Electromagnetic Virtual Playground

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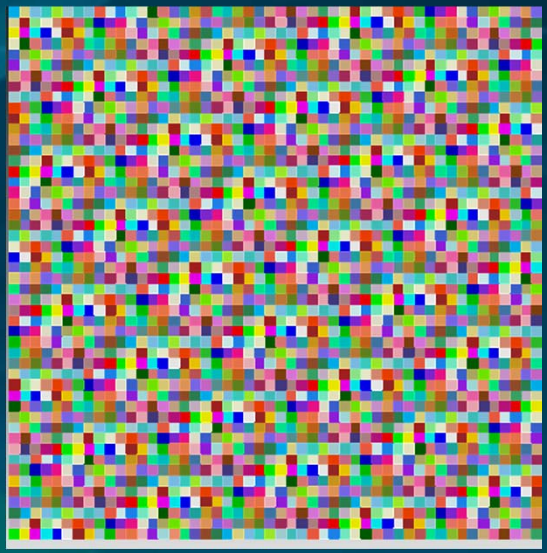
VIP Vertically Integrated Projects

BACKGROUND

The goal of this project is to design and implement an Electromagnetic (EM) Virtual Playground which visualizes the generation, propagation, and interaction of EM waves with environments. In any given spatial environment, the electromagnetic waves present are often randomly dispersed and near impossible to fully measure. Just like the distribution of pores in a sponge, the pores tend to overlapping in places. We plan to use this virtual playground to factor in for the randomization and dispersion of most of the waves in the given environment.

PRODUCT DESCRIPTION

The need of this experiment is the generation of randomized ellipsoids within the given area to allow users to conduct virtual experiments with different experimental setups, such as different sources, materials, and geometries, and perform simulations to monitor and visualize the process of EM phenomena such as antenna radiation, wave scattering and diffraction.



A sample simulation of a randomized field 2D checkerboard with the basis of non-overlapping squares

DESIGN REQUIREMENTS

- Trelis 16.1 - Mesh Generation Software
- LAPTOP - 1

Constraints

- Environmental: Code tampering with the surrounding particles in any given environment.
- Socio-Cultural: The customers may not be accustomed with the software being used to simulate the program.
- Compliance: The tool should be used for educational purposes only. Commercial or malicious use is prohibited.

Individual Ideas

Trelis 16.1

- a very advanced commercial-grade meshing software that is widely used within CFD and FEA simulations
- allows us to mesh in three dimensions, making it a very powerful tool for the purpose of our project

Individual Ideas

MATLAB

- a user-friendly multi-paradigm programming language and computing environment developed by Mathworks
- allows matrix manipulations, plotting of functions and data, creation of user interfaces, and interacts with external interfaces to allow the use of other programming languages
- allows for flexible creation of a uniform distribution code as it allows us to get input from other programming languages and then apply it into a random integer generator “rand ([R1 R2],N,1)”, where R1 & R2 are a range of integers, and N is the number of integers

Individual Ideas

Ansys

- an extremely powerful 3D design software that is capable of many different things
- possesses highly intelligent & automated meshing capability that make it very easy to arrive at a plethora of different multiphysics solutions
- generation of randomized ellipsoids can likely be carried out in the three-dimensional plane, but there might be some slight trouble obtaining a license for the software

Individual Ideas

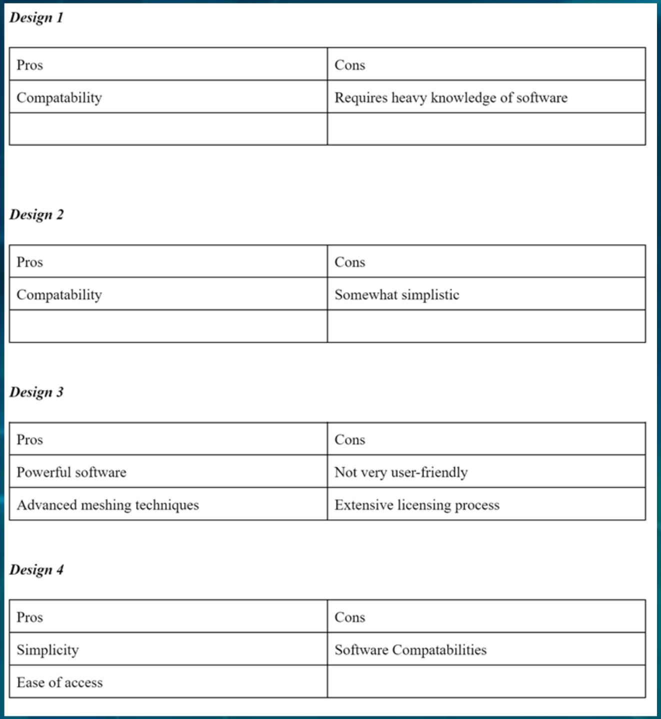
Anaconda/CAD

- Anaconda has data science applications and by creating a code that will generate objects inside of another object while keeping those particles from touching or overlapping, compiling that code on Anaconda, and then applying it to CAD to see how EM waves can be represented in a 3D rendering

First Decision Matrix

	Certification	User-Friendliness	Compatibility	Total
Trelis 16.1	6	5	8	19
MATLAB	8	7	6	21
Ansys	5	3	8	16
Anaconda	7	5	4	16

Pros and Cons



Design 1

Pros	Cons
Compatability	Requires heavy knowledge of software

Design 2

Pros	Cons
Compatability	Somewhat simplistic

Design 3

Pros	Cons
Powerful software	Not very user-friendly
Advanced meshing techniques	Extensive licensing process

Design 4

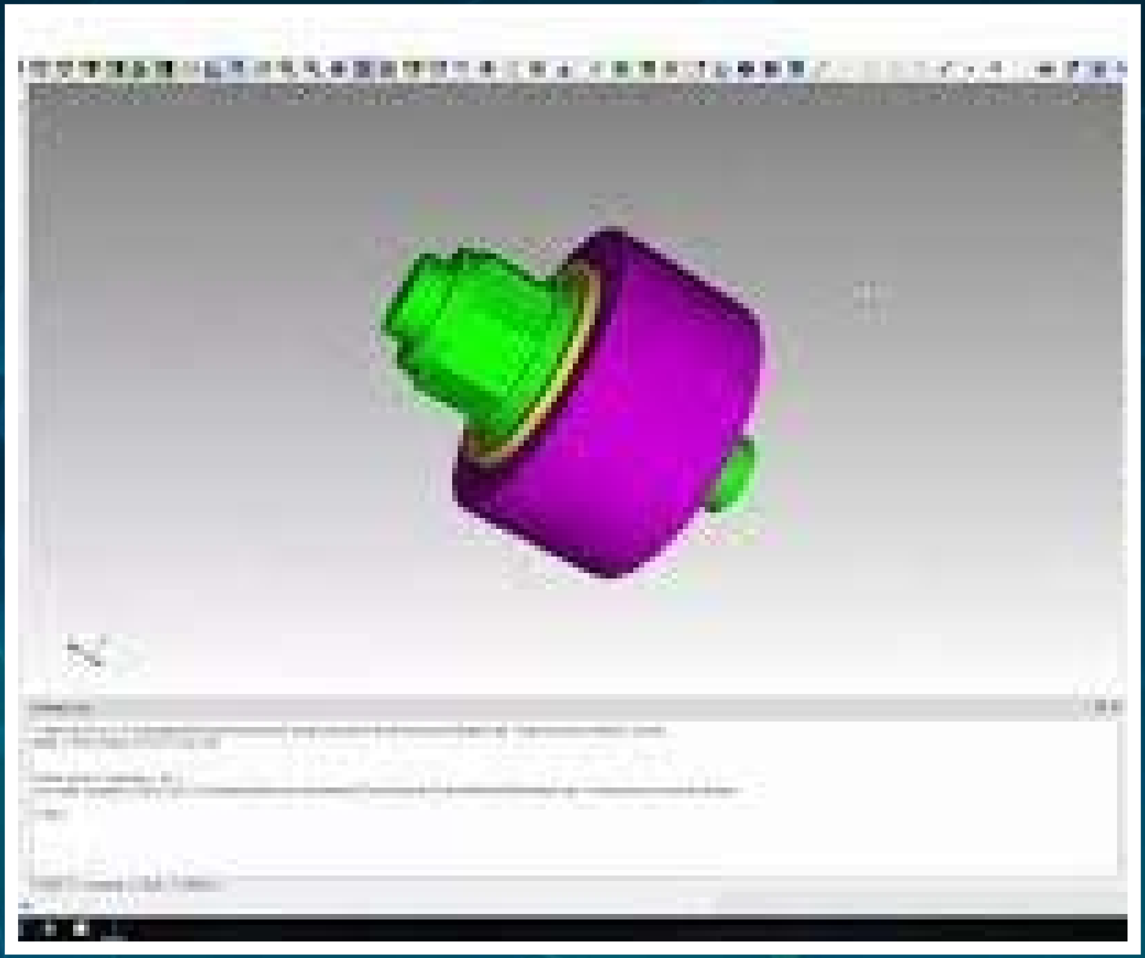
Pros	Cons
Simplicity	Software Compatabilities
Ease of access	

FAVORED DESIGN 1

TRELIS 16.1

Pros: Most compatible solution idea with the work at hand and cost-friendly

Cons: Requires heavy knowledge of the software (with at least a base knowledge of the Python programming language.

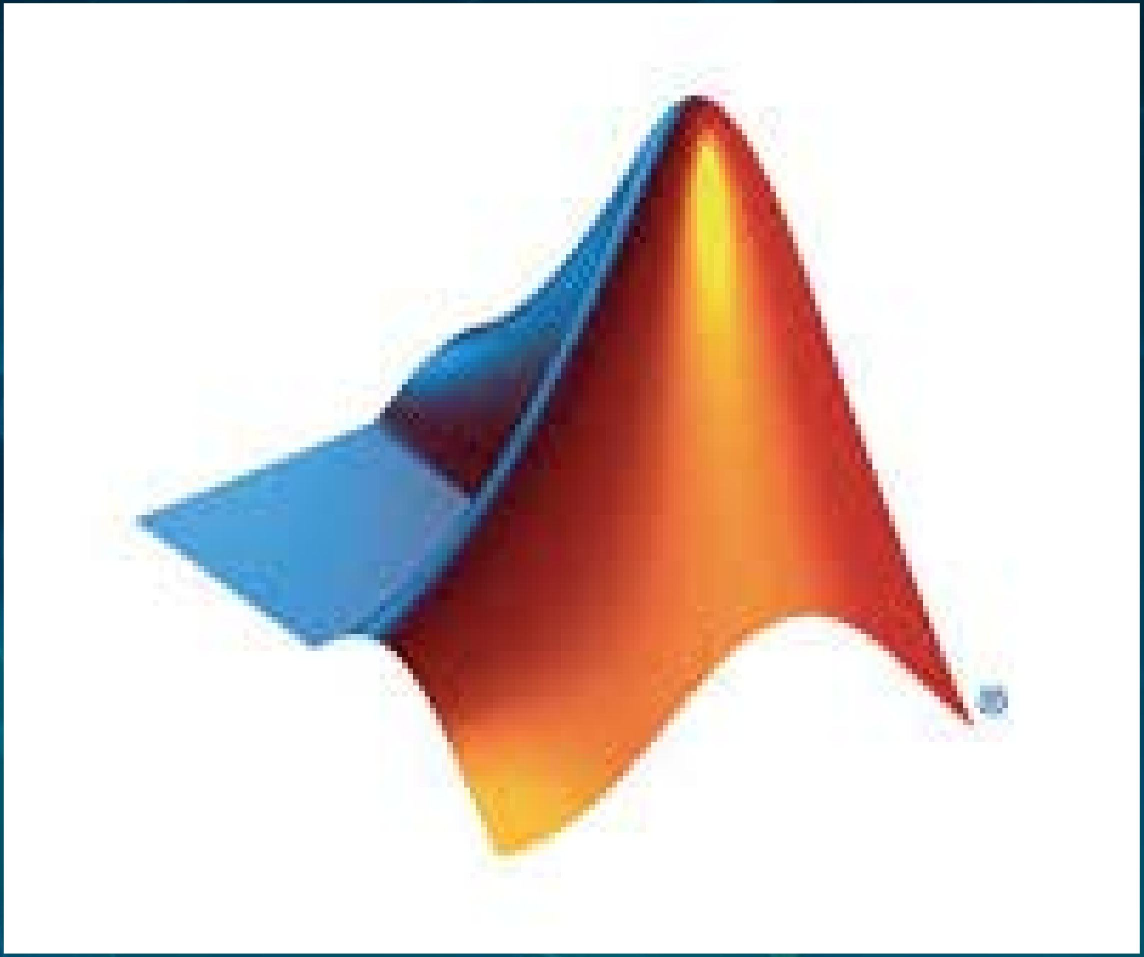


FAVORED DESIGN 2

MATLAB

Pros: Fairly-compatible (second most) with the work at hand, and the most user-friendly.

Cons: Ability to run code but not produce the caliber of mesh needed in the success of this project. May demand external virtual tools for some higher-end simulations..



Decision-Making Matrix

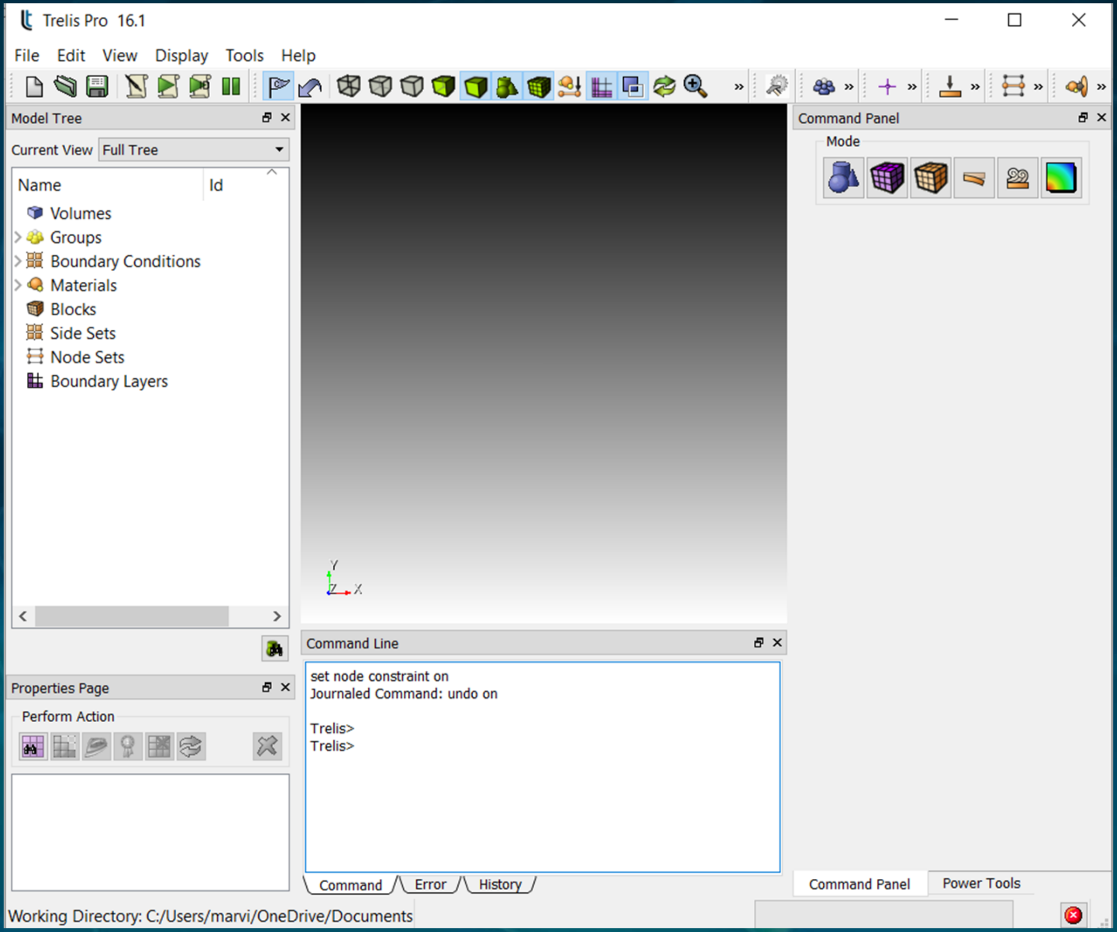
Software	Certification	User-Friendliness	Compatibility	Reference	Cost	Total
Trelis 16.1	8	5	8	7	9	37
MATLAB	8	7	6	8	7	36

Top Design

Trelis 16.1

- In comparison to its close competitor MATLAB, most of the tools needed to completely operate the software are free to the public domain
- Its cost played a big factor as the price is a lot kinder than the price for MATLAB

Trelis 16.1



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set node constraint on
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Trelis>
Trelis>
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Working Directory: C:/Users/marvi/OneDrive/Documents

Next Steps

- In January, we will proceed with the implementation of our top design solution (Trellis 16.1 Software).
- We've already begun the randomized generation process, starting with the simulation of a field 2D checkerboard with non-overlapping squares.
- The next step is to use the advanced simulation capabilities of Trellis Pro to create 3D meshes that allow us to move forward with the generation & analysis of EM waves.

Conclusion

- The need for our project is random ellipsoid generation that allows one to visualize & monitor different EM phenomena.
- Design required a software that was easy for customers to get acclimated to, and affordable for educational purposes.
- We first generated individual solutions, including the use of Trellis 16.1, MATLAB, Ansys, and Anaconda.
- Top 2 solutions were Trellis & MATLAB, and a decision matrix/pros and cons list was used to determine the best solution: **Trellis 16.1**

Conclusion Continued

- After this project is finished, the provided EM Playground will allow students to conduct virtual experiments with various experimental setups, including various sources, materials, and geometries, and perform simulations to track and view the progression of EM phenomena like antenna radiation, wave scattering, and diffraction.

END