the students must use are the rotation tools that rotate the molecule and the selection tool with which they can see the calculated bond lengths and bond angles. All other HyperChem operations, such as building the molecule, setting up calculations, doing the calculations, and observing the molecular orbitals are controlled by buttons in the ToolBook program.

We have written two ToolBook front-end programs -- one for molecular mechanics and the other for molecular orbital theory. The MO program is constructed as a series of pages that lead students through a Molecular Orbital Theory lesson. One page in this lesson covers the oxygen molecule. In this page, clicking on the Oxygen button in the ToolBook window prompts the construction of the oxygen molecule in the HyperChem window, followed by an AM1 calculation. The students can rotate the molecule using the HyperChem rotation tool or select the bond to observe the calculated bond length. They also can click on an energy level in a molecular orbital energy level diagram shown in the ToolBook window and see the contour of the corresponding HyperChem MO.

An additional advantage of using a ToolBook front-end program is the ability to include buttons that pop up "question windows" on the screen. For instance, three questions are included on the Oxygen page. The first question asks the students to sketch the eight valence electron MOs of oxygen and identify them as or and bonding or antibonding (a ToolBook reference page, which introduces these labels, is included in the program). The students next are asked to feed the oxygen electrons into the energy levels and to predict if molecular oxygen would have unpaired electrons. They then predict whether the molecule would be diamagnetic or paramagnetic, and observe a video of liquid oxygen in a magnetic field. The ability to ask questions such as these and to supply reference information in the same program that controls the molecular modeling software turns the ToolBook program into more than just a simple front-end. It also is being used as a teaching tool.

We have found that the ToolBook-HyperChem combination has several advantages. It has furnished us with an efficient way to introduce molecular modeling in conjunction with our laboratory program. It also has given us the opportunity to use molecular modeling to teach about organic chemistry and molecular orbital theory. The present ToolBook program is not totally satisfactory, however, because of one remaining problem that we have not been able to solve. The ToolBook program is set up so that it loads first as a window that occupies around 40% of the screen. After the ToolBook front-end has loaded, it automatically runs Hyperchem. Unfortunately, we have not found a way to get the HyperChem window to fill the other 60% of the screen. Because of this we must load the programs in at the beginning of the day, or when the programs have been shut down during the day, in order to manually bring the HyperChem window to the proper shape and size. This has not prevented us from using the program, but has been an annoyance that we would like to eliminate. We are in the process of pursuing a solution to this problem.

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Multimedia - Are we all speaking the same language?

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It's 11pm once again! For the last 4 weeks no one gets to leave before midnight. The programmer has been glued to the computer to the point that he can't see straight and my assistant and I have been burning (writing) CD-ROMs and testing them furiously mimicking all the varied things that students may do to the product once it's in their hands. Once again it's product deadline time. Sound glamorous? Well, it really is not, but it is the reality of larger scale multimedia productions. For the last 18 months, this large scale CD-ROM project has come in and out of my life, and if I'm lucky it will be done within the next six months. This is what happens when you have virtually no budget and a staff that until recently is mostly volunteers. On the upside, I have learned a tremendous amount (directly propor-

tional to the number of hairs I've lost from my head) and my current co-workers are becoming professionals! So I hear that you are interested in multimedia, I am all for it but make sure you think about it seriously before diving in, it will save you a lot of time in the end. I have been thinking non-stop about multimedia in education for the last 3 years and I hope I can shed some light on the process.

But before even thinking about making multimedia, what is multimedia? This term has been overused in the last few years to where it is used to describe almost anything that is on a computer. If we look at its traditional definition, it really just means that more than one type of media is used, e.g., pictures plus sound. Just think, lectures are multimedia if you write on a board and talk all in the same presentation! So how do we describe multimedia since the word is really not specific at all? I have been struggling with defining different educational media materials because in working with tens of different instructors, I find that a common vocabulary is a real challenge but necessary to understand what instructional media can do. I will apologize in advance that the samples I mention in this article are biased towards what I have been personally involved with or have had contact with the author - there are many wonderful pieces of instructional multimedia I have never seen.

Now to the task at hand, what vocabulary do I use when thinking about, and describing multimedia? To start, I ask myself several questions about various aspects of the media in order to describe it, including: 1) How is the information structured? 2) How does the user interact with the information? 3) What type of media is it? 4) How is it distributed to the user? I will expand on these questions below.

1) Structure of the media (information flow) can be classified as:

Singular - The media has only one screen or general interface. An example is a program such as the Rasmol molecular viewer or the emission applet on the web found at http://mc2.cchem.berkeley.edu/Java/emission/emission.html. In singular flow, the user can usually alter variables and manipulate data.

Linear - The media flows linearly through its content. A prime example is a movie or Powerpoint presentation.

Branched - The media elements flow through various branches that may, or may not have, interconnections. Examples include textbooks on CD-ROM

2) User interaction with the media can be thought of as:

Presentation mode

Passive - the user has little control over the flow of information other than stop, go, rewind, fast forward. This is the interaction found in a Powerpoint presentation or in a movie.

Active - the user has a choice over which paths to follow through the information. This type of interaction is found on the World Wide Web where there are millions of linear paths the user can navigate.

Interactive mode

Static - the user's choices, or question responses, have little or no effect on the flow or continuation of the piece.

Dynamic - the users' choices, or responses to questions, alter the behavior of the piece beyond just informing you of a right or wrong answer.

Synchronous - the user's actions, words, or images are communicated in a synchronized manner to instrumentation, various different locations, or to other individuals or groups. Examples of this include controlling machinery remotely and videoconferencing.

Asynchronous - the user's actions, words, or images, movies, etc. are communicated to others in an asynchronous fashion. E-mail and newsgroups are two examples of this type of interaction.

3) Type of media

Animation - A series of cartoons, drawings, or models that are played in a fairly linear fashion.

Video Movie - A video that is played back on a VCR.

Digital Movie - A movie that is stored in a digital fashion and viewed on a computer. The computer allows the user to resize, play in forward and reverse directions, alter speed, and step forward or backwards frame by frame.

Simulation - The user can alter variables and affect what happens on the screen. Things like the passage of time, size, scale, shape, color, behavior of objects, can all be changed and the effects observed.

Visualization tools - The user can view information and manipulate it to see different representations of given data. Molecular viewers are a prime example of this.

Databases - Repositories of information that can be used to gather information to complete a task. A prime example is the MoleculesR Us site sponsored by the NIH where the user can search for the coordinates of

any large bio-molecule - http://molbio.info.nih.gov/cgi-bin/pdb.

Explorations - Content provided to the user without a great deal of structure for the purpose of letting them explore and gather information to answer a given question. Examples of this include Web pages with a series of links for students to wander through to answer specific questions. More complex uses include pictures, movies, simulations, and animations.

Immersive environments - The user is immersed in a context and affects the outcome of what happens to him or her. Usually there is a story element that lends an element of reality. Examples of this type of media include our AirbagsRUs virtual company or the Wiley Liftoff module.

4) Ways of distributing the media

Internet - The material is made available on the Internet and is accessible via FTP or Web browsers like Netscape. The limitations with this approach include: the necessity of an Internet connection, slow transmission rates, and limitations to what web browsers allow.

Floppy disc/s - The old standard - almost everyone has the capability to read one. Main drawback - cannot hold more than about 1.4 Mb of material.

Removable discs - Removable discs such as Zip or Jaz discs hold 100-1,000 Mb of material - plenty but few people have them.

CD-ROM - The new (sort of) standard for delivering up to 600Mb of material. Relatively inexpensive but rather slow when looking at complex media pieces.

I hope that by mentioning how I think about media I have stimulated thoughts in you the reader. Be aware that any given multimedia piece can contain various media types. There are numerous other crucial issues that I think of when thinking about media including: 1) Educational value and effectiveness, 2) People, time and costs associated with producing the media, and 3) Strengths and weaknesses of the media. All of these issues are extremely important when you are creating educational media - I will not say more about them here but I will write more about them in the future with references to the latest literature.

As I return to burning more CD-ROMs, I just want to mention that the ways I think about media are in no manner exhaustive and this is really my first stab at putting all of this down on paper. I would welcome and appreciate any comments directed at molinaro@cchem.berkeley.edu. I find media fascinating and a wonderful tool to teach chemistry. I am certain that the next few years will bring us wonderful media that will enhance our students' understanding of chemistry, as well as our (at least my) own.

JCE Software: Changes for Changing Times

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If you read the Journal of Chemical Education, you probably know that anorganization called JCE Software publishes computer programs, videodiscs, videotapes, and CD-ROMs for chemistry education. You may not have noticed that JCE Software is actually the Journal of Chemical Education Software and is a publication of the Journal of Chemical Education, owned and operated by the Division of Chemical Education, Inc. of the American Chemical Society. As such, JCE Software is an academic publication with the same high standards of peer review as the Journal. Before I became a Technical Editor for JCE Software in 1994, I did not know much more about it than that, except for a little experience with some of the publications. Since then, I have learned a great deal more-this is a unique way of publishing software, combining rigorous review with a non-profit attitude and a desire to get the materials into the hands of as many educators as possible. Our goals are to provide the academic recognition due authors of electronic media for use in chemistry education and to make these materials available at prices any school or teacher can afford. I feel privileged to be a part of this vital organization. I'd like to tell you a little about some of the changes that have been going on in JCE Software over the past year.

JCE Software has since its beginnings been called the electronic publishing arm of the Journal of Chemical Education, but for the most part it functioned as a separate entity. That changed tremendously in September 1996 when John W. Moore, JCE Software's founding editor, assumed editorship of the Journal of Chemical Education. There are many obvious changes in the move of the Journal's editorial offices from Austin, TX to Madison, WI, home of JCE Software. In the spring of 1996 the JCE Software staff moved into "Journal House" a renovated house owned by the University of Wisconsin-Madison and located about a block away from the chemistry building. As the new members of the Journal staff were hired, they moved into Journal House. Now the Journal of Chemical Education and JCE Soft-