# Agitation and Temperature Control of Sample Wells in Bio-Layer Interferometry

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SiPhox

# SiPhox COVID-19 Device

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## SiPhox is developing a highly scalable COVID-19 test

A single CMOS chip factory can produce enough chips to test all 7.8 Billion people monthly.

[1]

# Motivation

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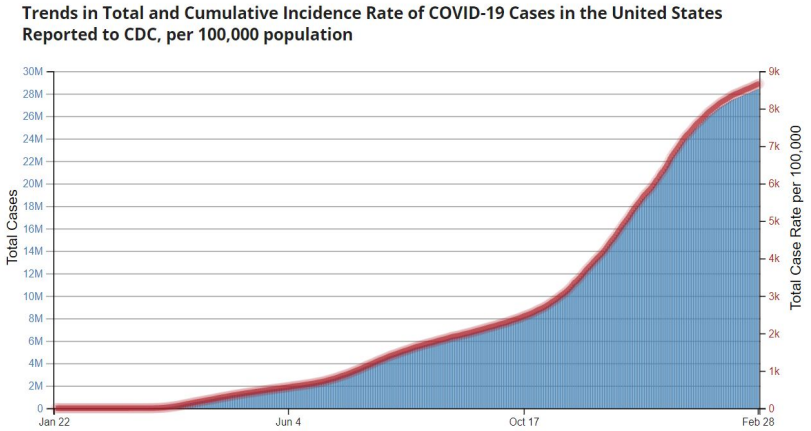
- Over 28M COVID-19 cases and 511K deaths in U.S.[3]
- Testing Benefits[5]
  - Prevents spread of infection by identifying individuals who need to isolate
  - Enables people to seek treatment earlier and prevent disability or death
- Current Diagnostic Test Methods[4]
  - Polymerase Chain Reaction (PCR) Test : detects genetic material of the virus, RNA
    - Sensitive and accurate
    - Usually not usable at point-of-care (POC)
    - Can take a few hours to a few days to return results
  - Antigen Test: detects specific proteins
    - Inexpensive, POC, fast turnaround time (15-60 min)
    - Less sensitive and accurate




Number of COVID-19 Cases in the United States [2]

# Approach

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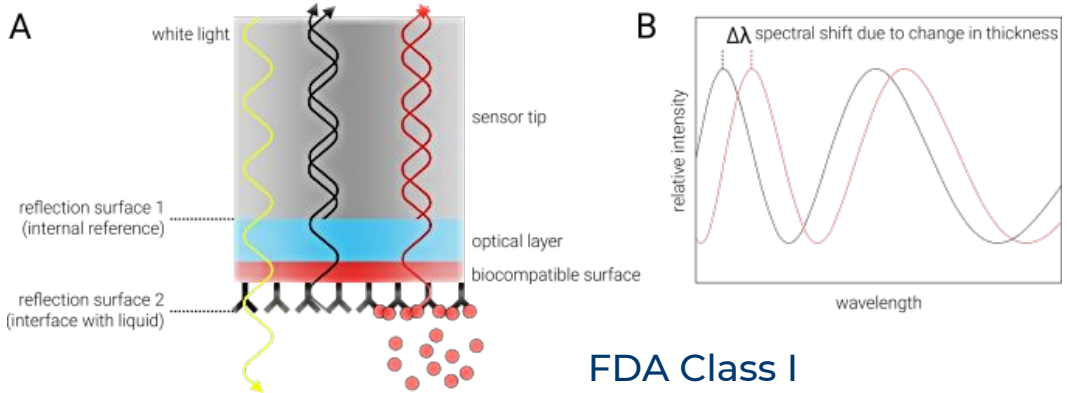
## Solution: Bio-Layer Interferometry (BLI)

- Shift in interference pattern of white light measures thickness of biological layer on biosensor tip
- Advantages[3]
  - High throughput
  - Accurate and highly sensitive
  - Fully automated
  - Excellent candidate for POC testing




FDA Class I

# Approach

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**Our Focus:** Agitation and Temperature Control Components

Our team will:

- Design a prototype that is easily alterable to test various parameters to include thermally cooling below ambient temperatures, fluid agitation, and temperature sensor accuracy.
- Use multiple thermocouples to measure the temperature at various points on the block - determine sufficient time for liquid in vials to reach optimum temperature - use a feedback loop to control the cooling elements output
- Analyze the time it takes for dye to sufficiently mix in the vials until homogenous for agitation parameter
- Determine how accurately we can measure and maintain the temperature below 20°C to desired temperature set by user.

# Design

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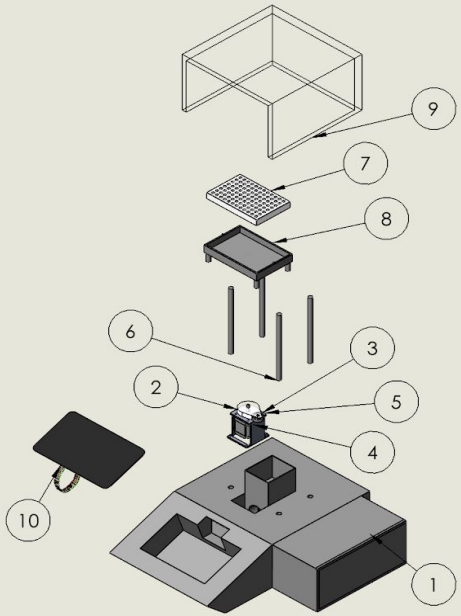


| ITEM NO. | PART NUMBER | DESCRIPTION | Material | QTY. |
|---|---|---|---|---|
| 1 | Housing Base | Weld | | 1 |
| 2 | Cam (2) | 3D Print | | 1 |
| 3 | Ball Bearing | McMaster Carr | | 1 |
| 4 | Motor | McMaster Carr | | 1 |
| 5 | Mounting Bracket | 3D Print | | 1 |
| 6 | Rubber Rods | McMaster Carr | Polyurethane | 4 |
| 7 | Temporary 96 Well Plate | Amazon | | 1 |
| 8 | 96 Well Plate Holder | Weld | | 1 |
| 9 | Cover | Assemble | Plexiglass | 1 |
| 10 | Screen and Pi | Assemble | | 1 |

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MMGS
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

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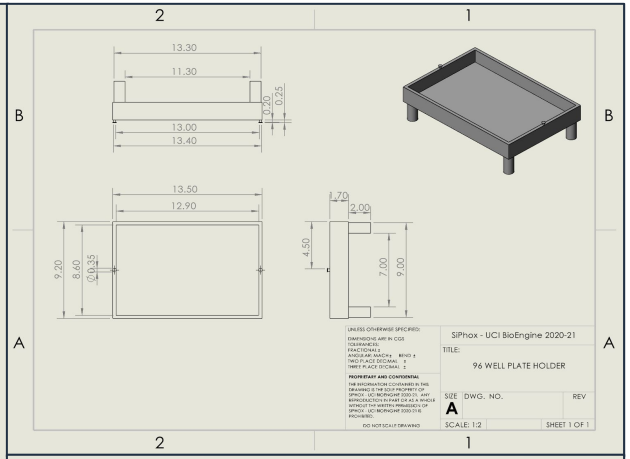
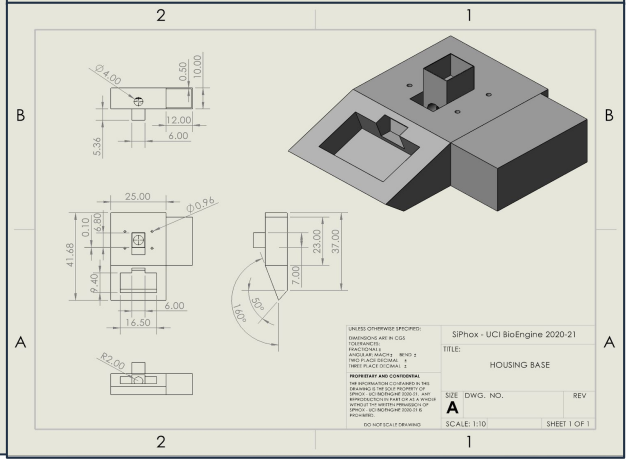
TITLE: COMPLETE HOUSING ASSEMBLY

SIZE A | DWG. NO. | REV

SCALE: 1:20 | SHEET 1 OF 1



# Design

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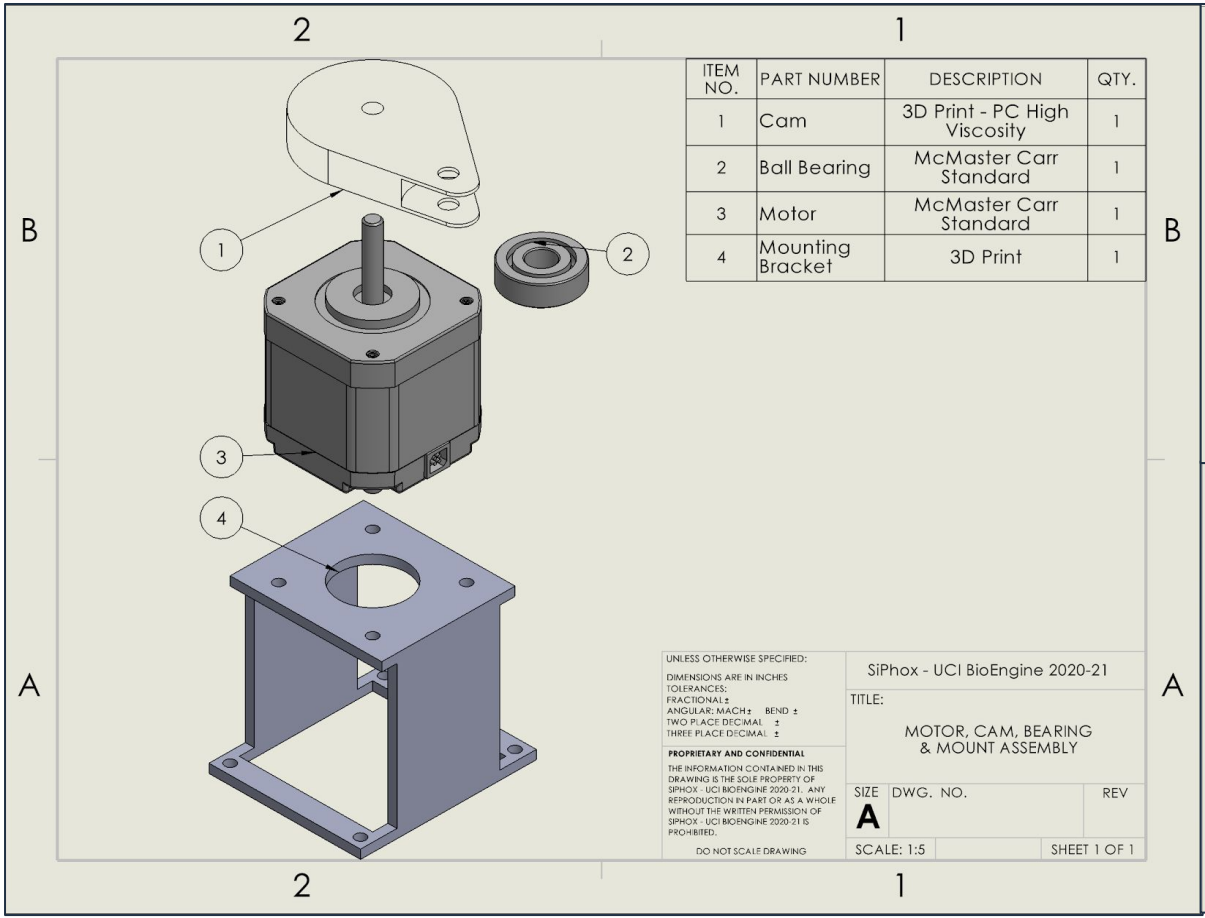


| ITEM NO. | PART NUMBER | DESCRIPTION | QTY. |
|---|---|---|---|
| 1 | Cam | 3D Print - PC High Viscosity | 1 |
| 2 | Ball Bearing | McMaster Carr Standard | 1 |
| 3 | Motor | McMaster Carr Standard | 1 |
| 4 | Mounting Bracket | 3D Print | 1 |

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±

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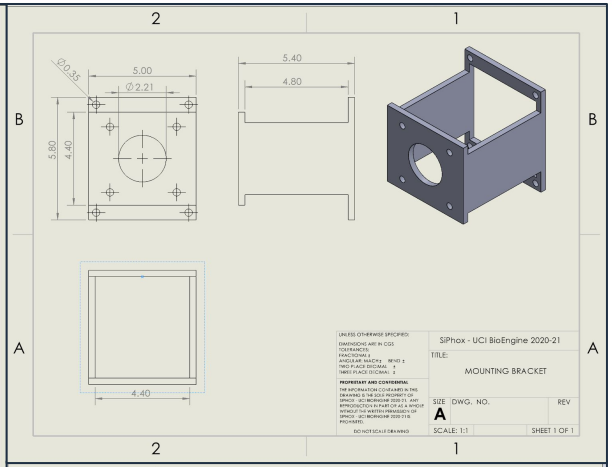
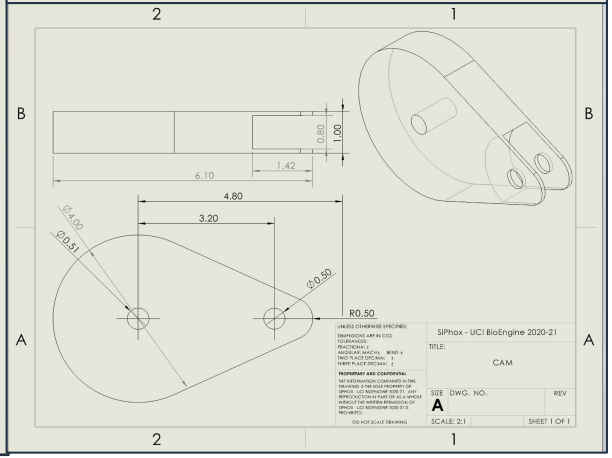
SiPhox - UCI BioEngine 2020-21

TITLE:
MOTOR, CAM, BEARING & MOUNT ASSEMBLY

SIZE A | DWG. NO. | REV

SCALE: 1:5 | SHEET 1 OF 1



# Design

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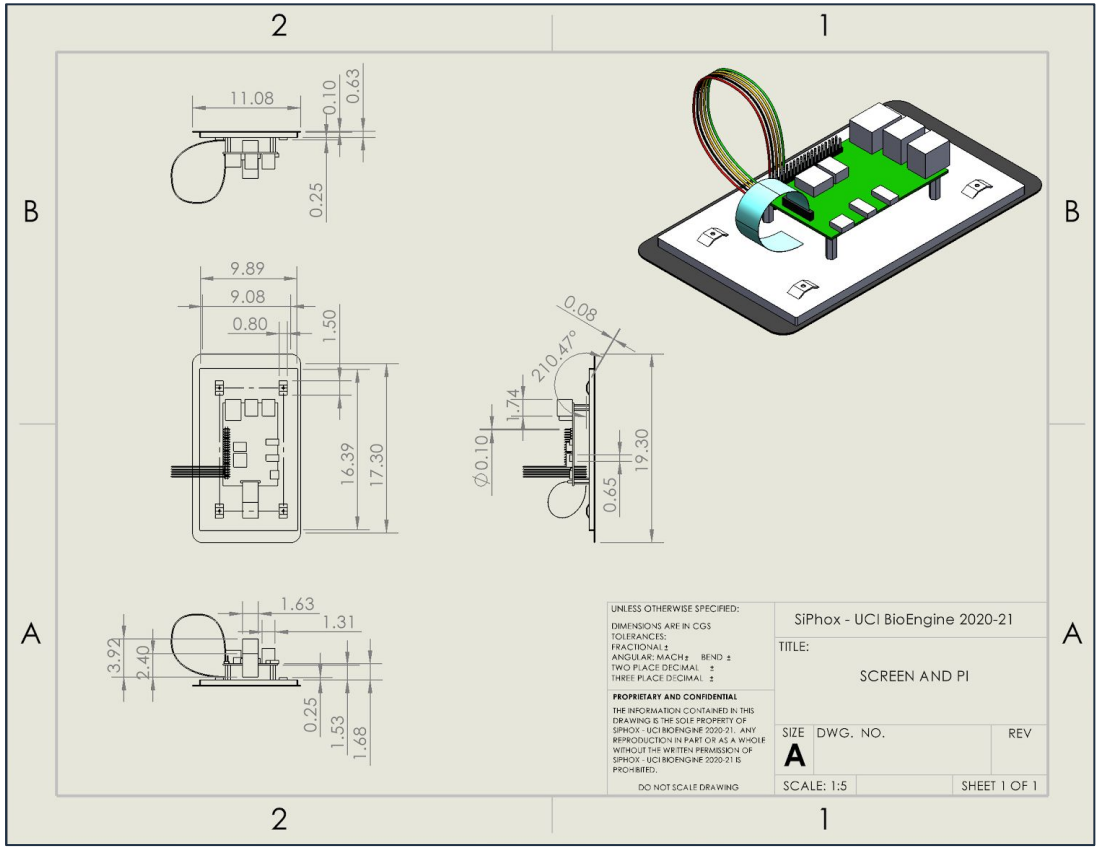


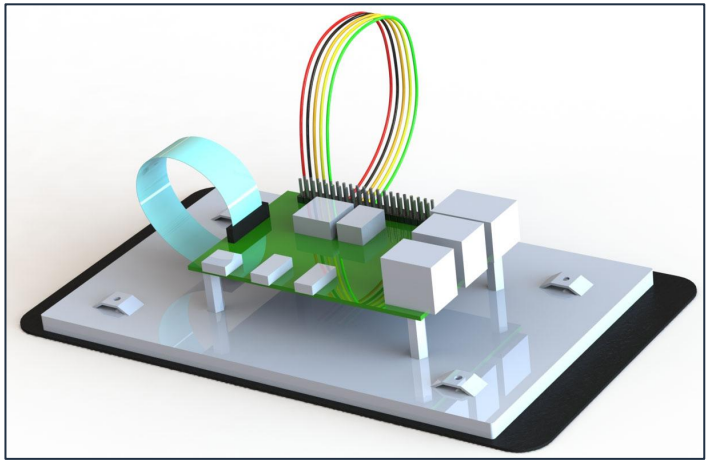

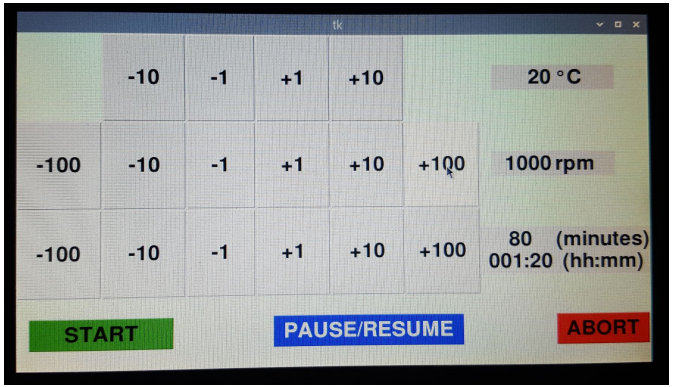

# Design Criteria

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| Design Criteria | Acceptance Criteria | Advantages | Disadvantages | Failure Mitigation |
|---|---|---|---|---|
| **Ingress Protection Rating** | IEC standard 60529: Reach an IPX4 | Water damage is less likely to occur | electrical failure build materials | Potting Silicone caulking |
| **Support Flexibility** | Allows for range of motion without fatiguing | No plastic deformation cheap | Can wear over time Potential to react | Endurance testing |
| **Over-Power Protection (IEC)** | Meet IEC standard with a properly rated and effective fuse | Prevents major electrical damage | - | Analyzing typical power draws |
| **Continuously Variable Temperature Control** | Achieves temperature precision of +- 5℃ | Increased accuracy for temperature sensitive samples | Increased set up time | Enough cooling power |
| **Complete Agitation** | Optical analysis of over 90% homogeneity | Well mixed samples are ideal for analysis | Best settings will differ from sample to sample | Optimal RPM and duration settings |

# Design Competitors

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- Opentrons - Expensive, larger scale testing devices


- Creative Biolabs - Only available for drug discovery and research lab settings

- ForteBio - Device is very heavy and not portable

# Market Strategy

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**Siphox**

- Our prototype will enable rapid development of their at-home testing device.
  - Build costs are around $1200 and can be used at medical labs nationwide
- Beyond COVID-19, the device will be able to test for other viruses using CRISPR based RNA sensing.
- Target market: Households around the world
  - Potential price point - $100

# Future Goals

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| Week: | 9 | 10 | 11 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | 3 | 3 | 3 | 3 | 3 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 6 |
| First day of week | 1 | 8 | 15 | 24 | 31 | 7 | 14 | 21 | 28 | 5 | 12 | 19 | 26 | 2 |
| Quarter: | W | W | W | S | S | S | S | S | S | S | S | S | S | S |
| **Tasks** | | | | | | | | | | | | | | |
| **Meetings with SiPhox** | | | | | | | | | | | | | | |
| **Detail Preferred Technical Solution** | | | | | | | | | | | | | | |
| **Winter Design Presentation** | | | | | | | | | | | | | | |
| **Winter Design Review Poster** | | | | | | | | | | | | | | |
| **Implement Initial Prototype** | | | | | | | | | | | | | | |
| **Review and Revise Design** | | | | | | | | | | | | | | |
| **Compile Complete Documentation** | | | | | | | | | | | | | | |
| **Prepare Slides/Poster for Final Presentations** | | | | | | | | | | | | | | |

| Tasks Key |
|---|
| Not Started |
| In Progress |
| Completed |

## Upcoming Goals:

- Finalize purchases for the prototype
- Begin physical build in Spring
- Test design criteria

[1]

# References


[1] “OneLab,” *SiPhox*. https://siphox.com/onelab (accessed Dec. 01, 2020).

[2] CDC, “COVID Data Tracker,” *Centers for Disease Control and Prevention*, Mar. 28, 2020. https://covid.cdc.gov/covid-data-tracker (accessed Mar. 01, 2021).

[3] CDC, “COVID-19 Cases, Deaths, and Trends in the US | CDC COVID Data Tracker,” *Centers for Disease Control and Prevention*, Mar. 28, 2020. https://covid.cdc.gov/covid-data-tracker (accessed Nov. 29, 2020).

[4] “How Nanophotonic Label-Free Biosensors Can Contribute to Rapid and Massive Diagnostics of Respiratory Virus Infections: COVID-19 Case | ACS Sensors.” https://pubs.acs.org/doi/full/10.1021/acssensors.0c01180 (accessed Nov. 29, 2020).

[5] “Why COVID-19 testing is the key to getting back to normal,” *National Institute on Aging*. http://www.nia.nih.gov/news/why-covid-19-testing-key-getting-back-normal (accessed Nov. 30, 2020).