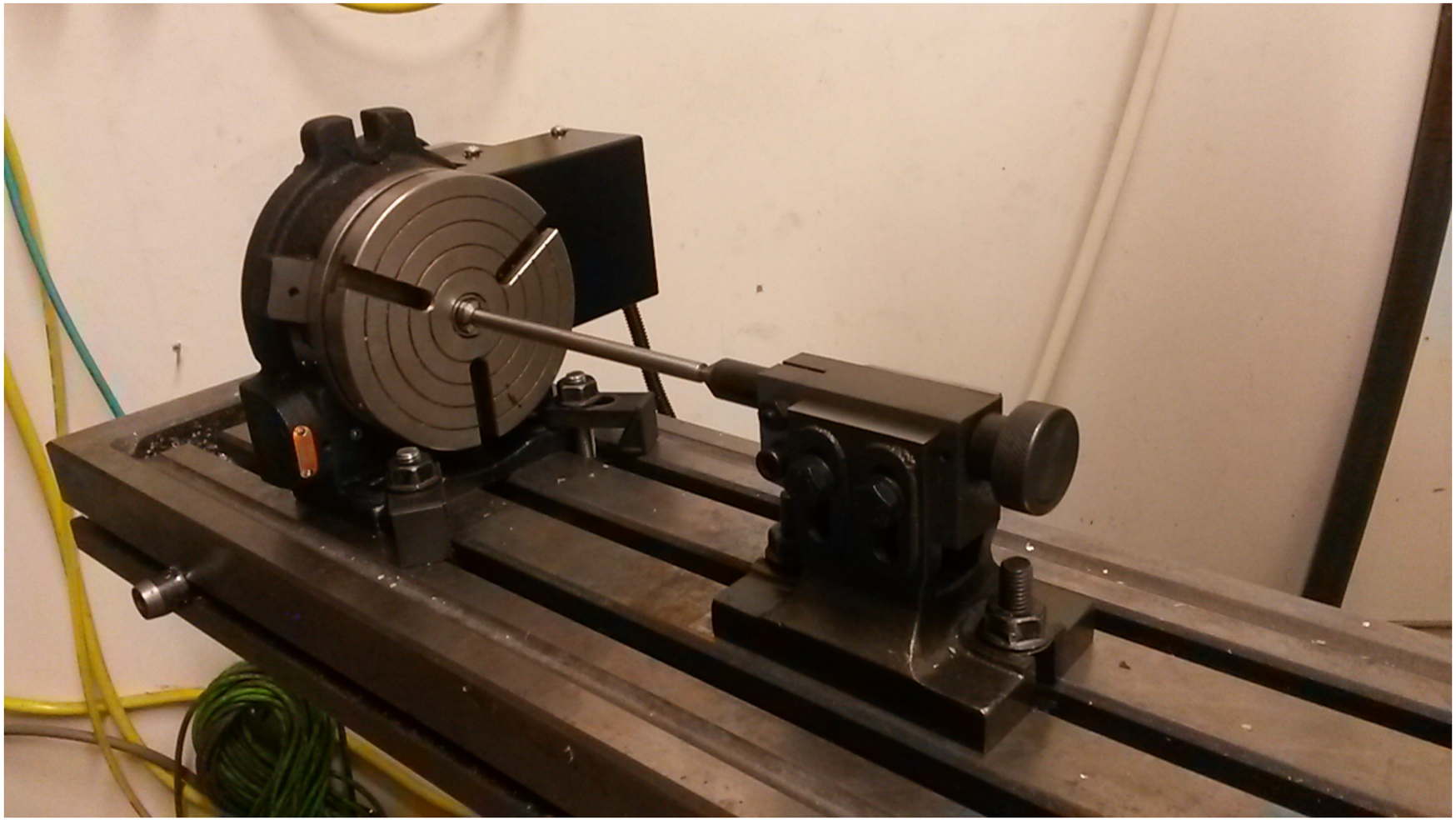
Parametrically designing 3D printer augers



Auger Iterations



4th Axis Milling Augers

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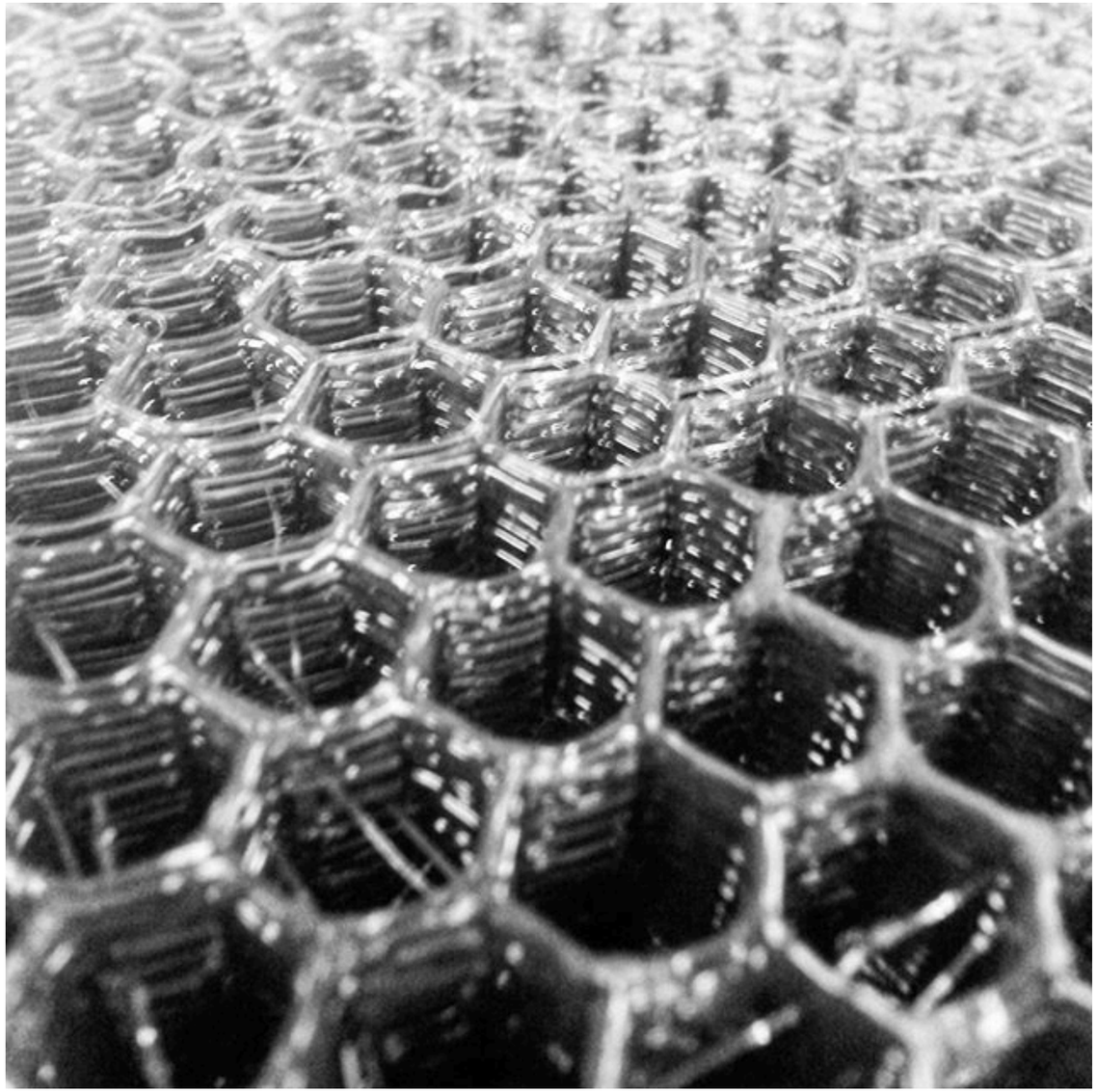
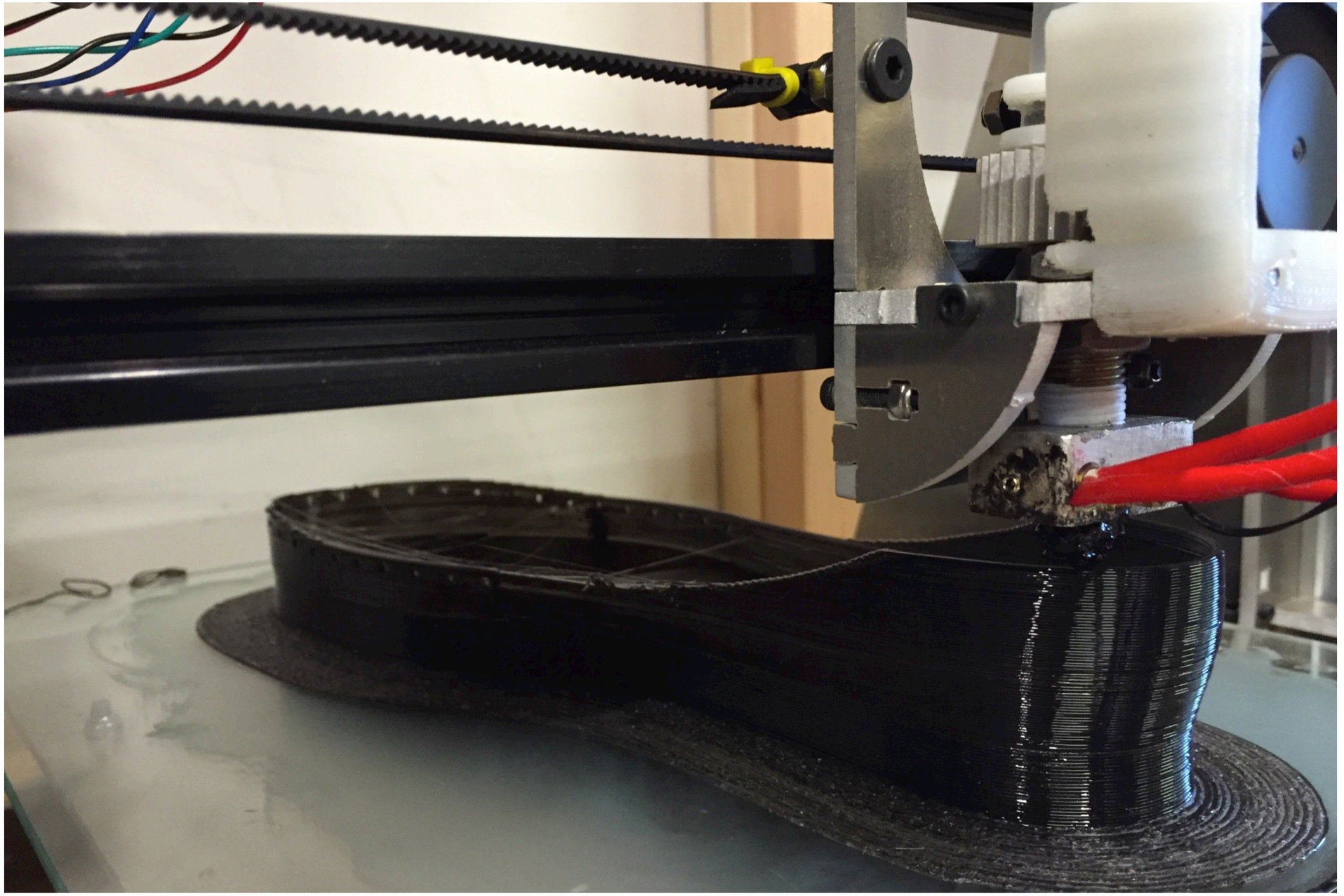
QESH
NATIONAL INSTRUMENTS

OESH 3D Printers
the final product

*Patent Pending

Advantages of 3D Printing





OESH Shoes
Introducing 3D Printed Sandals


DANGER

Sandal assembly
adding straps with rivets and pull tabs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OESHSHOES.COM
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~Envisioning the Future~

- We can 3D print holes into the soles that are super strong that can serve as attachment for an upper
- And we can make custom footwear

This summer we also introduced custom sandals for our local customers

- We trace the foot, tweak the pattern from and then print custom sole sizes
- This spring we'll also start customizing the stiffness of the sole


Healthy by design
Made for a woman, by a woman
For work & play

Athena Sandal | Limeade

$135.00

Athena Sandal | Maroon

$135.00

Athena Sandal | Phantom

$135.00

Athena Sandal | Poppy

$135.00

Athena Sandal | Slate

$135.00

Athena Sandal | Snapdragon

$135.00

Athena Sandal | Virginian

$135.00

Athena Sandal | Wildcat

$135.00

Artemis Sandal | Dark Moss

$140.00

Artemis Sandal | Moonrise

$140.00

Artemis Sandal | Obsidian

$140.00

Artemis Sandal | Shamrock

$140.00

A Measure of 3D Print Production Manufacturing Success: Listed in Top 10 Sandals in 2016!

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WALKING

Top Walking Sandals

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By Wendy Bumgardner

Updated August 29, 2016

Walkers choose walking sandals or trail sandals for both short and long distance

Very Well is the “Health” arm of “About.com”

OESH Athena Sandal. OESH

The OESH design has a perfectly flat footbed that sinks and rises as you walk. It 3-D printed honeycombed cushion is enough for standing all day with no discomfort. It has minimal webbing straps in a variety of colors that are happy in wet or dry conditions.


2016
PPE
2014
The polyurethanes book