Visualization for Better Learning in Chem 120

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Introduction

Many concepts in organic chemistry relate to spatial reasoning and the ability to translate two-dimensional representations into a three-dimensional mental image. It is critical that students gain a thorough understanding of visualizing atoms, orbitals and their interactions in three dimensions. By developing an E-book with computer graphics, 3D animations, H5P films, and online apps, we hope to enhance Depauw students' learning experiences in the CHEM 120 course. In this project, we would like to demonstrate 3D representations of chemical concepts to help students form these 3D mental images from a 2D surface. The process includes concept developing, storyboarding, 2D and 3D modeling, texturing, animation, rendering, and editing

Materials

Most of the procedure, including texturing, animation, and rendering are performed in Blender **(Fig.1)**. Other molecule editor softwares are used to support Blender graphic animation. 3D models are built in Avogadro **(Fig.2A)** and imported into Blender through Python **(Fig.2B)**, which is launched by Anaconda- Navigator **(Fig.2C)**. The rendered animation is edited in Adobe Premiere Pro **(Fig.2D)**.

Figure 1. Blender- 3D computer graphic software for creating 3D animation

(A) Avogadro **(B)** Python

(C) Anaconda-Navigator **(D)** Adobe Premiere Pro

Figure 2. Supportive molecule editors and video editing software

Results and Discussion

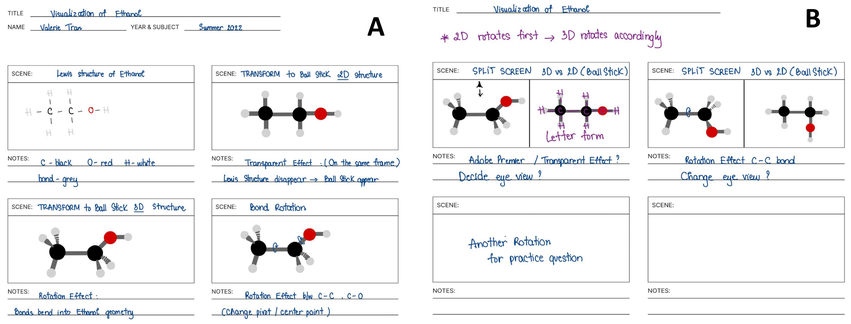

Figure 3. Storyboard of the animation illustrating Ethanol changing from 2D Lewis structure to 3D structure. **(A)** The structure changing from 2D to 3D. **(B)** Split screen to compare 2D and 3D rotation.

The main idea focuses on understanding bonding and structural information, which shows the transformation of a molecule from 2D to 3D structure. The script is pre-visualized via a storyboard **(Fig.3)**. Each scene is sketched out showing the molecule action.

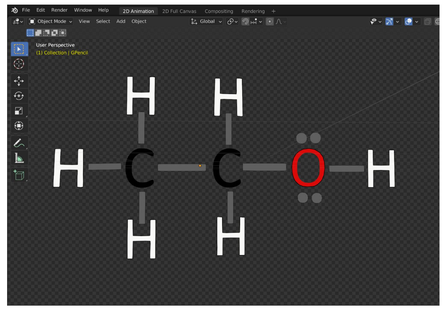

Figure 4. 2D Lewis Structure of Ethanol is drawn in Blender 2D Animation

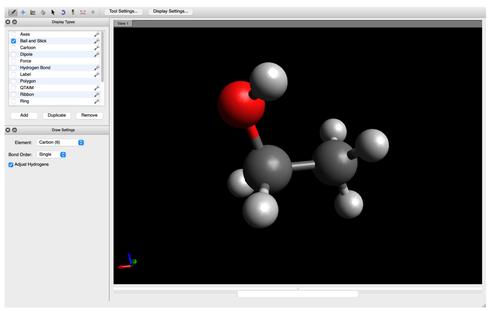

Figure 5. 3D structure of Ethanol built in Avogadro is exported as ".mol"

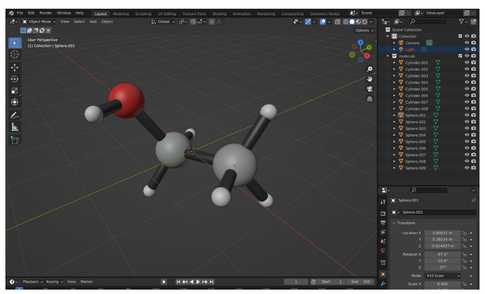

Figure 6. 3D structure is imported to Blender 3D Viewport using Python

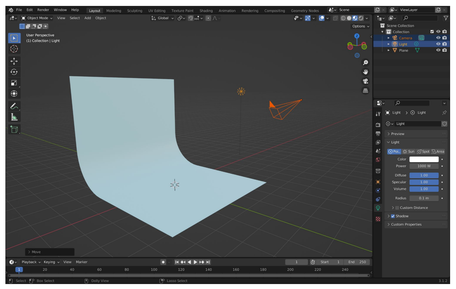

Figure 7. Backdrop, lights, and camera are set in Blender 3D Viewport

Each object is built separately based on the order of the storyboard **(Fig.4-6)**. All 2D and 3D models are imported into one main working space in Blender 3D Viewport for texturing and animating **(Fig.7)**.

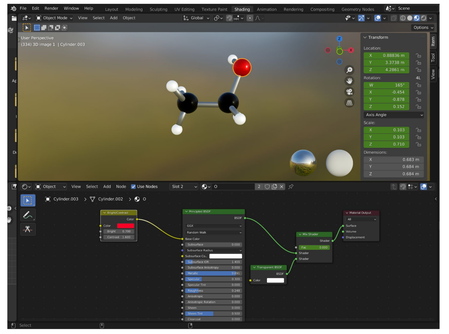

Figure 8. Material properties of a 3D Oxygen atom in Blender Shader Editor

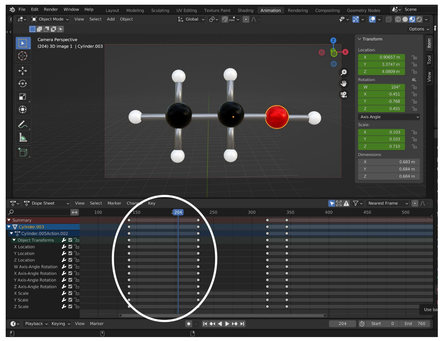

Figure 9. Keyframes of a 3D animated Oxygen in Blender Timeline Editor

The created 3D object undergoes texturing, including material properties, parenting, and transparency, etc **(Fig.8)**. The objects are animated through a sequence of movements by applying keyframes for different bond rotations, positions, and scales for each scene **(Fig.9)**. The processes are directed under multiple windows at once **(Fig.10)**.

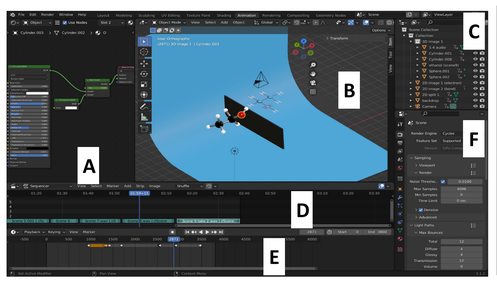

Figure 10. Multiple windows showing different datas in Blender, including **(A)** Shader Editor, **(B)** 3D Viewport, **(C)** Outliner, **(D)** Video Sequencer, **(E)** Timeline Editor,**(F)** Properties

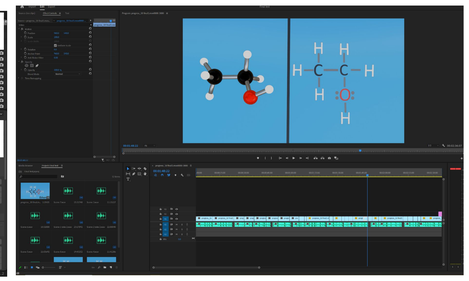

Figure 11. The animation is edited in Adobe Premiere Pro with applied audio.

The complete animation sequence is rendered and exported. After sound elements are added in Adobe Premiere Pro, the animation is edited and finalized.

Future Work

I hope to increase the rendered video quality and improve efficiency of the editing process. More flexible techniques of animation editing should be acquired for better 3D animation with different purposes for different units of the E-book.

Acknowledgements

I would like to thank Professor Hansen for his overview and guidance throughout the project. I would also like to thank the Department of Chemistry and Biochemistry at DePauw University for all the support provided, the Tenzer Technology Initiative and the J. William Asher and Dorothy A. Asher Endowed Fund in the Social Sciences for the generous funding and softwares installation