JAVA Applets:

Web-based Interactive Visualization Tools to Enhance the Effectiveness of Teaching / Learning of Architectonics

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Three years ago Vice-President Al Gore successfully predicted that the information super-highway would be accessible to the general public by the end of the century. The highway is actually a very appropriate metaphor; the structure of Internet could be compared to the structure of the roadway systems of the United States. The current automotive system depends upon an interconnected network of primary, secondary, tertiary and rural roads. Each is constructed of varying widths, materials and levels of comfort, yet all maintain a certain standard that provides for motorized transport along and between the levels. Certain types of vehicles pass across all types of roads while other are restricted by their size or function to movement along ditinct systems. The current Internet can be compared to the US Highway network that preceeded the Interstate system. When that early system linked the states it esialy served the needs of the newly motorized public. However, that did not last. Currently, literally millions of users are now clogging the virtual highways and byways, creating a new need for a higher-speed, more robust Supra-network. The need for a rapid defense deployment system was used to sell the Interstate system; what will facilitate the creation of the new network?

This paper describes one vehicle that plies the Internet lanes. It is a vehicle that was designed specifically for this highway and those that can drive up the Internet ramp and merge into its traffic. These vehicles do not depend upon expert driving skills because most have not had the time or interest to acquire Internet programming skills which are so rapidly outdated. They are vehicles that can be utilized by drivers of all ages and skills. The World Wide Web (WWW) has the potential to change the way in which education is perceived and conceived. The "web" has become a part of households faster than any Interstate highway was ever built. It has developed faster than any other technological manifestation in this decade. As a matter of fact, it has proliferated faster than any technological development in this century. For many this is a boon; and for others a bane. For educators of architectonic issues in schools of architecture it can be either; but it should be the former.

There are as many factors which influence highway design that influence the design of effective web based teaching/learning tools. Most highways were originally animal tracks, Native American hunting trails or paths of least resistance between two points. The depth and complexity of their traveling surfaces evolved over time to include geotextiles, sub-strata, load-bearing surfaces and wearing surfaces. This a response to both the technological potential and to public demands as modes of transportation changed and volume steadily increased. Both needs and desires drove the changes. Multi-media, web-based tools also reflect the public's changing attitudes towards both educational need and desire. The Internet's potholes have been all but eliminated by hardware that is very reliable and does not require a second mortgage to acquire. The once bumpy driving surface has become a smooth ride with platform independent browsers that allow global place displacements with only a "click."

Browsing the web can now be compared to driving on urban roadways; sometimes traffic is clear and fast, other times clogged and slow. JAVA Applets are like the public transportation modes of transportation for the Internet. They can service an infinite number of users without running out of fuel. The JAVA programming language allows the development of interactive "programs," otherwise known as applets, which reside in a central location and are downloaded on demand to a local personal computer through a browser (i.e., Netscape or Mosaic). The applet is loaded into the local user's RAM. The user at the local personal computer can then interact with the program as long as desired without clogging up the Internet. In this way, the advantages of a central distribution location is combined with the ever-increasing power and speed of the individual personal computer. This reduces the traffic on the Internet superhighway to an absolute minimum. The potentially slow, frustrating connection between the servers and the personal computer is reduced, if not eliminated. The applet remains in the RAM of the local personal computer providing true interactivity. Interactive programs are one of the best ways to enhance the teaching/learning of architectonic issues; exploration by trial and error with

immediate feedback. The applet is then deleted from RAM after the user no longer wants to utilize it. The speed and computational power of the personal computer are utilized as is the power of the central server.

Three JAVA applets have been produced that can be integrated into a structures curriculum. The first facilitates observations of the relationship between a building's height, its width, a horizontal wind load and the resulting forces in a tower (see Figures 1 - 5).

The second illustrates the effects of materials, span and uniform distributed load on the internal forces and deflection of a simply supported beam. The span, magnitude of the distributed load, beam width, beam depth and material of the beam can all be changed and the diagrams simultaneously reflect the changes as they are made (see Figures 6 - 10).

The third applet illustrates the relationship between the geometrical configuration and relative magnitude of the reaction forces of a three-hinged frame. The location of the middle hinge can be moved anywhere within the limited

Fig. 1. The screen after the Pencil Tower applet has initially loaded. Each slider can be manipulated until appropriate values are found.

Fig. 2. Screen with the indicated values and graphical images; the diagrams are continually changing as the slider bars are manipulated.
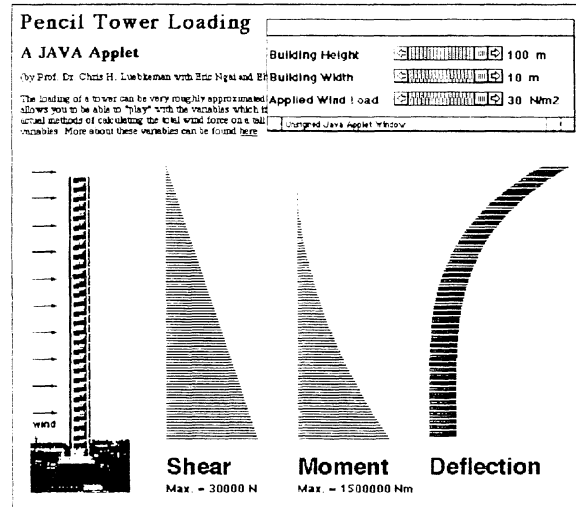

Fig. 3. The screen when the sliders are pushed to their maximum values. Compare this to the previous screen. One can clearly see the differences in the shapes of the curve.
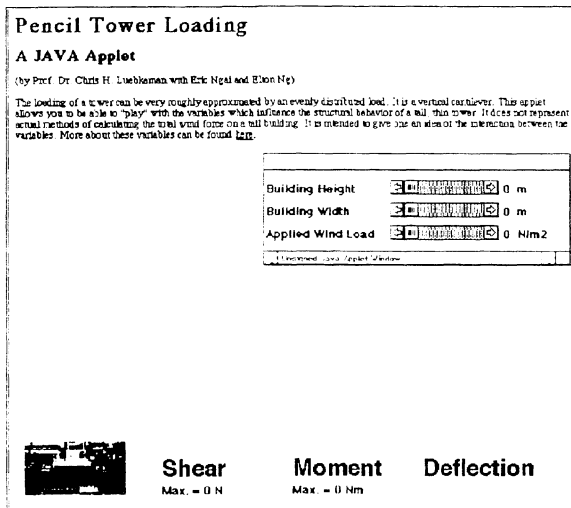
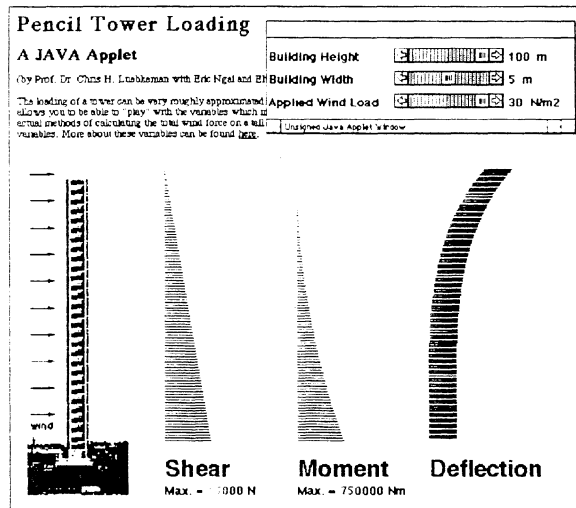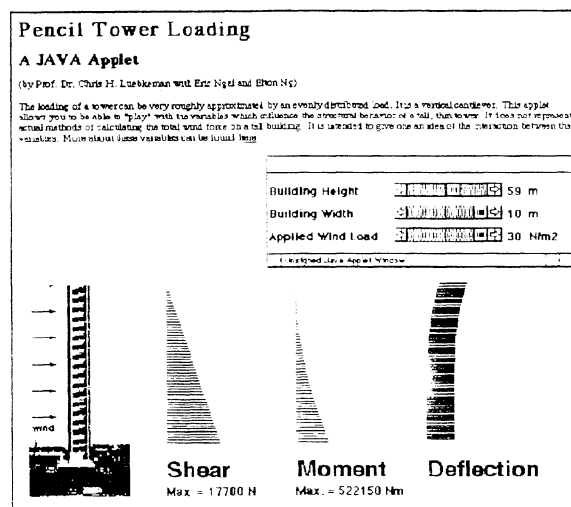

Fig. 4. In this screen the building width has been reduced. Notice the reduction in the curves, yet there remains a pronounced deflection.
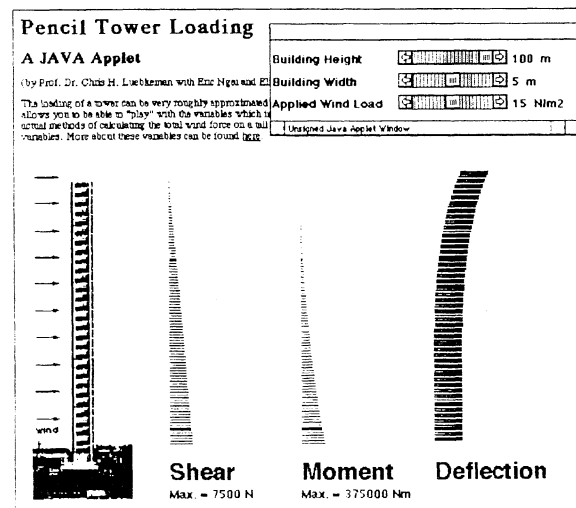

Fig. 5. In this screen both the building width and wind load have been reduced. Notice how much flatter the curves appear.
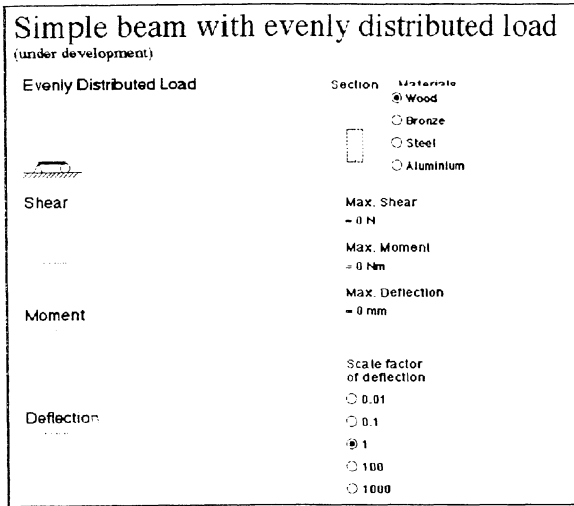
Fig. 6. This Applet describes the behavior or a simply supported beam under an evenly distributed load. All of the variables effecting the behavior of the beam can be manipulated. The effects are "instantly" seen on the screen as the various factors are changed.
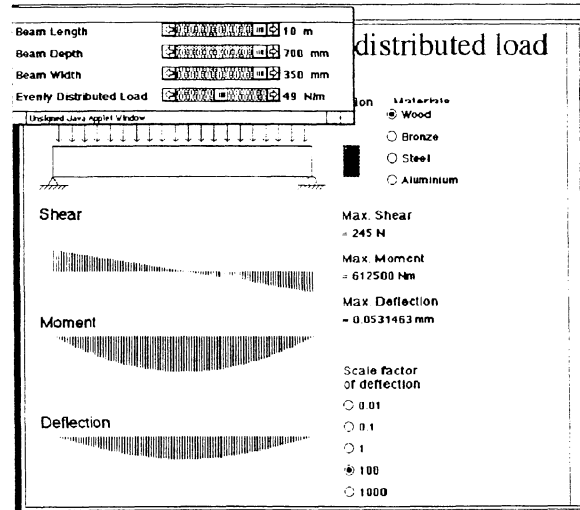

Fig. 7. A short wood beam with a moderate load. The deflection has been exaggerated with a scale factor of 100.

Fig. 8. A longer wood beam with a moderate load.

Fig. 9. A larger wood beam with a moderate load with a much deeper cross section. Notice the effect of the change of cross section on the Deflection, but not on the Shear and Moment. A clear graphical representation that the internal forces are not effected by a change in beam geometry.
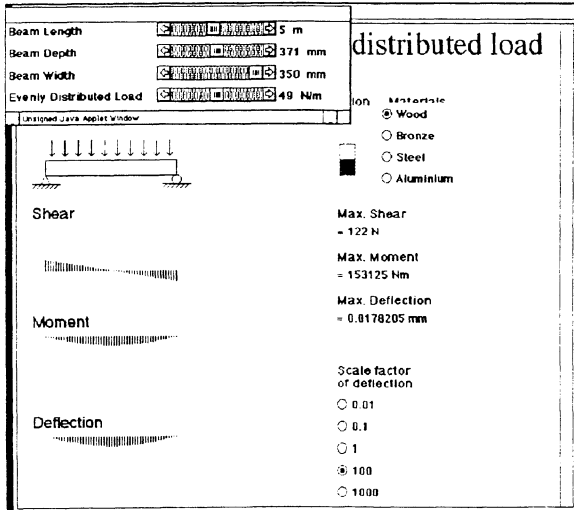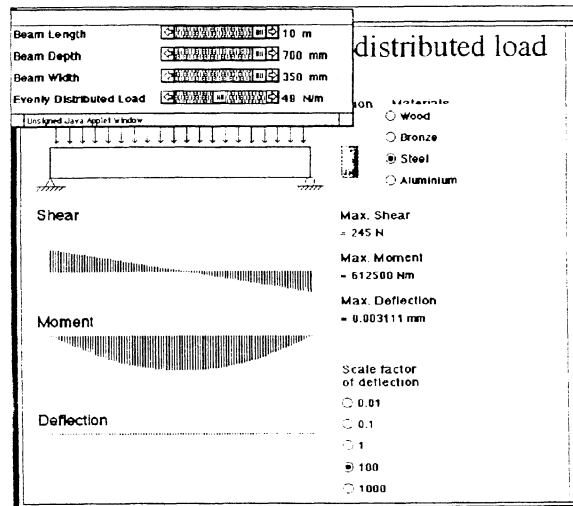

Fig. 10. This window illustrates the behavior if the same beam were made of steel instead of wood. The internal forces remain constant and the deflection reduces to almost null.
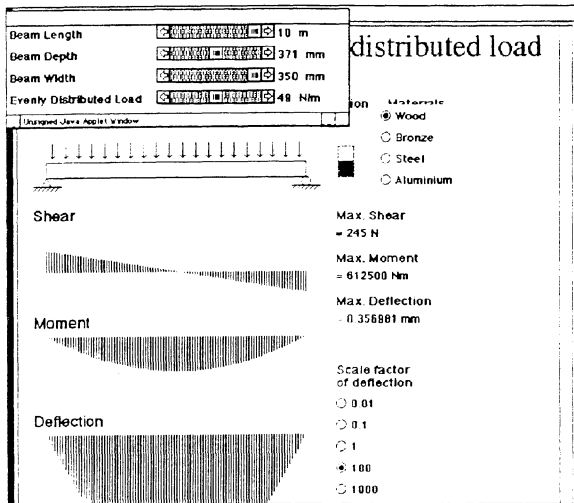
field on the screen. The magnitude of the point load applied to the hinge can also be altered (see Figures 11 - 14).

Both numerical and graphical representations for the support reactions are shown. One observes the lengthening, or shortening, of the reaction's component force vectors as the frame's geometry is altered. One can also correlate these movements with the numerical data that is also seen on the screen. Each applet clearly illustrates the effects that the variables of the mathematical equations that govern the physical behavior of the structural element.

One of the advantages of these three interactive JAVA applets can be found in the way that they can be integrated into a broader set of web based teaching/learning materials. They can be included within lectures that describe the behavior in a written verbal format and then allow a student
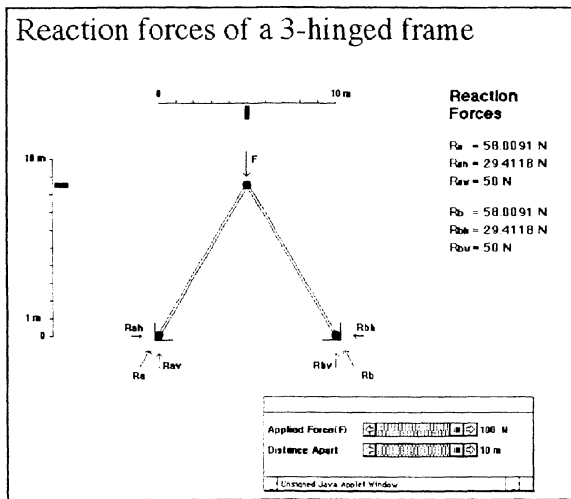
Reaction forces of a 3-hinged frame

Reaction Forces

Ra = 58.0091 N
Rah = 29.4118 N
Rav = 50 N

Rb = 58.0091 N
Rbh = 29.4118 N
Rbv = 50 N

Applied Force(F) 100 N
Distance Apart 10 m

Fig. 11. This the opening screen of the third applet illustrating effects of the geometry of a three-hinged frame on the reaction forces.
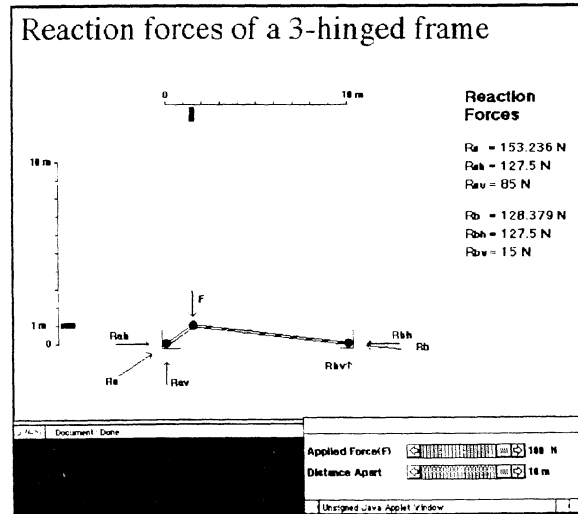
Reaction forces of a 3-hinged frame

Reaction Forces

Ra = 153.236 N
Rah = 127.5 N
Rav = 85 N

Rb = 128.379 N
Rbh = 127.5 N
Rbv = 15 N

Applied Force(F) 100 N
Distance Apart 10 m

Fig. 13. In this screen the central hinge has been pushed very low. Notice how the horizontal reactions are significantly greater now.

Reaction forces of a 3-hinged frame

Reaction Forces

Ra = 89.4999 N
Rah = 28.022 N
Rav = 85 N

Rb = 31.7841 N
Rbh = 28.022 N
Rbv = 15 N
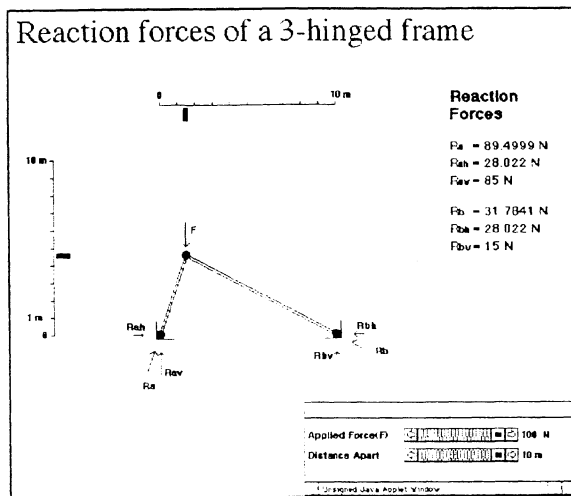
Applied Force(F) 100 N
Distance Apart 10 m

Fig. 12. In this frame the location of the hinge has been moved to the left. Note the proportional change of the reaction forces. The vectors are drawn so that they are proportional to their magnitude.

Reaction forces of a 3-hinged frame

Reaction Forces

Ra = 254.951 N
Rah = 250 N
Rav = 50 N

Rb = 254.951 N
Rbh = 250 N
Rbv = 50 N

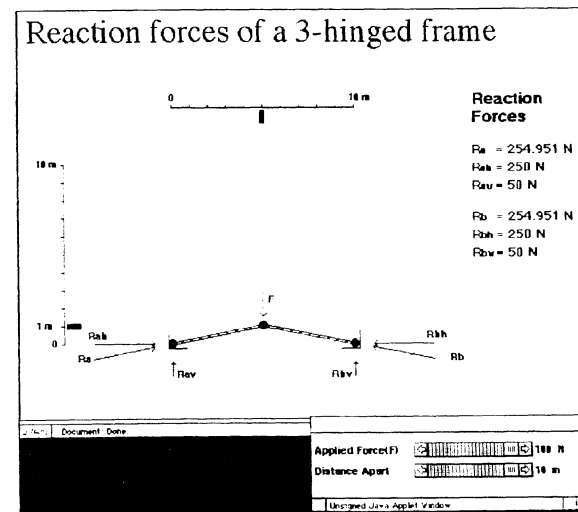Applied Force(F) 100 N
Distance Apart 10 m

Fig. 14. This screen illustrates the way in which the applet clearly demonstrates the effect of the change in geometry of a frame on the end reactions.

to "see" the behavior graphically. Each student can interact/ exercise at their own pace. Since the applet actually resides in a remote site and is "flushed" from the system when it is no longer needed, it can be called upon at any time during a lecture or demonstration; or it can be opened as a completely independent browser window that remains in the background at all times. The applet can be linked to the appropriate pages within a site. The end result is that a student learns through active engagement.

The active engagement of the student is one of the most important advantages of this kind of interactive web-based program. In all three cases, slide bars allow the student to alter variables with distinct numerical values. These applets were not designed to remove the numerical representation, but rather to reinforce the concept that numbers are also only one way to represent a reality. In all cases, there are

numerical values clearly expressed for both the input and output. Intuitive understanding of structural behavior can be confirmed, or at least trained, through exploration and observation. It is anticipated that these applets, included as part of a comparative learning pedagogy, will significantly enhance both the learning process and the retention of important architectonic concepts.

Production Notes