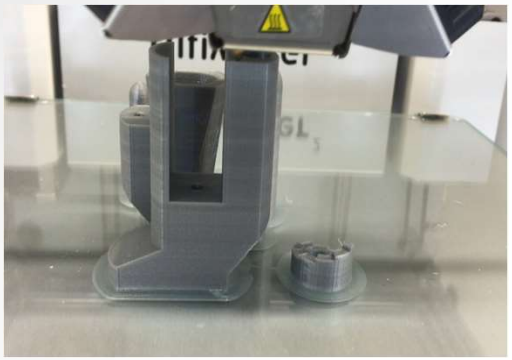

NEUROSCIENCE & THE OPEN HARDWARE STORY

Royhaan O. Folarin ***PhD FASLN***

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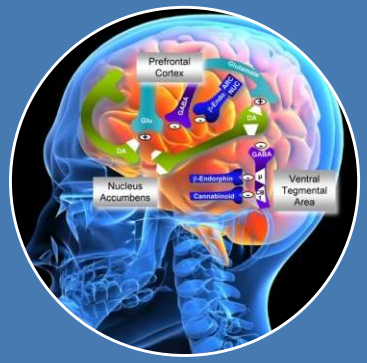
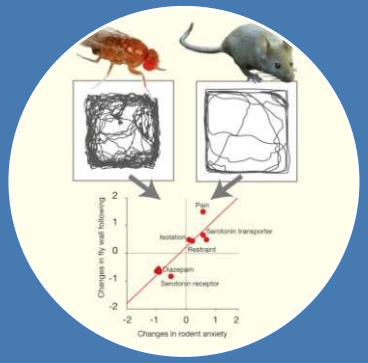
Touching lives through innovation

Pretoria, South Africa, December, 2022

Pleasure Meeting You...

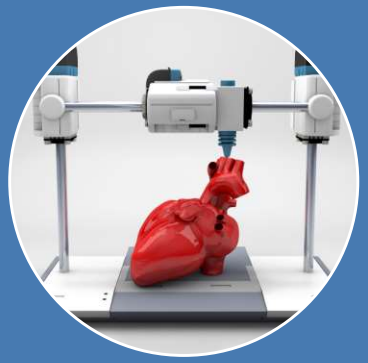


Biopsychiatry & Neuroregeneration



Mice & *Drosophila* Models

Phytotherapeutic Investigations



Free & Open Source Labware

(3D Printing)

Things I do...

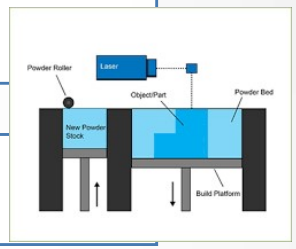
Seven 3D Printing categories

Vat polymerization

•liquid photopolymer (resin) cured by light

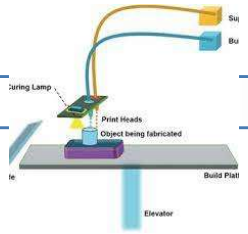
Material extrusion:

•molten thermoplastic (filament) deposited through a heated nozzle



Powder bed fusion (PBF)

•powder particles fused by a high-energy source

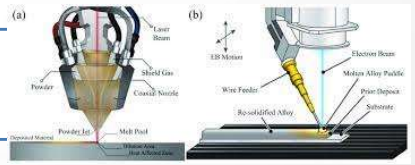


Material jetting

•droplets of liquid photosensitive fusing agent deposited on a powder bed and cured by light

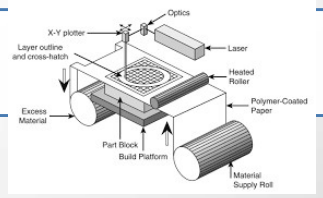
Binder jetting

•droplets of liquid binding agent deposited on a bed of granulated materials, which are later sintered together



Direct energy deposition

•molten metal simultaneously deposited and fused



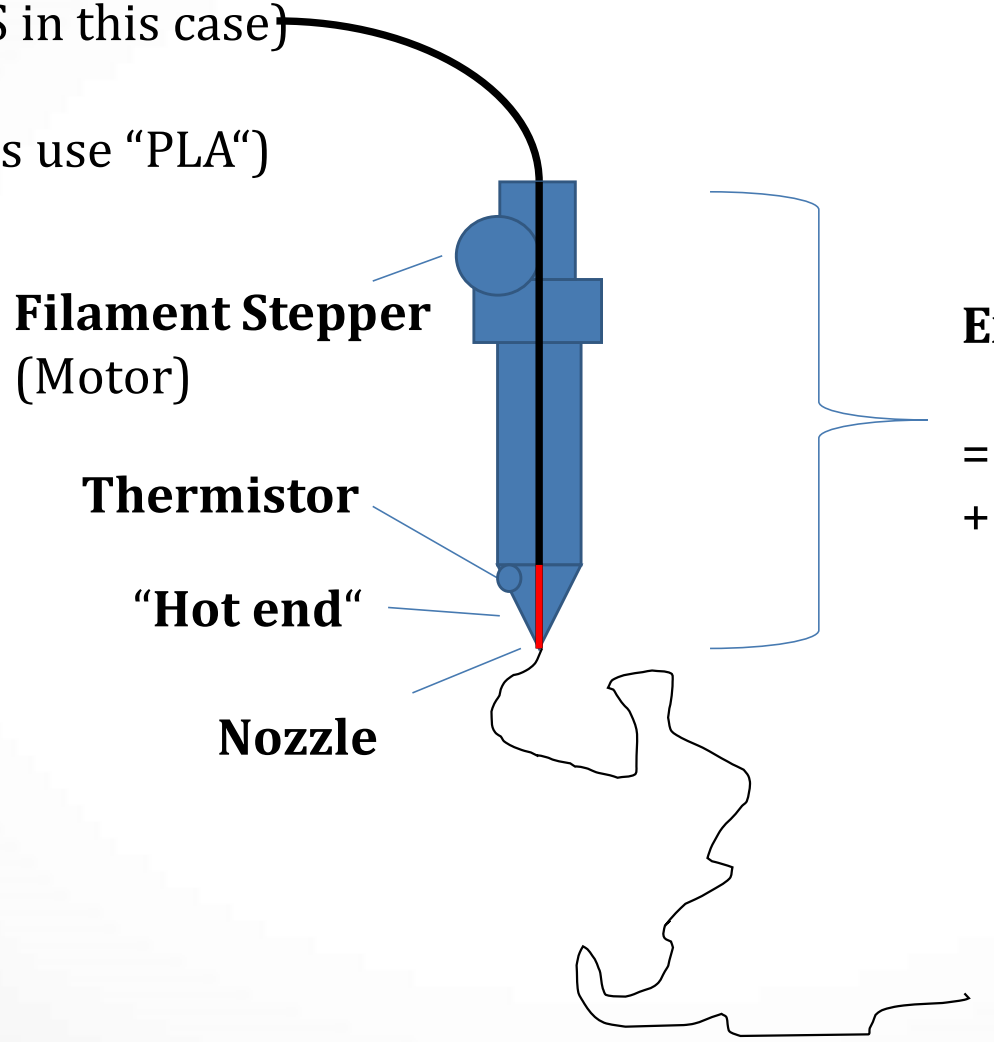
Sheet lamination

•individual sheets of material cut to shape and laminated together

FDM System

Basic principle

Filament (ABS in this case)
1.75 mm
(other printers use “PLA“)

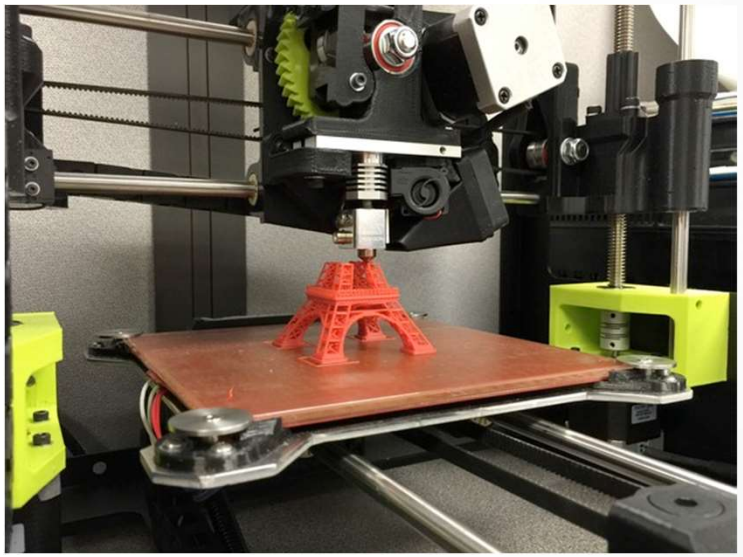


Extruder

= “Hot End“ + Filament Stepper
+ Mechanics

Some Applications of 3D Printing in

Neuroscience

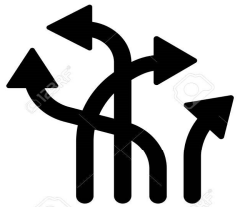


Diverse Research Questions

Common Research Denominator

- Things companies won't readily make for you,

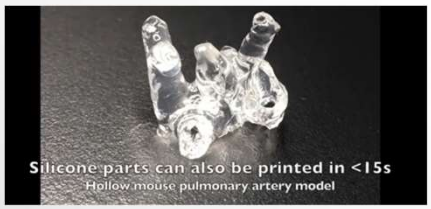
- To make common technology more flexible,



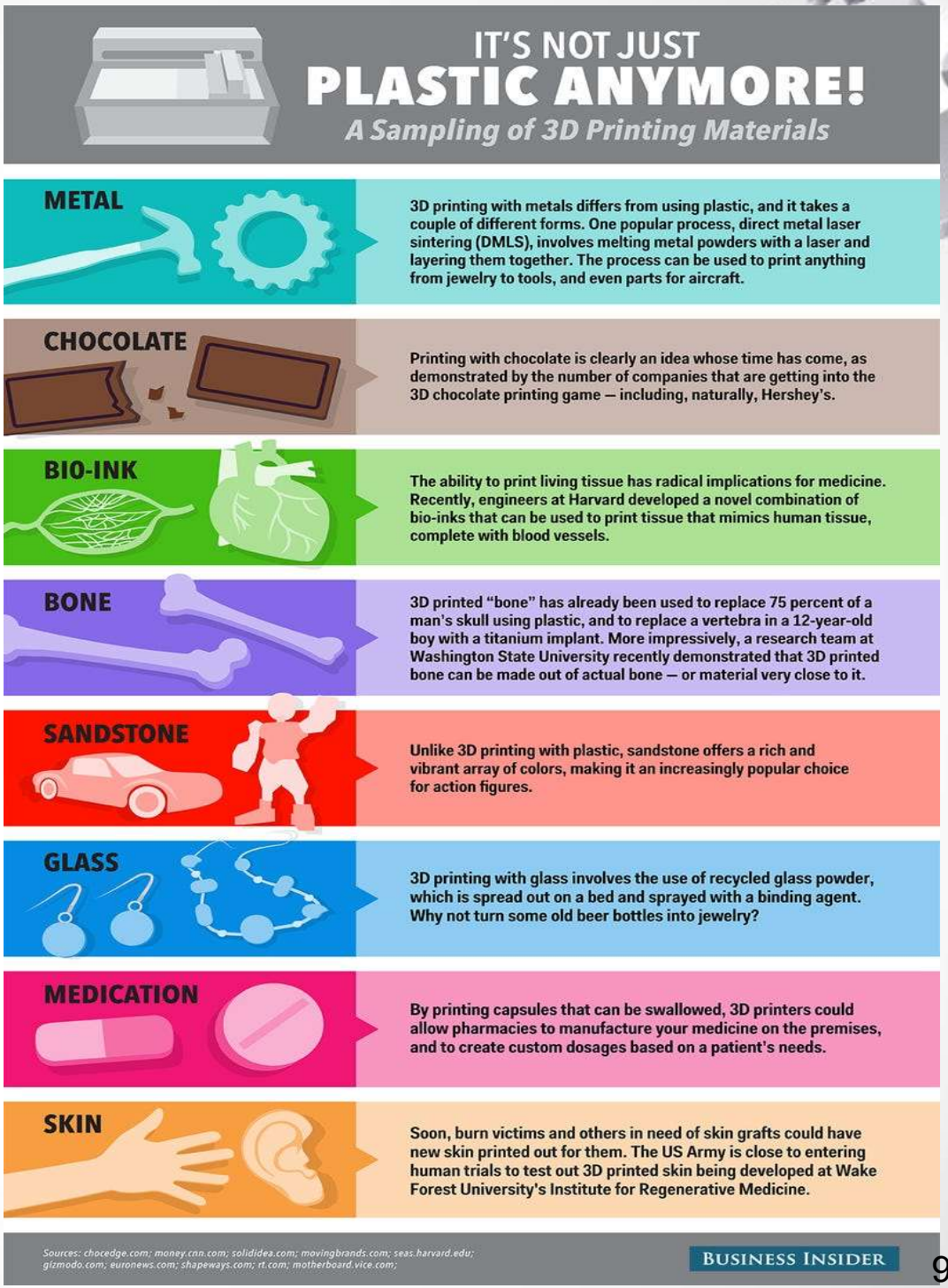
- High detail of customized design

- To make crucial instrumentation cheaper and more accessible

Limitless Printing Materials

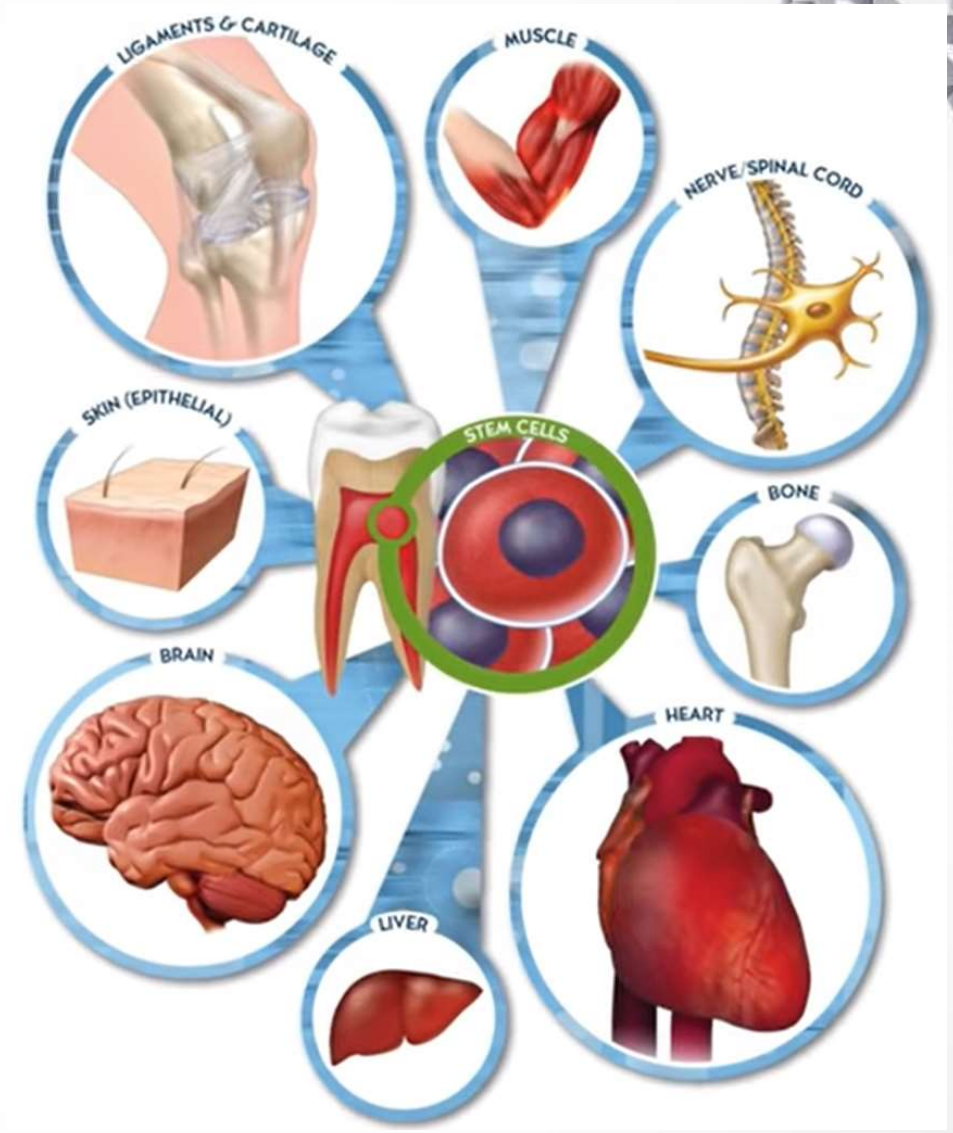


3D Printing in Neuroscience...



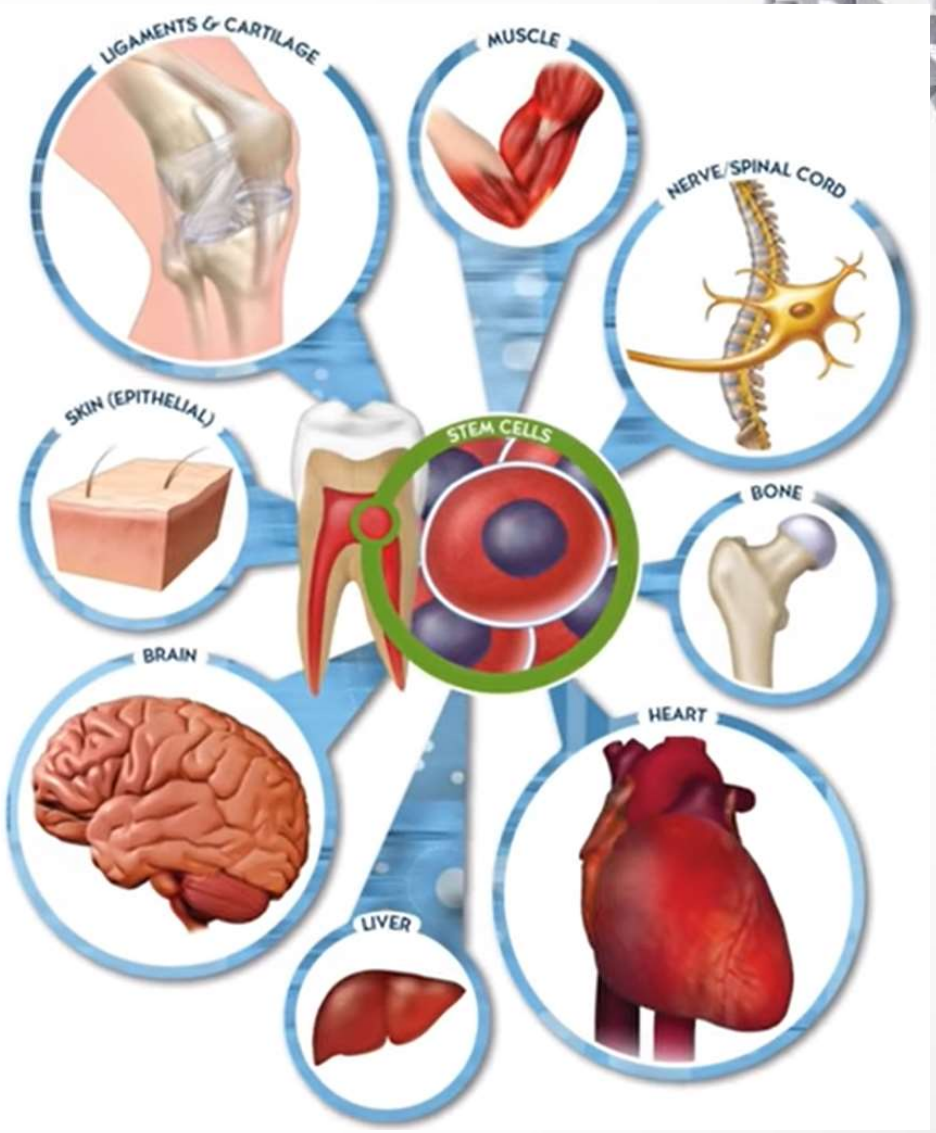
Stem Cells

- Pluripotent elements
- The body's raw materials
- Isolation & production help understand human cell function
- Regeneration in disease and trauma



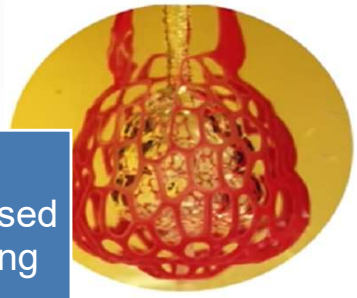
3D-Printing Stem Cells

- Assembly of neural 3D networks
- Well-defined duplicatable 3D scaffold, capable of imitating brain activity
- Test the modulatory effects of pharmacological and toxicological compounds

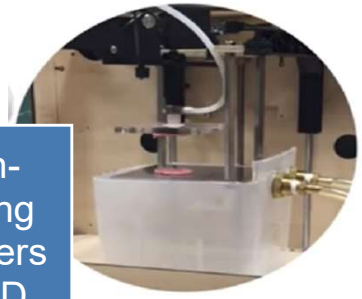


3D Printing Approaches to Stem Cells

Dye-based Layering



Flash-freezing 2D layers into 3D



Populating 3D-printed cellulose with SCs

Ultrasound corralling of cell placement

Integrating live cells into bionic prosthetics

frontiers | Frontiers in Systems Neuroscience All journals All articles About journal

METHODS article

Front. Syst. Neurosci., 13 May 2013

https://doi.org/10.3389/fnsys.2013.00008

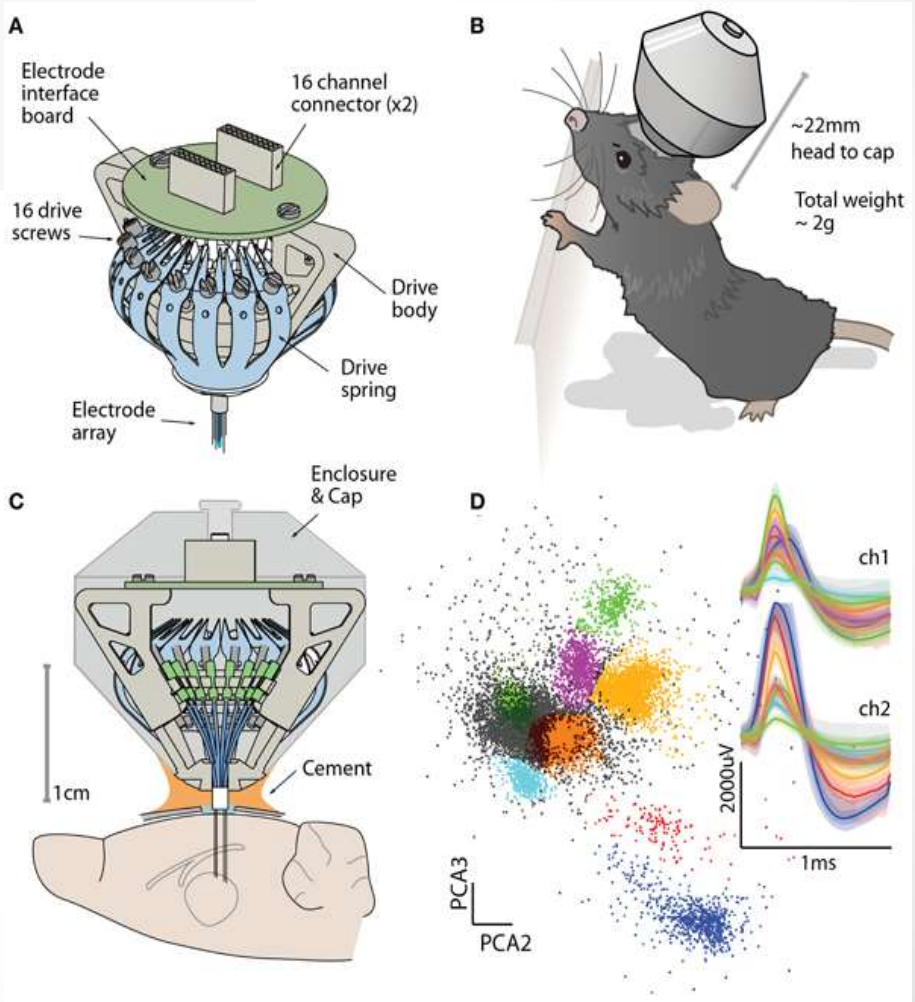
The flexDrive: an ultra-light implant for optical control and highly parallel chronic recording of neuronal ensembles in freely moving mice

Jakob Voigts[1,2], Joshua H. Siegle[1,2], Dominique L. Pritchett[2,3] and Christopher I. Moore[2]*

[1] Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, MA, USA
[2] Department of Neuroscience, Brown University, Providence, RI, USA
[3] Center for Neuroscience, Boston University, Boston, MA, USA

Flexdrive

- Voigts et al. (2013)
- Spring-based drive mechanism that reduces implant weight and complexity
- For **optical control** & highly parallel **chronic recording of neuronal ensembles** in freely moving mice
- Ultra-light implant
  - 16 electrodes, 64 channels, weighs ~2 g



Journal of Neuroscience Methods
Volume 286, 15 July 2017, Pages 38-55

3D printing and modelling of customized implants and surgical guides for non-human primates

Xing Chen [a], Jessy K. Possel [a], Catherine Wacongne [a], Anne F. van Ham [a], P. Christiaan Klink [a, b, c, d], Pieter R. Roelfsema [a, c, d]

Show more

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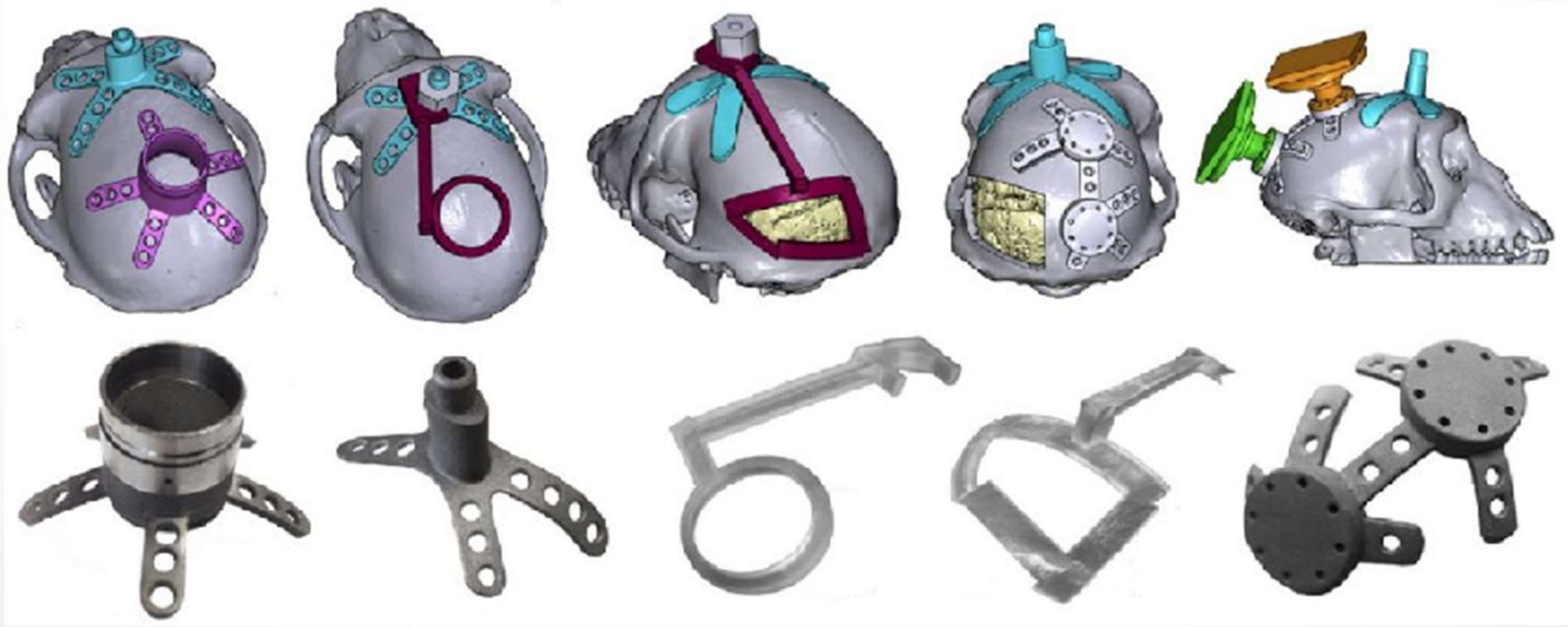
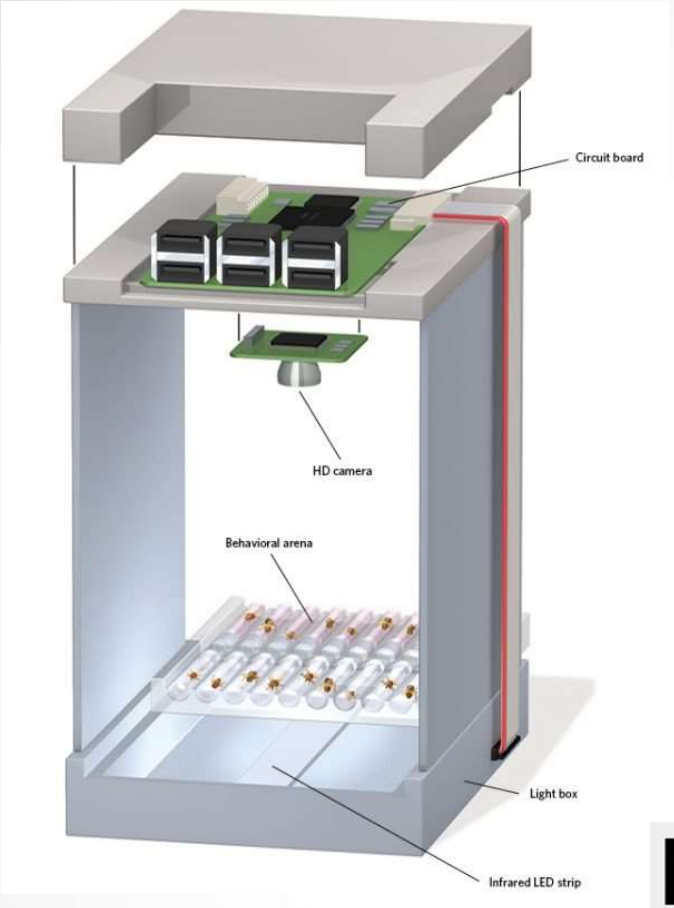
https://doi.org/10.1016/j.jneumeth.2017.05.013

Customized Cranial Implants

- Chen et al. (2017)
- Titanium 3D prints
  Tailored to the anatomy of individual animals
- for primate electrophysiology
- plastic prototyping,
- titanium final prints





3D-printed Ethoscope

- Geissman et al. (2017)
- Behavior quantification box for flies
- 5 to 8 times less expensive than commercial alternatives

PLOS BIOLOGY

OPEN ACCESS

COMMUNITY PAGE

Ethoscopes: An open platform for high-throughput *ethomics*

Quentin Geissmann, Luis Garcia Rodriguez, Esteban J. Beckwith, Alice S. French, Arian R. Jamasb, Giorgio F. Gilestro

Published: October 19, 2017 • https://doi.org/10.1371/journal.pbio.2003026

See the preprint

PLOS BIOLOGY

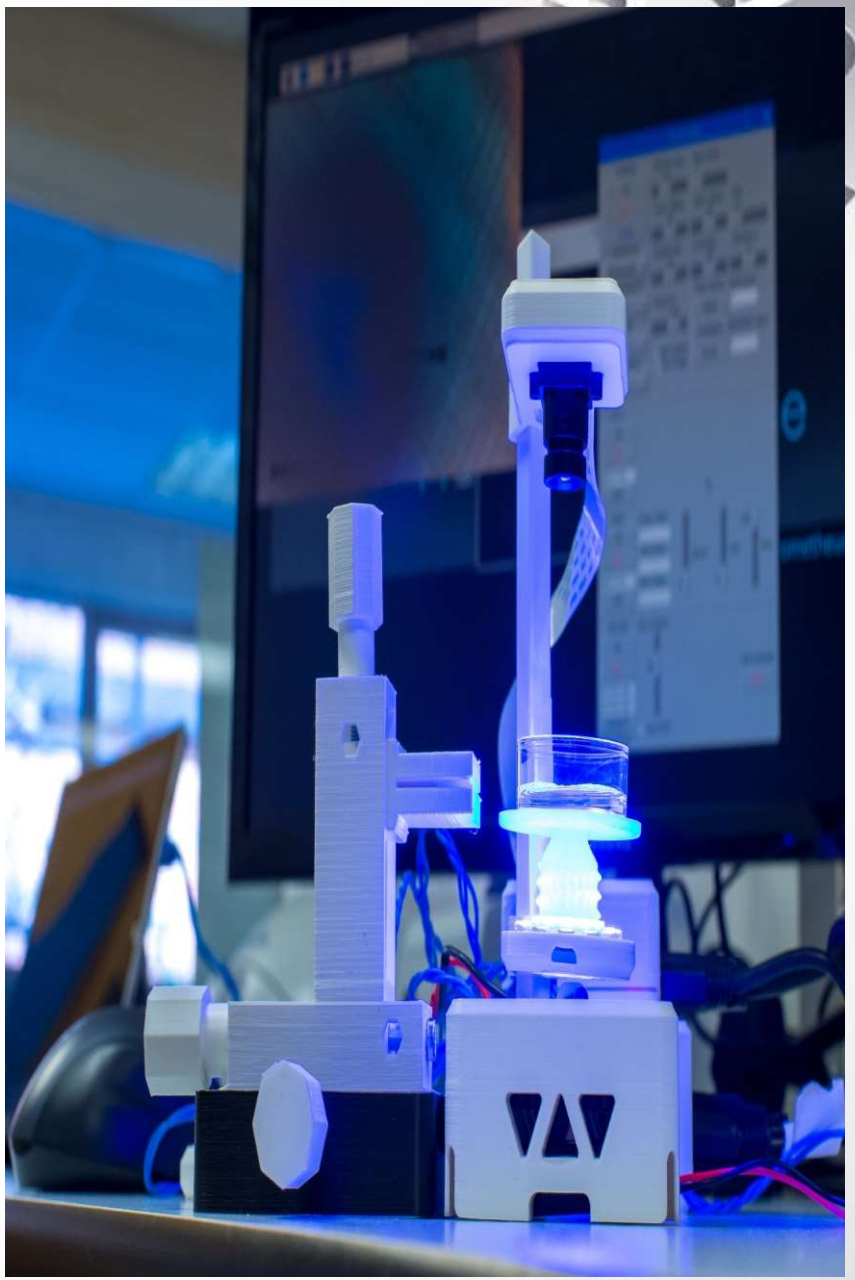
COMMUNITY PAGE

The €100 lab: A 3D-printable open-source platform for fluorescence microscopy, optogenetics, and accurate temperature control during behaviour of zebrafish, *Drosophila*, and *Caenorhabditis elegans*

Andre Maia Chagas[1,2,3,4]*, **Lucia L. Prieto-Godino**[3,5], **Aristides B. Arrenberg**[1,6], **Tom Baden**[1,3,4,7]*

1 Werner Reichardt Centre for Integrative Neuroscience, University of Tübingen, Tübingen, Germany, 2 Graduate school for Neural and Behavioural Neuroscience, University of Tübingen, Tübingen, Germany, 3 TReND in Africa gUG, Bonn, Germany, 4 Institute of Ophthalmic Research, University of Tübingen, Tübingen, Germany, 5 Center of Integrative Genomics, University of Lausanne, Lausanne, Switzerland, 6 Institute of Neurobiology, University of Tübingen, Tübingen, Germany, 7 School of Life Sciences, University of Sussex, Brighton, United Kingdom

* andremaia.chagas@gmail.com (AMC); t.baden@sussex.ac.uk (TB)




miniSpin
eppendorf

Labwares

OPEN ACCESS

COMMUNITY PAGE

PLOS BIOLOGY

FIFTEENTH ANNIVERSARY

Open Labware: 3-D Printing Your Own Lab Equipment

Tom Baden, Andre Maia Chagas, Greg Gage, Timothy Marzullo, Lucia L. Prieto-Godino, Thomas Euler

Published: March 20, 2015 • https://doi.org/10.1371/journal.pbio.1002086

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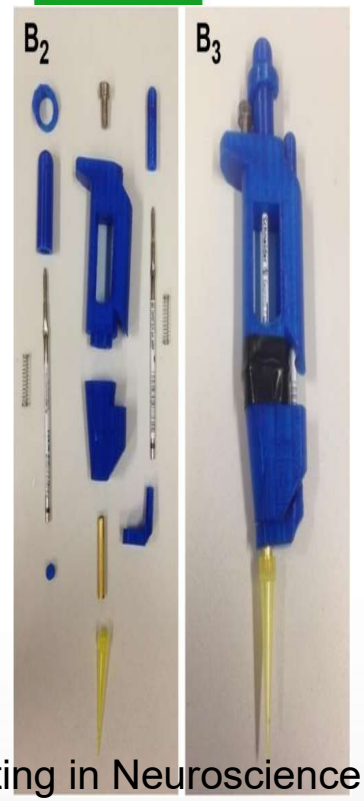
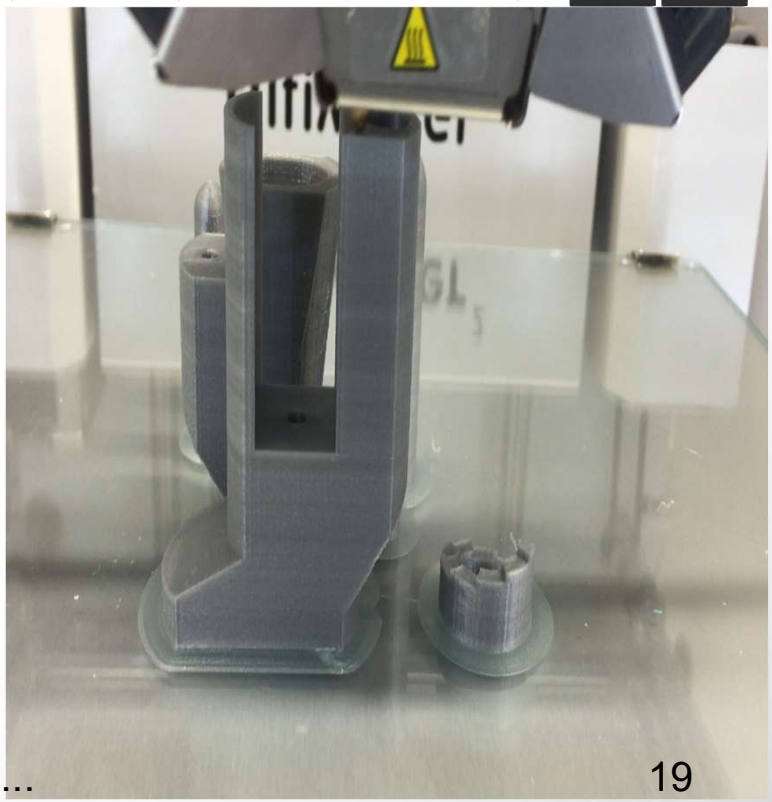




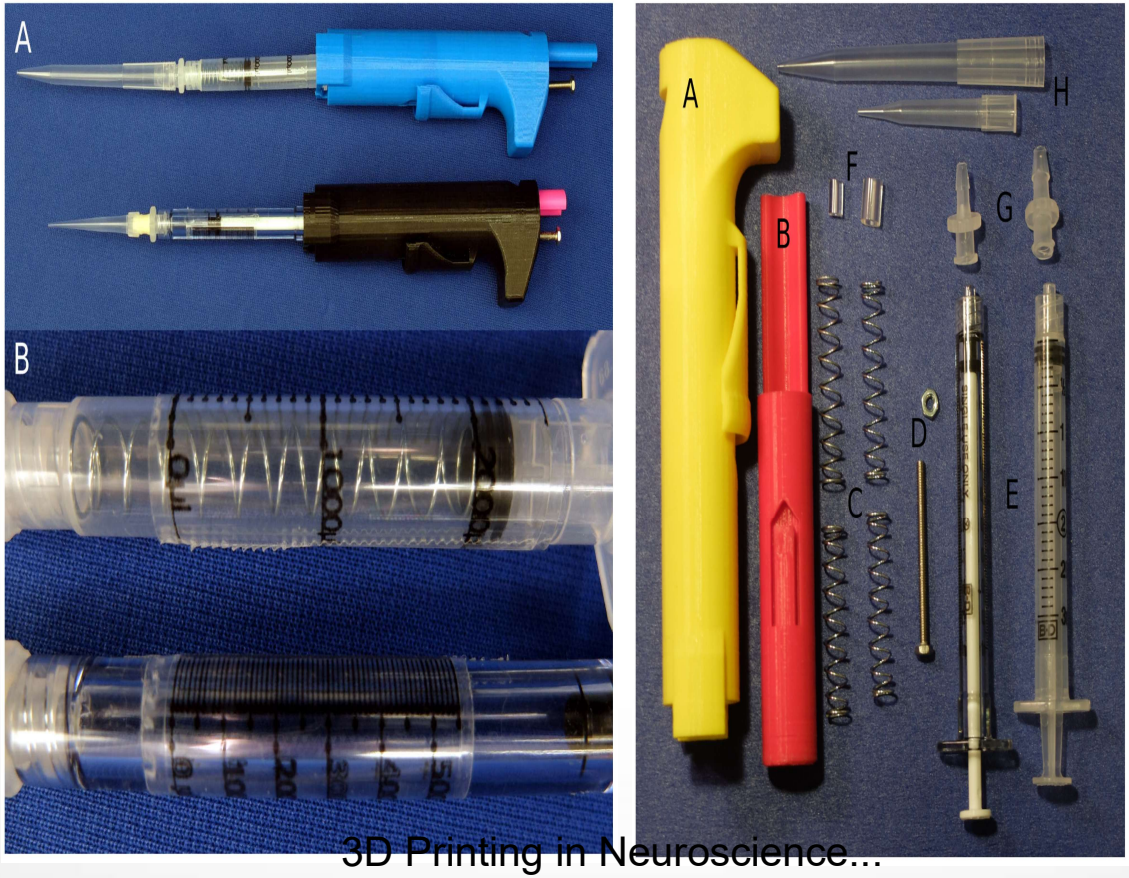
Micromachines **2018**, *9*(4), 191; https://doi.org/10.3390/mi9040191

Open Access Article

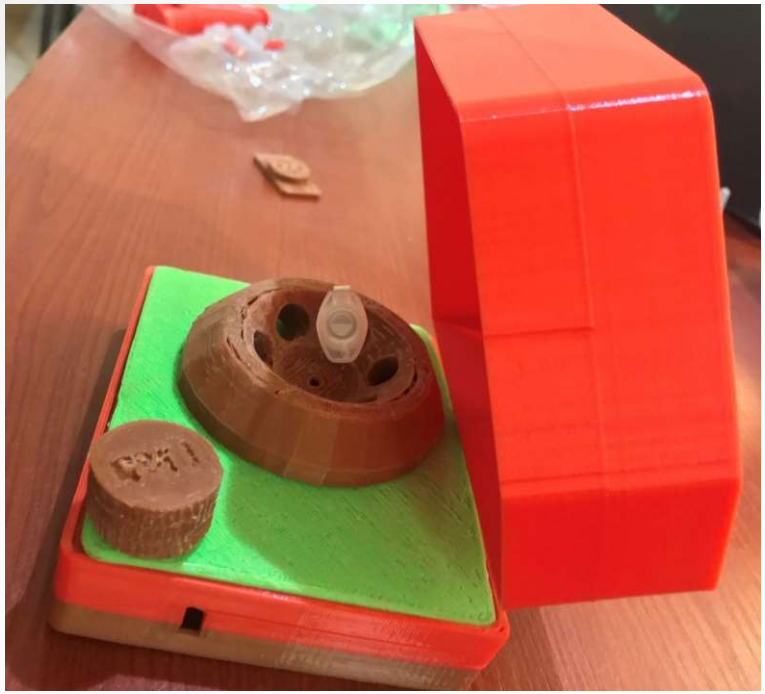
Open Design 3D-Printable Adjustable Micropipette that Meets the ISO Standard for Accuracy

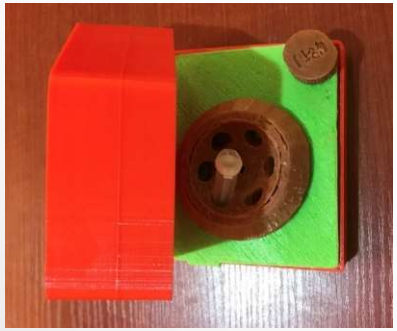
Martin D. Brennan, Fahad F. Bokhari and David T. Eddington *

Department of Bioengineering, University of Illinois at Chicago, Chicago, IL 60607, USA



3D-Printed Centrifuge, from NPTRL





3D F

PLOS BIOLOGY

COMMUNITY PAGE

Bypassing shortages of personal protective equipment in low-income settings using local production and open source tools

Royhaan Olamide Folarin[1,2]*, Mahmoud Bukar Maina[2,3,4], Abisola Kaosara Akinbo[1], Tamramat Iyabo Runsewe-Abiodun[5], Omobola Abioye Ogundahunsi[6], Ahmed Adebowale Adedeji[7]*, Andre Maia Chagas[2,3,4]*

1 Department of Anatomy, Olabisi Onabanjo University, Sagamu (Ogun State), Nigeria, **2** TReND in Africa, Brighton, United Kingdom, **3** Sussex Neuroscience, School of Life Sciences, University of Sussex, Brighton, United Kingdom, **4** Department of Anatomy, Olabisi Onabanjo University, Sagamu (Ogun State), Nigeria, **5** Department of Anatomy, Olabisi Onabanjo Univeristy, Sagamu (Ogun State), Nigeria, **6** Department of Anatomy, Olabisi Onabanjo University, Sagamu (Ogun State), Nigeria, **7** Nigerian Institute of Medical Research, Yaba, Lagos, Nigeria, Olabisi Onabanjo University, Sagamu (Ogun State), Nigeria, Nigerian Institute of Medical Sciences, Olabisi Onabanjo University, Sagamu (Ogun State), Nigeria

* royhaan.folarin@sussex.ac.uk (RF); a.maia-chagas@sussex.ac.uk (AMC)

Free and ... of locally sourced ... solving, as proven by ... shields and masks in ... during the COVID-...

Citation: Folarin RO, Maina MB, Akinbo AK, Runsewe-Abiodun TI, Ogundahunsi OA, Adedeji AA, et al. (2022) Bypassing shortages of personal protective equipment in low-income settings using local production and open source tools. PLoS Biol 20(5): e3001658. https://doi.org/10.1371/journal.pbio.3001658

Published: May 20, 2022

Funding: The author(s) received no specific funding for this work.

Competing interests: The authors have declared that no competing interests exist.

Abbreviations: COVID-19, Coronavirus Disease 2019; FOSH, free and open-source hardware; PETG, polyethylene terephthalate glycol; PLA, polylactic acid; PPE, personal protective equipment.

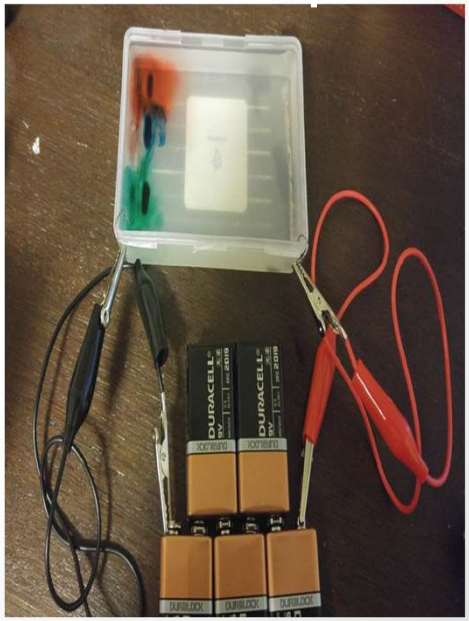
Body text

As the infecti... personal protective equipme... ased effective-ness in health... surgical gowns hiked, and so... 1], while others reportedly in... highest bidder [2]. To help tackle this issue, alternative means of achieving PPE production and distribution were

3D-Printed Nose masks (inset shows packaged & sealed nose masks with filters)

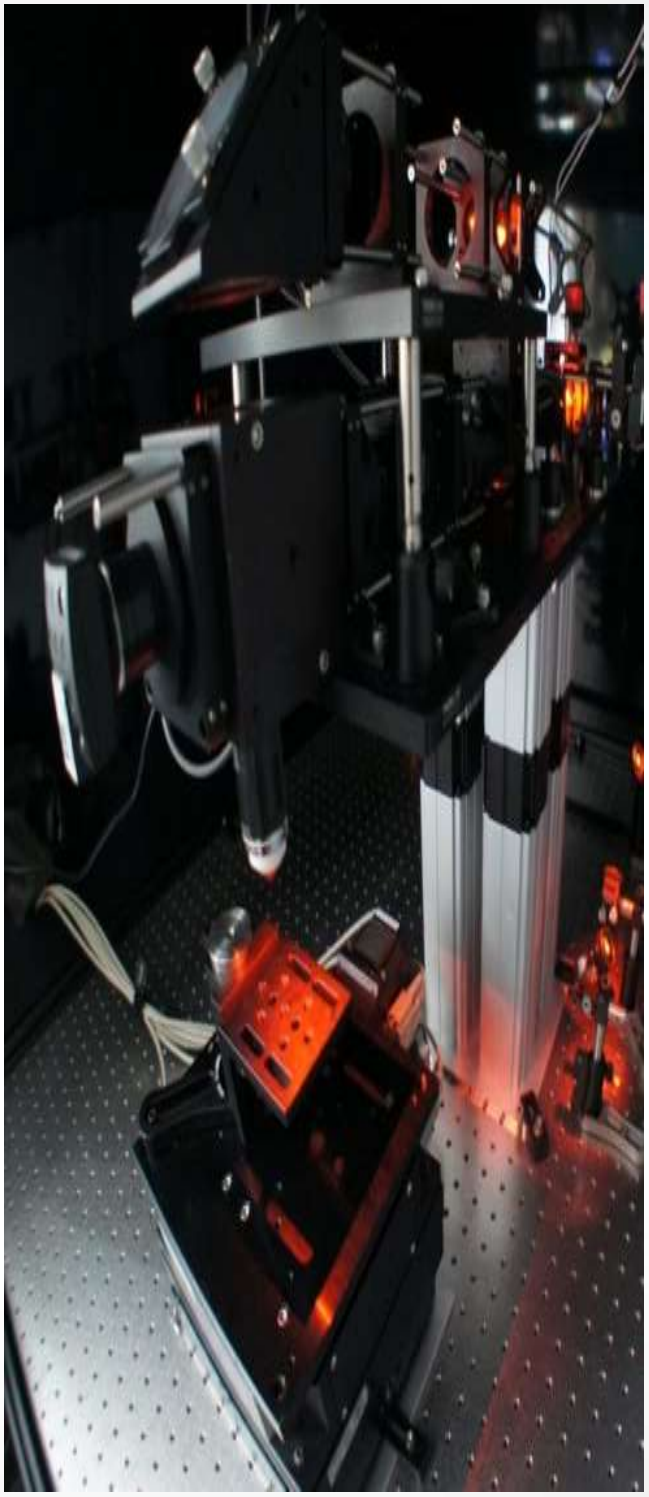
Harnessing the underlying principles...

Incubate… Spin Heat+Cool Zap…

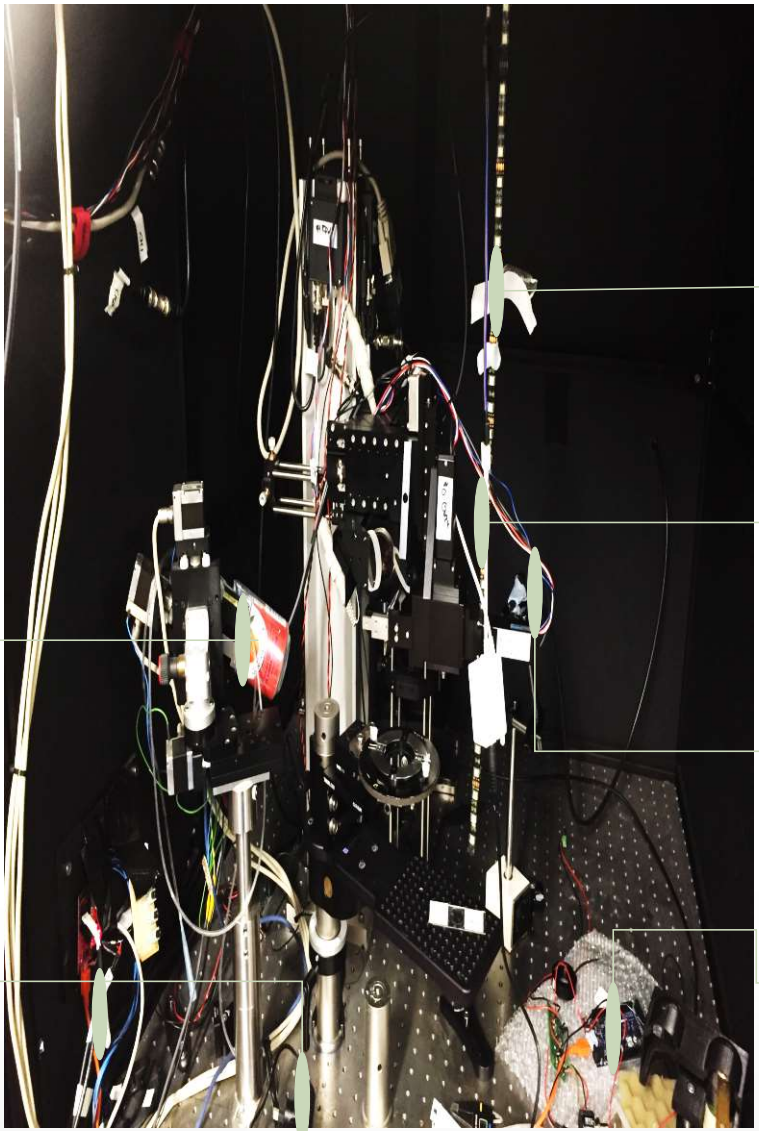



STAMINOL
MOTOR OIL
Reproducibility?
LG
KING PLUGS
DUNLOP

2-photon microscope



Complicated = Simple * n



Journal of open hardware

Delmans, M and Haseloff, J 2018 µCube: A Framework for 3D Printable Optomechanics. *Journal of Open Hardware*, 2(1): 2, pp. 1–9, DOI: https://doi.org/10.5334/joh.8

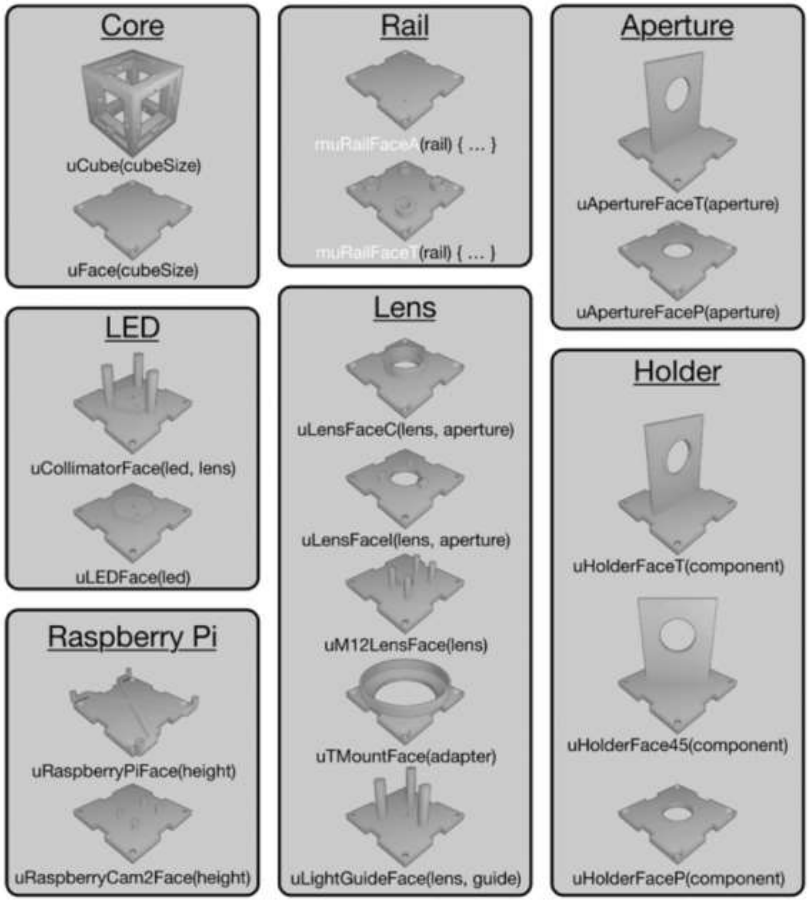
HARDWARE METAPAPER

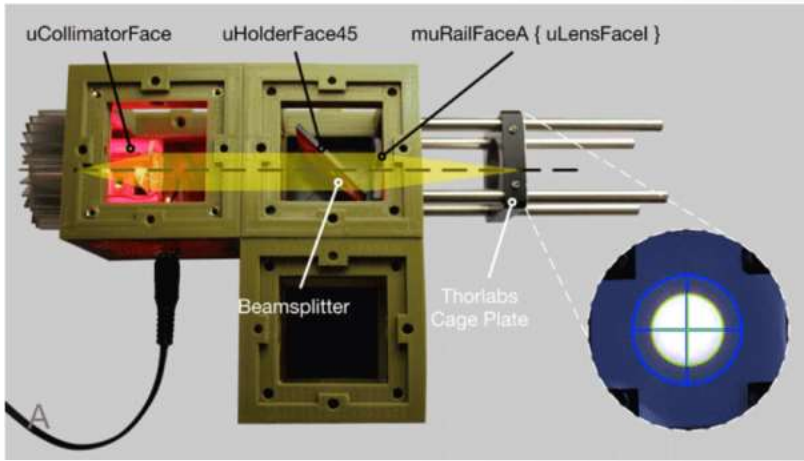
µCube: A Framework for 3D Printable Optomechanics

Mihails Delmans and Jim Haseloff

Optomechanics components

- Delmans and Haselhof (2018)
- µCube system Parts library
- easily adjust the dimensions
- metal is the material of choice





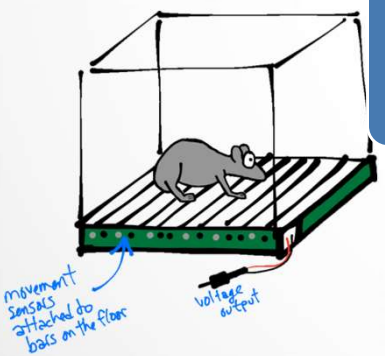
Current Project

Neuropsychiatric Disorders (NPDs)

NPD Patients show Impaired Prepulse inhibition (PPI) (sensorimotor gating)

Mice Models of NPDs & the measurement of PPI

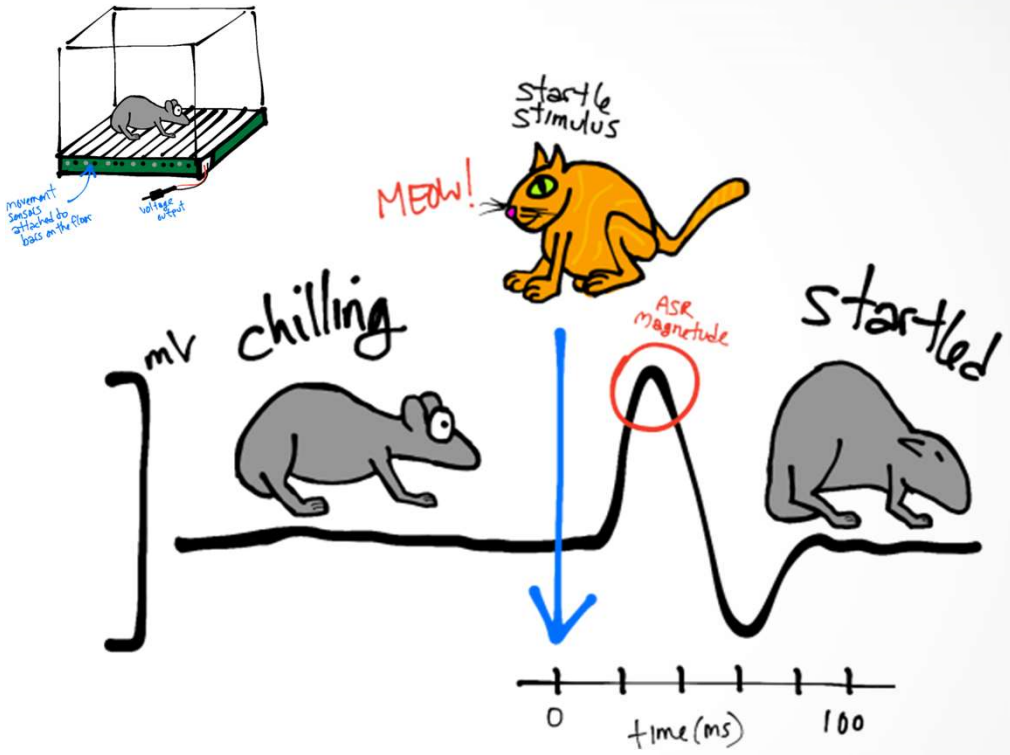
Startle Reflex Apparatus



https://conductscience.com/maze/acoustic-startle-response/

How it works

- Weak acoustic impulse before stronger **acoustic impulse**.
- Reactivity scores based on **timing** and **intensity** of the **body movement** during startle

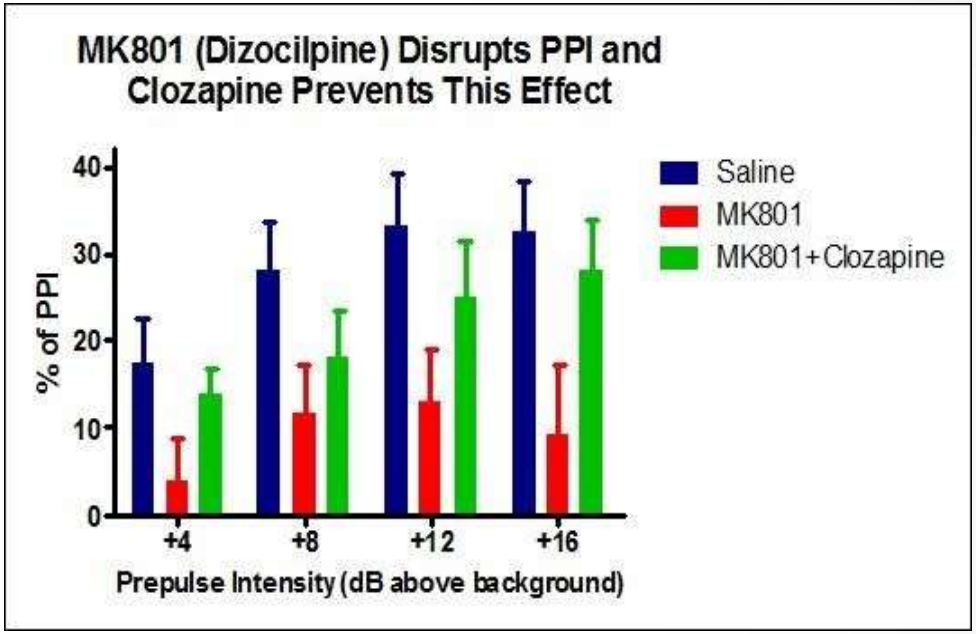


https://conductscience.com/maze/acoustic-startle-response/

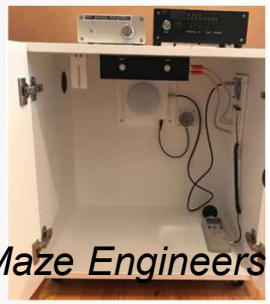
Users

- Researchers who model neuropsychiatric disorders in

https://speakingofresearch.com/2015/01/22/why-i-became-an-animal-technologist/



https://med.stanford.edu/sbfnl/services/bm/ep/pre-pulse.html

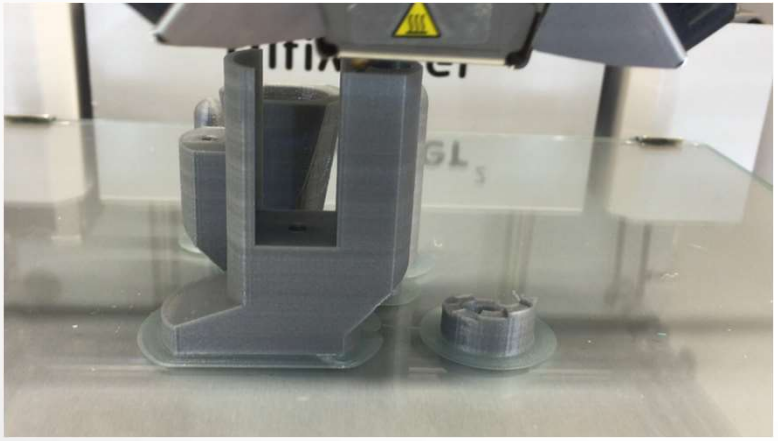


Maze Engineers

So,...

- What 1,2,3... things do you consider worthy of 3D-Printing in your research project?

A whole lot of needs on the continent …



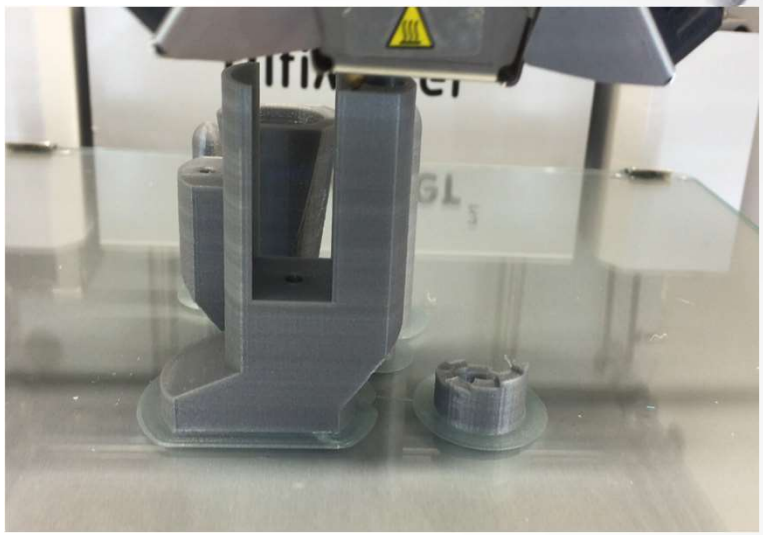
Just before you go...

When to Use 3D Printing

- Relatively low quantities (1-50)
  - Otherwise, start exploring alternatives
- Complex geometrical design that is critical to part's function
- Not killing a fly with a hammer
- Aligning technology's peculiarities with your most important requirements

So,...

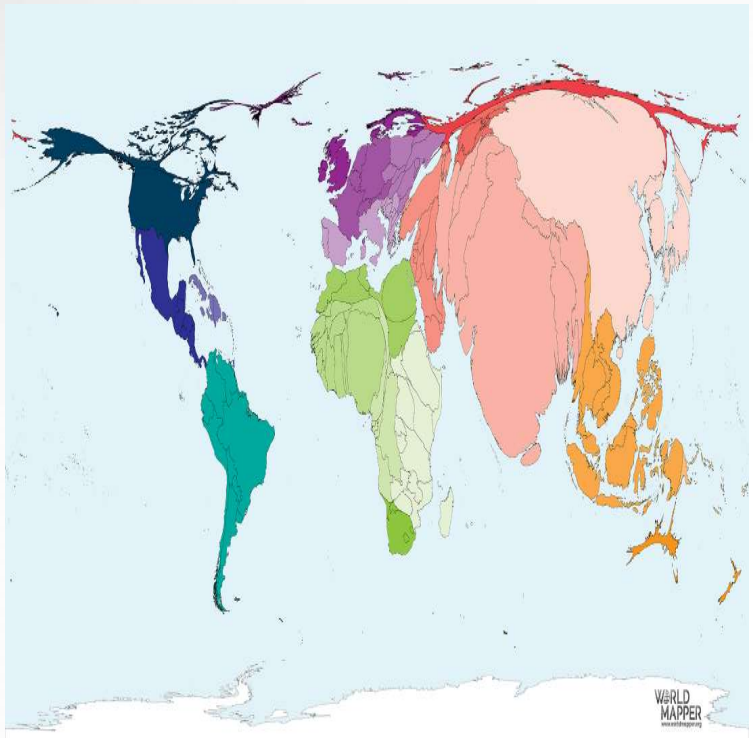
- Assess your needs effectively
- Imagine your solution
- Clarify your goals
- Determine your desired materials
- Acquire a reliable and non-technical printing method/machine
  - Fused deposition modeling (FDM) most affordable & ideal for beginners
  - Makerbot, Ultimaker or Creality Ender
- Get a design that is sound and grounded in the limitations of the 3D printing process.

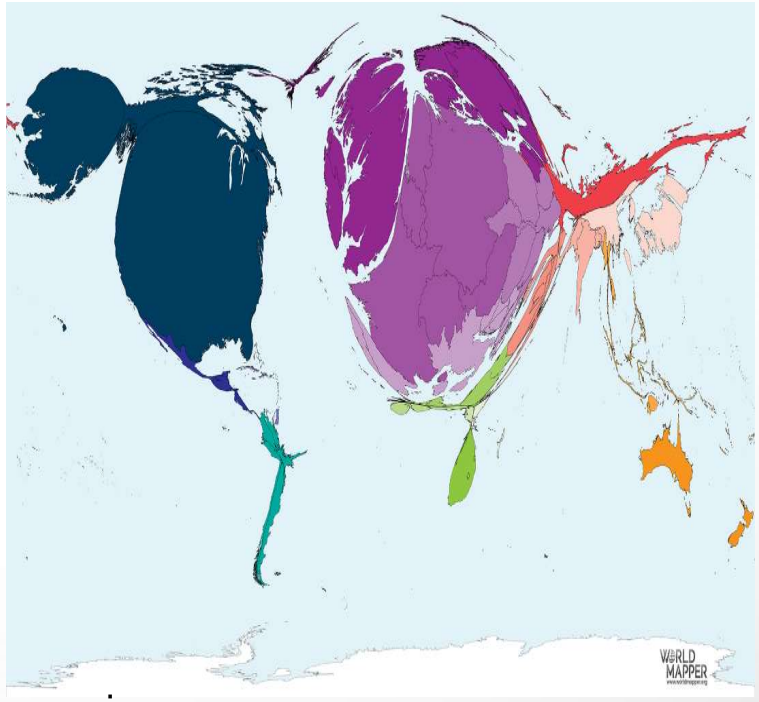


3D PRINTING IN NEUROSCIENCE?

- Far-reaching possibilities
- vast neuroscience potential .

The worthy alternative...





Self help

✚

“Education
is the most powerful weapon which you can use to

change the world”

-Nelson Mandela

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Warm Cheers & Gratitude!

3D Printing in Neuroscience...

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