

IDRC-S2PAfrica Undergraduate Studentships & SSCE Courses

# Rethinking the West African Engineering Ecosystem:

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# Connecting the Dots

2

- Fundamental idea is to connect Engineering Science the universities offer to product development and ultimately to industrial development in the West African Subregion.
  - IDRC is funding this effort in a 3-year pilot project that has facilitated the production of teaching materials, testing platforms and online delivery systems that enables us to reach students at Universities in Lagos, Ilorin, Ekpoma, Ado-Ekiti and other parts of West Africa.
  - Our effort has also revealed upstream issues that students enter universities to study engineering without necessary technical skills such as 3D solid modeling, programming and are essentially only equipped with rote learned Math and Physics.

# Interventions

3

- Upstream issues are addressed by two courses covering modeling, python programming and LaTeX with the Autodesk Fusion 360 and Microsoft Visual Studio Code and Python that are offered for 100-level undergraduates but are also accessible for senior secondary students from January 2021.
- These, in addition to regular engineering classes, prepare the students for enhancement in their vector and tensor analyses, continuum mechanics and simulation to cover, in one coherent package, the theories needed for mechanical design.

- Fusion 360 simulation added to Autodesk Computational Fluid Dynamics and similar software that help practicing engineers worldwide to design products are used as delivery vehicles for these trainings.
- The studentships that are now available are to develop the Applications Programming experience that will create a crop of undergraduates that can automate simulation scenarios that will naturally lead to design optimizations in the design of basic mechanical systems.

- Beginning with low-lying fruits in
  1. Turbomachinery (turbine design, pumps and mixers, wind generators, etc.)
  2. Energy optimization
  3. Heat exchangers and engine design
  4. Solar and other renewable systems
- Participants in this projects will create and automate simulation scenarios of models that can be optimized in the Multiphysical environments of Fusion 360 simulation and CFD

# Applications

6

- Several of these models will be available to demonstrate
  1. Theoretical underpinnings of these mechanical systems: How they work, why they work, etc.
  2. Their design and optimization. Students will prepare for international design competitions.
  3. Learn the application of modern software (simulation and design, general programming - OOP and Functional) to the modern panoply of engineering skills they need.
  4. Be industry-ready and be able to challenge themselves to react to the needs in their local space, be useful to employers of labour and be ready for graduate work

# Intellectual Property

7

- There will be a significant amount of intellectual property given to you during your training here.
  - They do NOT belong to you.
  - You are given an opportunity to share in the labour of other people that have been working on these ahead of you.
  - Some of you are actually paid a stipend while learning
  - You CANNOT claim ownership by simply adding a few lines to another person's code.
  - You are being prepared to be successful and make us proud in the things you will be able to achieve after the experience here.

# Public Domain

8

- Your work with this project will be usable to you in the public domain as it is funded work.
  - You should acknowledge resources that are given to you.
  - There are three hours of Zoom lectures each week. In addition to these you will give **six hours** a week to attending to **issues arising from the lectures, correcting code, navigating the APIs** and understanding and **practicing with simulation software**.
  - Lectures in Continuum Mechanics, augmenting these efforts continue once universities reopen. You will be given access to notes and videos for your learning.



# Cost and Reference Materials

9

- The API course is not free. It costs 10,000 Naira per month to attend the lectures and access the course materials.
- Truancy will not be tolerated. If you already know what to do, you do not need to register for the courses.
  - You cannot find the materials you are given here in the regular general Python training on the web. You will have to navigate the APIs and technical simulation manuals to get useful materials.
  - Let us know when you find the materials difficult, we will go over difficult areas if there is a request to do so.
  - Imagining that you can simply take hobbyist courses is a waste of time

# Studentships

10

- University of Lagos students - especially Systems and Mechanical students are favoured to get these studentships.
- They are reviewed every three months and you will need to re-apply.
- There are also monthly achievement goals for each awardee.
- Students from other departments, and other universities can apply. They can take our courses online and will receive the same assistance as Unilag students.

- The studentships are presently valued at 50,000 Naira per month for successful candidates.
- Those who do not win a studentship may continue in the project and can make a good case for awards in the next iteration if they can show progress.
- The Design courses are open to students, instructors and practicing engineers that can reach our materials and Zoom lectures online. Four courses are planned to start in January:

# API and Upstream Zoom Courses

12

| No | Description                                      | Level                        |
|----|--------------------------------------------------|------------------------------|
| 1  | Modeling & Design Intro: Fusion 360              | Senior Secondary & 100 Level |
| 2  | Python, Further Math, Latex                      | Senior Secondary, 100 level  |
| 3  | Python & Fusion 360 API                          | 300 Level                    |
| 4  | API & Scenario Modeling (Virtual Lab Developers) | 500 Level, PG                |

# High School and Lower-Level Students

13

- The relevant courses for the studentships are numbers 3 and 4 in the previous slide.
- Numbers 1 and 2 are to prepare students with weak backgrounds in modeling, math and programming.
- They are available to all students in all fields. These can in fact be taken by students in humanities, social, biological and medical sciences that desire to develop themselves in data analytics and modern software applications.
- We cover basic math requirements they may have missed in high school

# High School and Lower-Level Students

14

- Numbers 1 and 2 with make no assumptions beyond elementary algebra. Can therefore be taken by Senior Secondary students who want to offer further math for their SSCE.

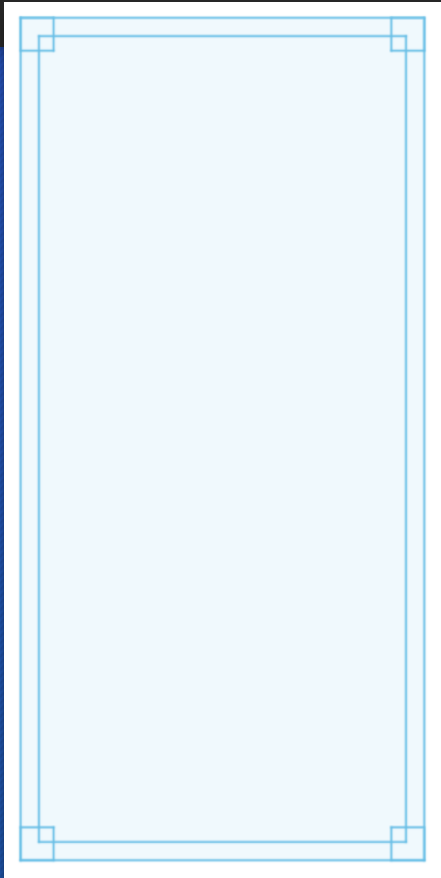
# Python & Fusion 360

15

- How much Python do you know?
  - Do you understand basic data structures such as list, set, tuple and dict?
  - Can you use them to manipulate graphical objects such as the ones that arise in the Fusion 360 API?
  - Do you understand the import system of Python?
  - Can you successfully modularize your code?
  - Do you know the meaning of types, classes, objects, functions, methods and attributes?
  - What is functional programming? Lambda and anonymous functions?
  - What is Object-Oriented Programming?

# Fusion 360

16



- Beyond playing around with the Fusion 360 GUI, are you able, for example, to write a Python program that can identify or count the closed profiles in the sketch here?
- Count the close profiles?
- Can you programmatically select a particular profile, any of them, or a combination of them for a solid operation such as extrusion?

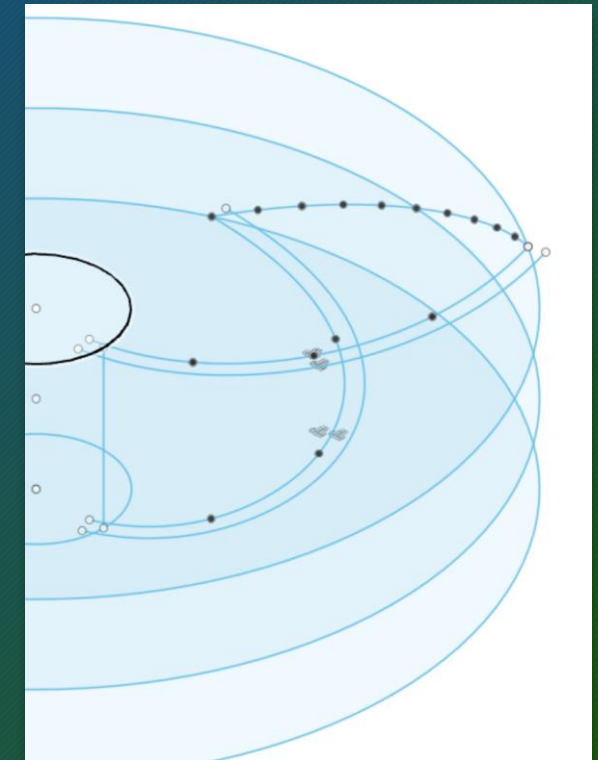
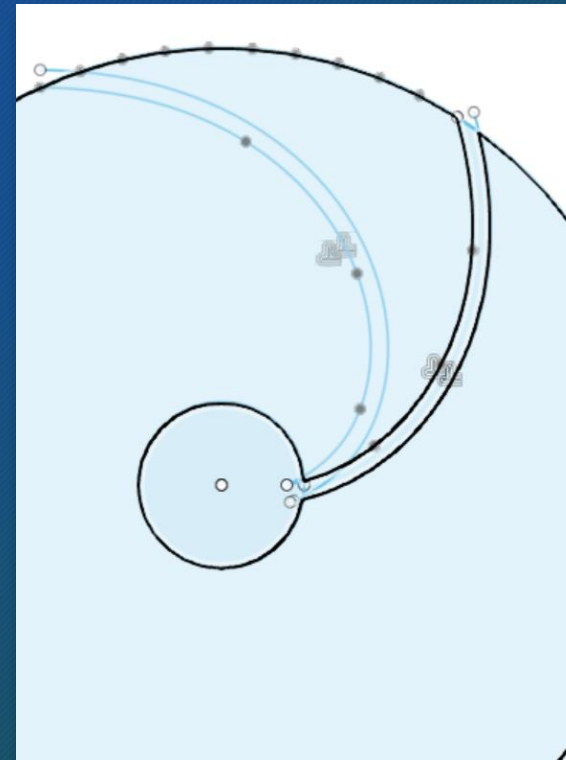


```
def areaProps(pal):
    areaList = []
    for prof in pal.profiles:
        areaProps = prof.areaProperties(adsk.fusion.CalculationAccuracy.MediumCa
        # Get area
        area = areaProps.area
        # Get centroid
        centroid = areaProps.centroid
        # Get perimeter
        peri = areaProps.perimeter
        # Get angle of rotation of the principal axes
        rotPrin = areaProps.rotationToPrincipal
        # Accuracy
        acc = areaProps.accuracy
        areaList.append((area, centroid, peri, rotPrin, acc, prof))
    return sorted(areaList, key = itemgetter(2), reverse = False)
```

# Programmatic Lofting

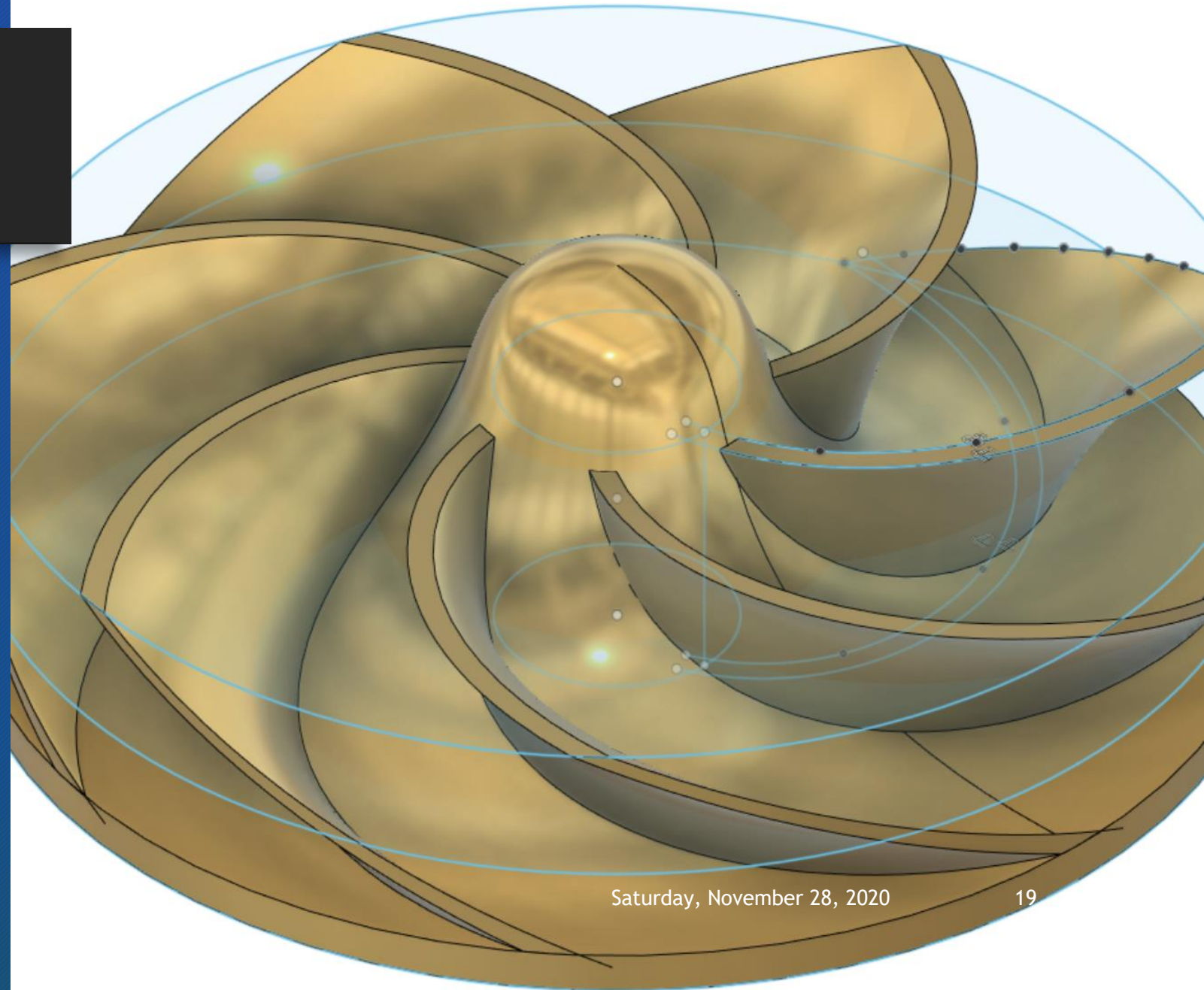
18

- Consider the problem of selecting the lofting profiles in the impeller diagrams here:
- How do you write your Python code to distinguish the correct lofting profiles in order to obtain



# Impeller

- Program in such a way to include various scenarios of blade number, angular orientation, tilt and turning for an optimal Impeller
- Scenarios for Computational Fluid Dynamics Simulation



# Python Issues



Do you know what function or object decorators are?



Do you understand the class hierarchies of Python and what virtual functions are?



What is polymorphic programming? Do you know the difference between early and late binding? Which one is done in Python and how does that affect the identifiers or variables you use?



What distinguishes Python from other popular OOP languages such as Java, C# and C++

# Course #3

21

- Several of these issues have been covered in course #3 that we shall offer again in January.
- If you want in on the advanced API modeling, Simulation Scenarios and Virtual Laboratories that we are planning for January, you will need to do the following:

# Prerequisites

22

- Continuum Mechanics
  - The 300 and 400 level courses have been offered. The materials are free on our website [lms.s2pafrica.com](https://lms.s2pafrica.com)
  - If your Python is not meeting to the preliminary standard, you may want to take a crash course of twelve lectures and tutorials available at a cost on our website.
  - If you choose to join in January then your advanced course will have to wait till March.

# Workflow example

23

# COVID Door Opener

- Simple design for COVID door openers
- Open a door without touching the handle!
- Design, simulate and optimize for printing on a 3D printer.

