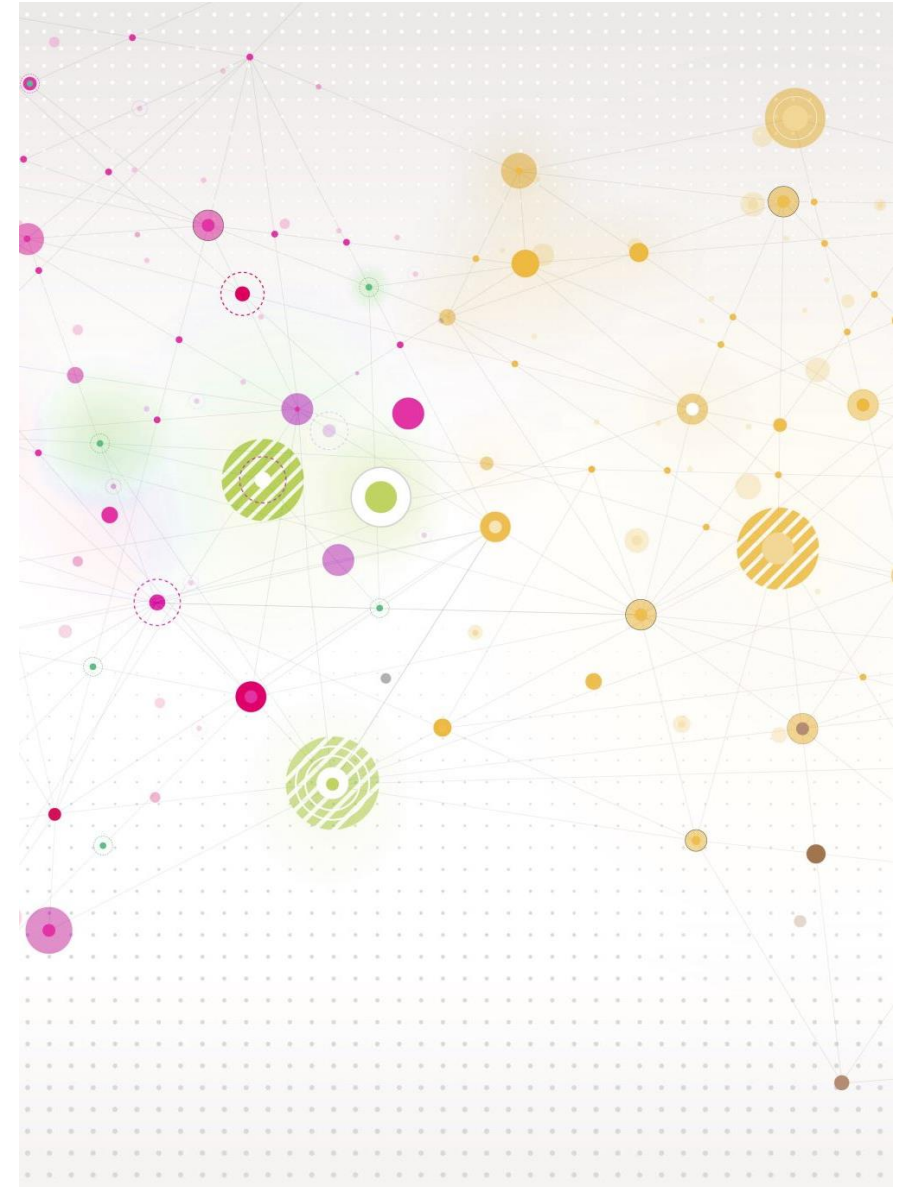


# Why academics should happily embrace Generative Artificial Intelligence Systems: An Engineering Case study.

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# Outline

1. What are Generative Artificial Intelligence Systems (GAIS)?
2. Techno-utopians and Techno-pessimists
3. Pedagogy of AI in teaching and learning
4. GAIS: An Engineering Case Study: Erosion Damage of Turbine blades
5. Specific uses of AI in higher education in the Case Study
6. Futuristic Uses of AI in HEI as identified by ChatGPT itself
7. Conclusions

# What are Generative AI Systems

Generative Artificial Intelligence Systems (GAIS) are a **class of AI** models involved with the **creation of digital contents** such as **text-based compositions, music compositions**, and **images** without reliance on human authors/creators.



ChatGPT



DALL·E 2



MidJourney



# Partisan groups of AI users



The techno-utopians believe that AI is going to revolutionize everything including higher education.

Techno-pessimists have very fatalistic and catastrophizing disposition to AI seeing it as possibly going to negatively disrupt education and degrade the quality of graduates from our institutions



# Pedagogy of AI in Learning & Teaching



- Pedagogy of GAIS in teaching, learning and assessment is at its infancy due to from the recency of the AI revolution.
- Earliest research of AI in L&T is in form of multi-media assisted pedagogy (MMAP) (Eva Dobozy, 2007).
- MMAP will certainly impact the way higher education evolves.
- There is a worrying prevalence of positive and negative assumptions to the pedagogic impact of AI on teaching and learning
- These assumptions have not been critically and scientifically examined: a position that Kirkwood and Price (2013) insist is highly detrimental to the tuition in higher education.



A man in a grey suit and blue tie is shown from the chest up, holding a large gear with a brain icon inside. The background is a dark blue digital interface with various icons, gears, and text. The text "ARTIFICIAL INTELLIGENCE" is prominently displayed in a large gear. Other gears contain icons like a bar chart, a person, and binary code. The overall theme is artificial intelligence and engineering.

**ARTIFICIAL  
INTELLIGENCE**

# **GAIIS: An Engineering Case Study**



# Case Study: Erosion Damage of Turbine blades

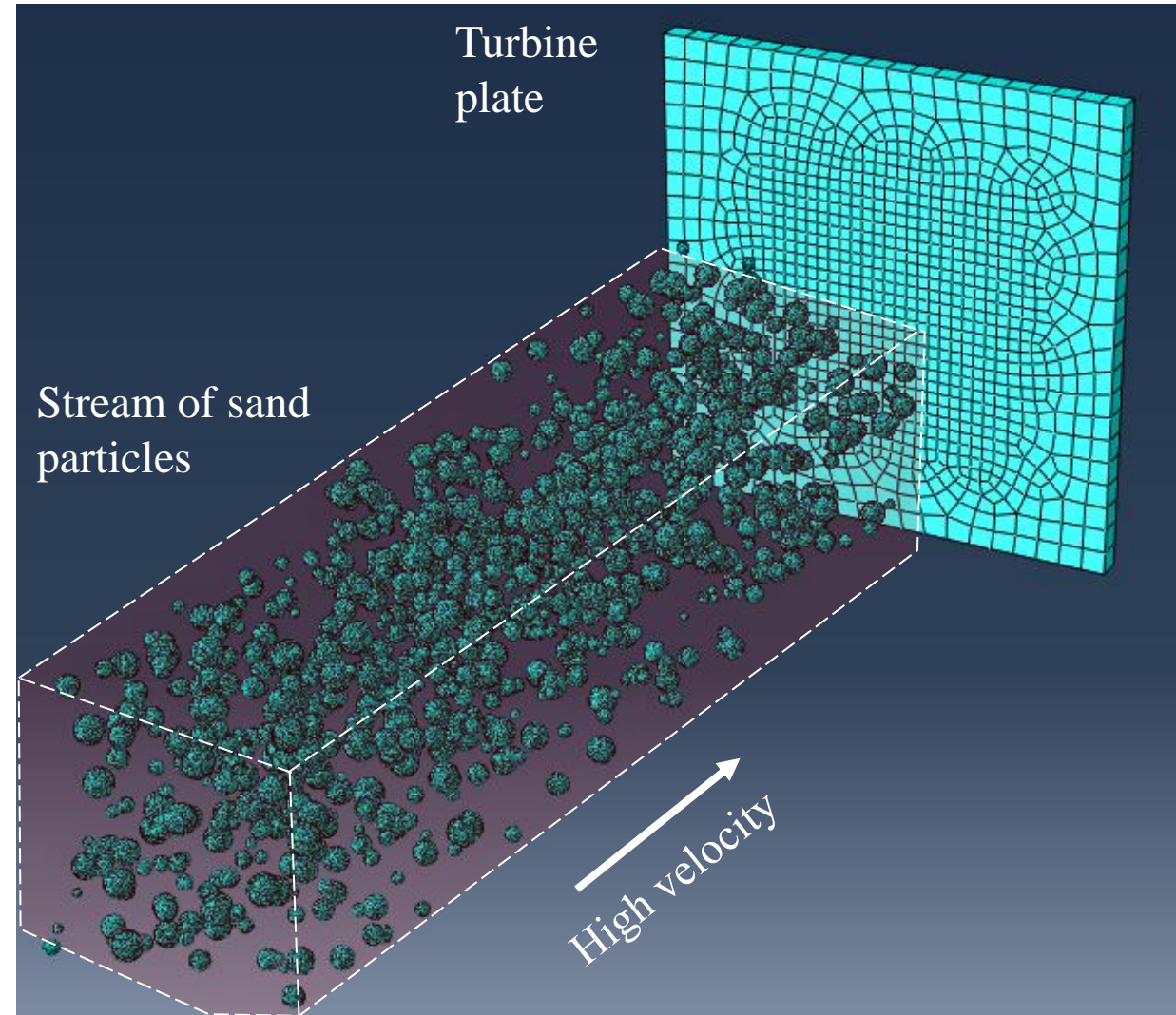
## Description of Problem

### Aim:

To assess wear/erosion damage due to high velocity impact of sand/rock particles on a wind turbine plate.

### Tasks:

1. Automate creation of sand particles randomly distributed in the stream
2. Create various particle stream profiles
3. Create a numerical framework for the assessment so you can do more studies to check effect of model parameters of prediction of damaged area.



# Case Study: **Outlining of Project in ChatGPT**

1

The user asks ChatGPT detailed questions about the proposed project and ask for it to outline steps required to take to start and complete the project

Y

I am a mechanical engineering student undertaking a research master's degree. The title of my project is "Developing a numerical framework for the assessment of sand erosion effects in wind turbines." I am considering using Abaqus alongside Python scripts to generate random sand particles impacting a sheet of material to investigate the erosion that may occur. how should I go about working on this?



# Case Study: Outlining of Project in ChatGPT

## Outlining of Project in ChatGPT

1



Your research topic is quite interesting and complex. Developing a numerical framework for the assessment of sand erosion effects in wind turbines could provide important insights into the durability and maintenance of these important energy structures.

Here's a general outline of how you might proceed:

### 1. Literature Review:

Before starting with any practical work, it's important to carry out a detailed literature review to understand the current state of research in your area. Look for articles on wind turbine erosion, sand particle simulation, and the use of Abaqus and Python in such research. You should also look for existing models of sand erosion that you can use or adapt for your project.

### 2. Understand and Define the Problem:

Understand the physics of the problem you are dealing with. In this case, you need to know how sand particles interact with turbine materials, which depends on the material properties and the speed, size, and angle of sand particles when they hit the turbine.

### 3. Develop a Computational Model:

You will be developing a computational model to represent the physical problem you defined in step 2. This step includes setting up the governing equations, boundary conditions, and initial conditions.

### 4. Simulation using Abaqus and Python:

Abaqus is a powerful software used for finite element analysis. Here are the general steps:

- **Pre-processing:** Define the geometry of your model (the wind turbine blades), apply material properties, and set up the initial and boundary conditions.
- **Meshing:** Mesh the geometry. The quality of your mesh can affect the accuracy of your results, so make sure you have a high-quality mesh.
- **Solve:** Define the sand particles as a cloud impacting the blade at different speeds and angles. You can define these sand particles using a discrete element method (DEM) or a smoothed-particle hydrodynamics (SPH) method, both of which Abaqus supports. Run your simulation.
- **Post-processing:** Analyze the results, look at the deformation, stress distribution, etc.

You can use Python alongside Abaqus to create scripts for repetitive tasks, parameterize your model, and analyze your results.

### 5. Validate your Model:

It's crucial to validate your model to make sure it accurately represents reality. You can do this by comparing your simulation results with experimental data or with the results of other validated models from the literature.

### 6. Perform the Study and Analyze the Results:

Once your model is validated, you can perform your study. This might involve running simulations with different parameters (e.g., different sand particle sizes, different wind speeds, etc.) to understand how these factors affect the erosion of the wind turbines. Analyze and interpret your results in the context of the problem you're studying.

# Case Study: Search for Relevant Papers in study area

Y

name a few research papers that study the erosion of wind turbine blades

3



As an AI developed by OpenAI, I don't have direct access to databases of individual research papers, hence I cannot provide exact names of papers. However, as of my last training cut-off in September 2021, here are the topics and author information from notable papers related to your field of interest:

1. "Modelling of Raindrop Erosion on Wind Turbine Blades" - Authors: Graham, J. M. R., Xiao, Q., and Linton, C. M. (Journal of Physics: Conference Series)
2. "Erosion of wind turbine blade material by atmospheric particles" - Authors: Keegan, M. H., Nash, D. H., and Stack, M. M. (Journal of Physics D: Applied Physics)
3. "Sand Erosion of Wind Turbine Blades and the Influencing Parameters—A Review of the Current State of Knowledge" - Authors: Song, W., Hu, Y., Tian, X. (Energies)
4. "Erosion Testing of Wind Turbine Blade Materials: A Review of Methods, Progress and Remaining Challenges" - Authors: Nijssen, R. P. L. (Energies)

# Case Study: Creation of Sand particle stream

2

The user now wants to focus on creating Sand particle streams and asks ChatGPT for some insight into the problem.

Y

How would I create a simulation which would include a sandstorm made up of randomised sand particles?





# Case Study: Creation of Sand particle stream

2



Creating a realistic simulation of a sandstorm that includes randomised sand particles can be a complex process. You would have to consider several factors, such as the size, speed, and direction of each sand particle.

Here is a step-by-step process of how you could achieve this:

## Step 1: Define the parameters of your simulation

First, you need to define the parameters of your simulation. This includes the area of the wind turbine that you want to simulate (e.g., a single blade), the duration of the sandstorm, the average speed and direction of the sandstorm, and the distribution of sand particle sizes.

## Step 2: Create a model of your wind turbine in Abaqus

Abaqus is a software for finite element analysis that you can use to create a detailed 3D model of the wind turbine or the part of the turbine you want to simulate. This includes the geometry of the turbine, the material properties, and the boundary and initial conditions.

## Step 3: Generate the randomised sand particles

To simulate a sandstorm, you need to generate a large number of randomised sand particles. Each particle should have its own size, speed, and direction. You can generate these values using Python, based on the parameters you defined in Step 1.

Here's an example of how you might generate these values for each sand particle:

- **Size:** You can use a statistical distribution (like a log-normal distribution) to generate random sizes for each sand particle. The parameters of this distribution (mean, standard deviation, etc.) can be determined from experimental data or from literature.
- **Speed:** Similarly, you can use a statistical distribution to generate random speeds for each sand particle. The average speed should correspond to the speed of the sandstorm.
- **Direction:** The direction of the sand particles can be randomized within certain limits. For example, if the sandstorm is coming from the west, most of the sand particles should also be coming from the west, but with some variability.

## Step 4: Input the sand particles into Abaqus

Once you have your randomised sand particles, you can input them into Abaqus. One way to do this is to represent each sand particle as a discrete particle in a particle-based method, like the discrete element method (DEM) or the smoothed-particle hydrodynamics (SPH) method. You can use Python scripts to automate the process of inputting the sand particles into Abaqus.

## Step 5: Run the simulation

After you've set up your model and input the sand particles, you can run the simulation in Abaqus. During the simulation, the software will calculate the impact of each sand particle on the wind turbine, based on the size, speed, and direction of the particle and the material properties of the turbine.

## Step 6: Analyse the results

After the simulation has finished, you can analyse the results. This includes looking at the erosion patterns on the wind turbine, the amount of material that has been eroded, and the locations of maximum erosion.

This process provides a high-level idea of the steps you could take to create a simulation of a sandstorm with randomised sand particles. The exact steps might vary depending on the specifics of your project and the capabilities of your software.

# Case Study: Creation of Sand particle shape

4

The user now focuses on creating exact geometry of sand.

Y

how would i go about creating a polyhedral in abaqus



Creating a polyhedral geometry in Abaqus, a popular finite element analysis (FEA) software, can be done using the following steps:

1. Start Abaqus/CAE:

Launch the Abaqus/CAE software on your computer, and create a new model database or open an existing one.

2. Create a new part:

Go to the Model Tree in the left panel, right-click on 'Parts', and select 'Create'. In the 'Create Part' dialog box, specify the part's name and type (3D, deformable, or discrete), and select 'Polyhedral' as the base feature shape.

3. Define the polyhedral geometry:

In the Sketcher, you can define the polyhedral geometry by creating vertices, edges, and faces.

a. Create vertices:

Use the 'Create Point' tool to create vertices by specifying their coordinates in the sketch plane or by clicking on the desired locations.

b. Create edges:

Use the 'Create Line' tool to create edges by clicking on two vertices in the sketch plane.

c. Create faces:

To create a face, select the 'Create Face' tool, and then select the edges surrounding the face in the sketch plane. The order in which you select the edges is important, as it determines the orientation of the face.

4. Create the solid:

Once you have defined the polyhedral geometry, exit the Sketcher, and Abaqus/CAE will automatically create the polyhedral solid.

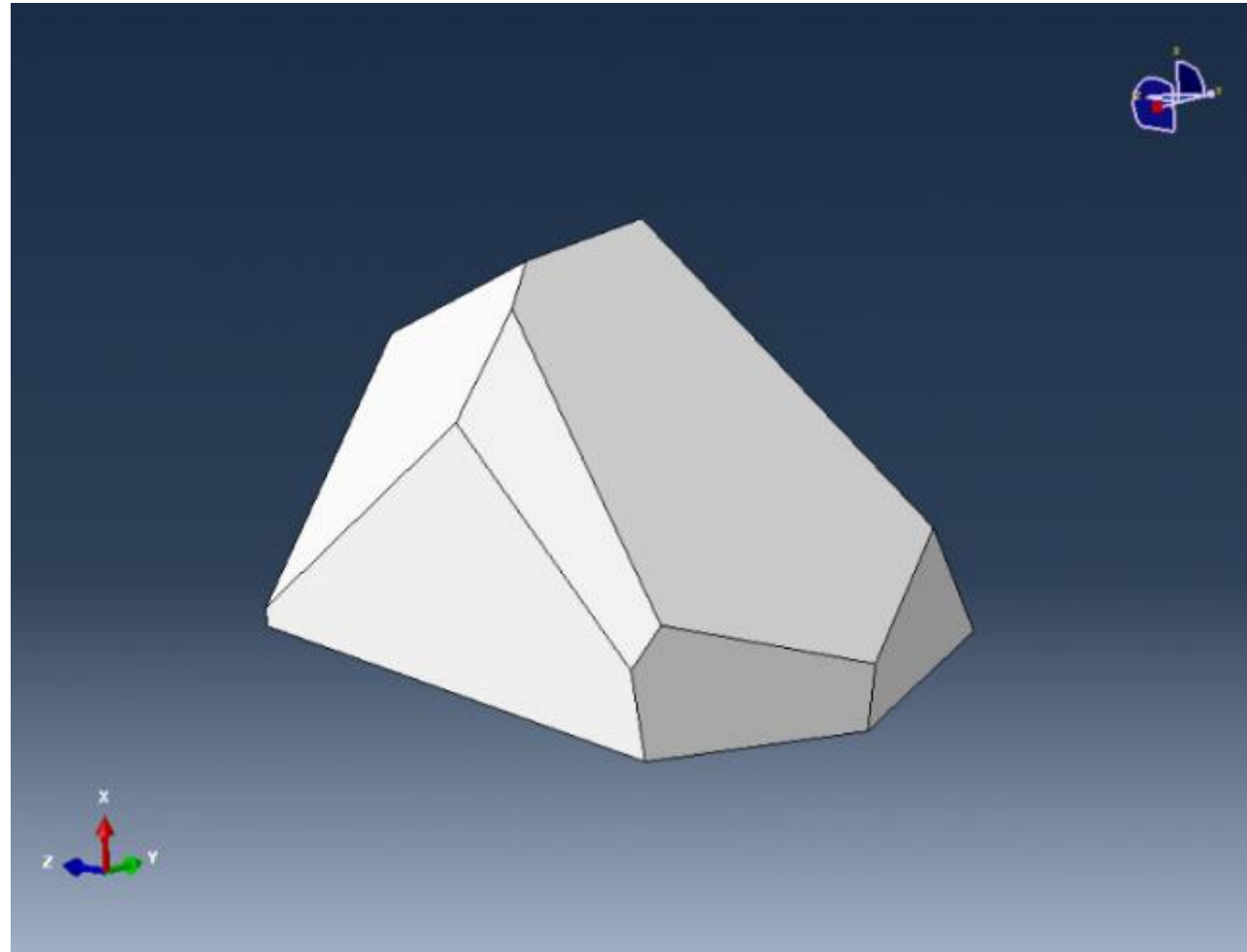
5. Define material properties and section assignments:

Go to the Model Tree, and under 'Materials', create a new material by specifying

# Case Study: Creation of Sand particle shape

4

The user will be able to generate this typical shape of sand.





# Case Study: Code development and debugging

5

The user works with ChatGPT to develop and debug his code

Y

Abqaus said I have a syntax error. Can you spot it?

```
for m in range(0,len(Sphere_Radius_Coor)):
```

```
    a = mdb.models[Model_name].rootAssembly
    p = mdb.models[Model_name].parts[name]
    a.Instance(name = Instance_Silica, part=p, dependent=ON)
#####
```



Yes, I can spot the syntax error in the provided code. It appears that there is a closing parenthesis ")" missing at the end of the `a.Instance()` line. Here's the corrected code:

python

Copy code

```
for m in range(0, len(Sphere_Radius_Coor)):
    a = mdb.models[Model_name].rootAssembly
    p = mdb.models[Model_name].parts[name]
    a.Instance(name=Instance_Silica, part=p, dependent=ON)
```

Please note that I assumed the variable names `Model_name`, `name`, and `Instance_Silica` are defined properly elsewhere in your code.

# Case Study: Creation of sand particle streams

6

It was necessary to create different sand particle streams. ChatGPT was asked for support in developing these code snippets.

Y In my particle generation code, I use a cuboid to house the sand particles can you change it into a pyramid? Only edit parts that are necessary.

```
from mesh import *
from optimization import *
from job import *
```



To change the cuboid container to a pyramid container, you need to modify the code that generates the particles within the container. Here, I've made the necessary changes to your code:



1. Replace the following lines:

```
python Copy code
X_Strat = 0.0
X_End = 8.0

Y_Strat = 0.0
Y_End = 2.0

Z_Strat = 0.0
Z_End = 2.0
```

with:

```
python Copy code
X_Strat = 0.0
X_End = 8.0

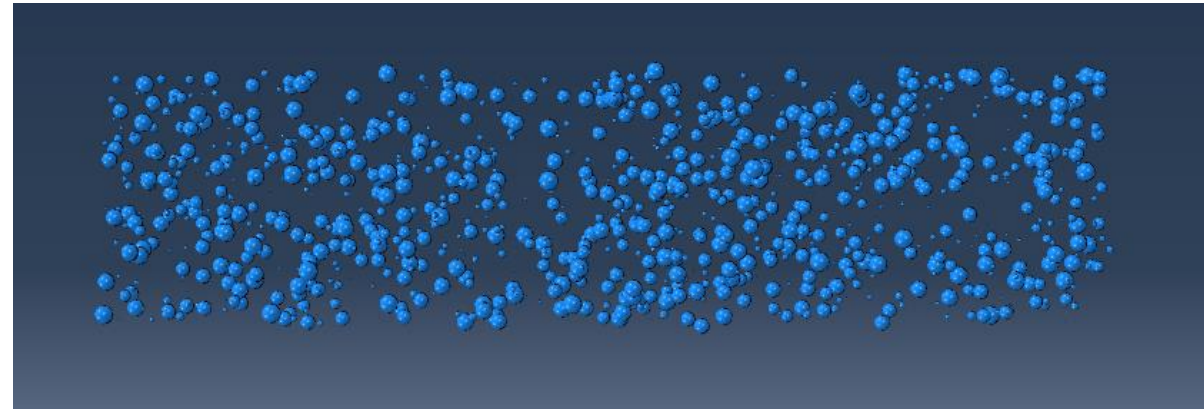
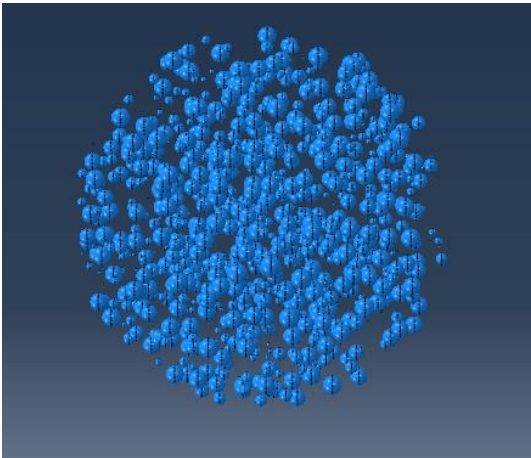
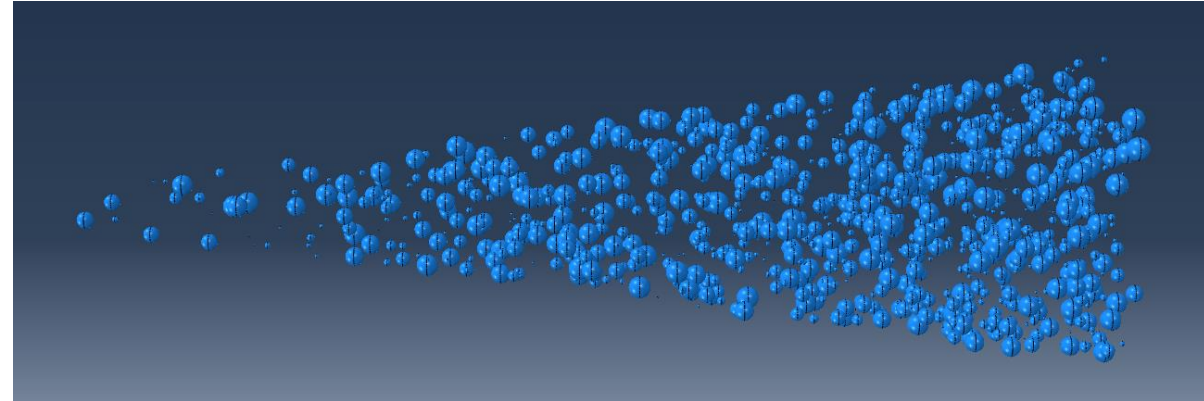
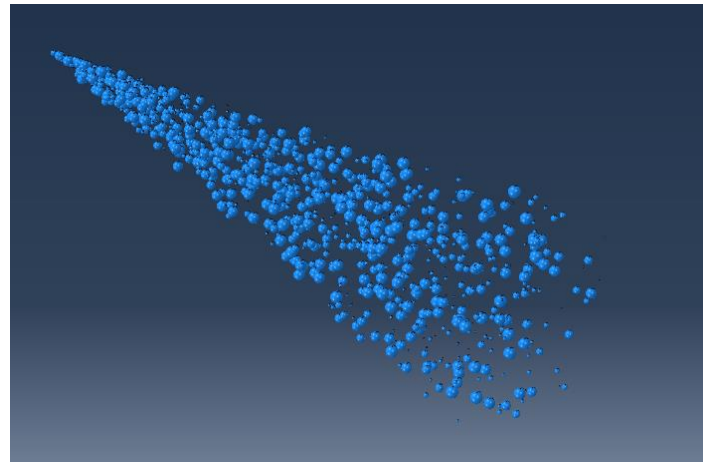
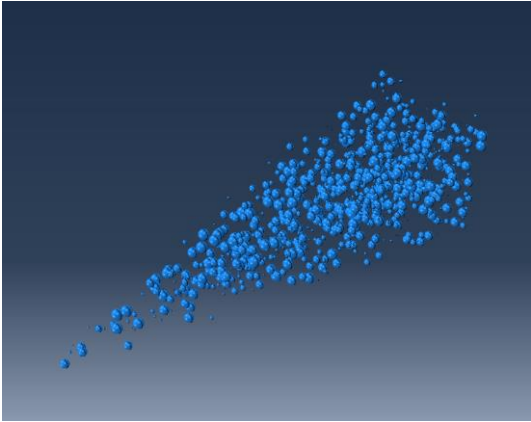
Y_Strat = 0.0
Y_End = 8.0

Z_Strat = 0.0
Z_End = 2.0

Height_Pyramid = 2.0
```

# Case Study: Creation of sand particle streams

6 Here are examples of particle streams created with the aid of ChatGPT. The user of course had to modify things further.





# **Specific uses of AI in the Case Study**

- a) Enhancing independent learning of concepts
- b) Enablers of research and literature Reviews
- c) Virtual Professor
- d) Development and debugging of computer codes
- e) Question bank generator

# Futuristic Uses of AI in HEI by ChatGPT

- 1. "Personalized learning:** AI can analyse individual student data and provide personalized learning experiences tailored to their needs and preferences.
- 2. Student support services:** AI chatbots and virtual assistants can assist students with queries and provide support services such as academic counselling, mental health support, and financial aid advice.
- 3. Intelligent tutoring systems:** AI-based tutoring systems can provide individualized feedback and support to students, helping them to improve their learning outcomes.
- 4. Automated grading:** AI algorithms can be trained to grade assignments and assessments, reducing the workload of educators, and providing more consistent grading.

# Futuristic Uses of AI in HEI by ChatGPT

- 5. Data analysis and decision-making:** AI can be used to analyse large amounts of data to inform decision-making processes in higher education institutions, such as admission policies, curriculum design, and resource allocation.
- 6. Course recommendation systems:** AI algorithms can recommend courses and degree programs based on students' interests, academic backgrounds, and career goals.
- 7. Predictive analytics:** AI can analyse data to predict student outcomes and identify at-risk students who may need additional support or intervention.
- 8. Collaborative learning:** AI-powered collaboration tools can facilitate teamwork and communication among students and educators, enhancing the learning experience.
- 9. Campus management:** AI can assist in managing campus resources and facilities, such as scheduling classrooms and maintaining equipment."

# Conclusion

- This paper has presented some current and futuristic used cases of ChatGPT as an enabler of learning, teaching, and assessment of STEM-based courses.
- The researchers have used as a case study the engineering discipline, especially under computational modelling specialisation.
- The work concludes that the higher education is on the cusp of the most revolutionary changes and AI will continue to play an increasingly key role in influencing how we relate, teach, assess, and reward students' efforts in higher education.
- The Engineering case study shown here should provide some confidence to AI techno-pessimists in shaping how the interaction of AI with players in the higher education sector.