

## APPLICATION OF JAVA APPLETS TO BASIC ULTRASONICS EDUCATION VIA THE INTERNET

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### INTRODUCTION

An Internet course in NDE/NDT technology and applications is being developed as part of the North Central Collaboration for NDE/NDT Education to complement new course materials and instructional modules for use in NDE/NDT technician programs, curriculum redevelopment, and innovation in NDE/NDT technological education in community and technical colleges. Java applets provide a widely used mechanism for platform-independent interactive graphics applicable to learning environments. Embedded in web pages, Java applets enhance the understanding of a physical phenomenon with adaptive visualization. Additionally, many applets can serve as an on-line calculators often required as part of NDE/NDT inspection planning. This paper demonstrates the application of Java applets to basic ultrasonics education via the internet.

### BACKGROUND AND PROGRESS TO DATE

The North Central Collaboration for NDE Education began efforts to enhance NDE education in October of 1996 with funding from the National Science Foundation (NSF). Some of the Collaboration's tasks involve enhancing NDT education in the two-year programs at community colleges (CC), fostering collaborations between CNDE and the surrounding CCs and encouraging qualified graduates of CC programs to become engineering students at ISU, advancing their NDE related education and career opportunities. Development of web-based materials benefits by interactions with Collaboration members and NDT instructors at Cowley County Community College in Arkansas City, Kansas, Ridgewater College in Hutchinson Campuses, Minnesota, Northeast Iowa Community College in Peosta, Iowa and Southeast Community College in Milford, Nebraska.

Our web-based educational materials addresses two broad audiences. The first audience are elementary students. It is in the late elementary and early middle school grades that youngsters become impressed with ideas that can eventually lead to career choices. Our goal is to foster interest in basic science and mathematics--to play on the student's natural curiosity--asking questions like, "Do you ever wonder why a paper clip is attracted to a magnet? Do you ever wonder what a magnet is?"

Before actual development began, the Collaboration members benefited from workshops provided by Dr. E. Ann Thompson and her colleagues at ISU's College of Education to better understand how students learn. Our approach is to take advantage of youngsters' natural inquisitiveness to teach them science concepts in an entertaining, interactive way. This leads them to a simple nondestructive testing experiments that hopefully relates the science of testing to real things in their lives--things like pop cans and CDs, the things we wouldn't want to live without, all products of science and technology. It is essential to get kids interested in science and engineering early on if they are to be educated properly to become NDT technicians or engineers with NDE training.

Community college students and engineering students at universities make up the second audience. The purpose of the advanced NDE/NDT internet offering is to serve as complementary and resource materials for NDT courses taught at technical schools and community colleges, and NDE courses offered at universities. These web pages incorporate user-interactive Java applets to engage the students in active learning. The pages are designed to aid in conceptual learning, to reinforce materials provided at the student's schools, and to serve as working tools to aid students, working technician and engineers.

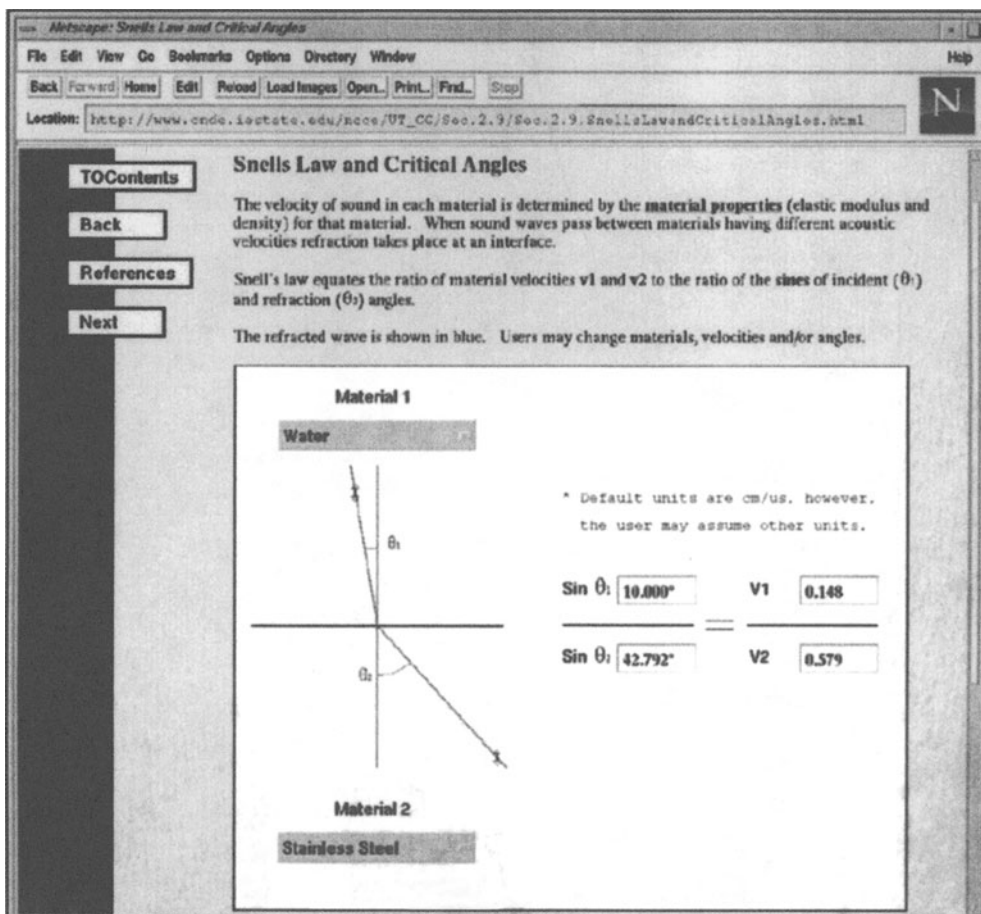


Figure 1. Web page with Snell's Law interactive Java applet. The user may select material properties via pull-down menus, grab incident or refracted rays with the mouse, and edit numerical fields.

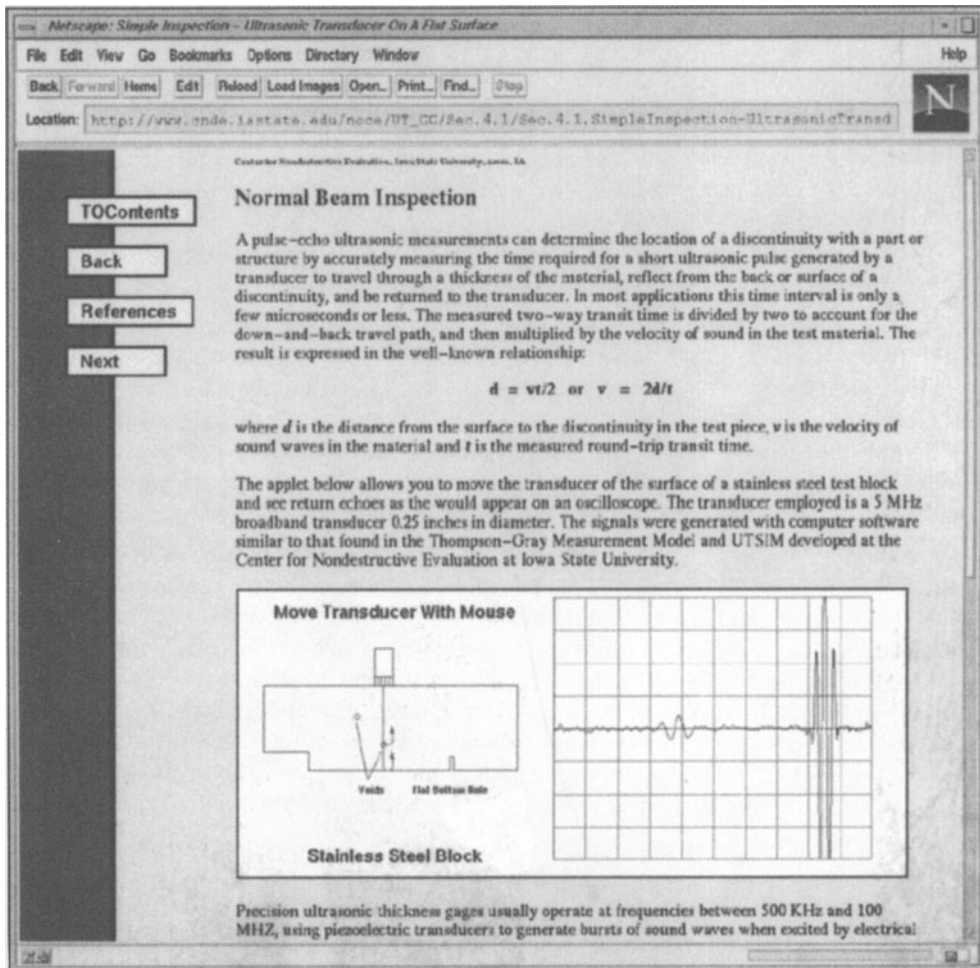


Figure 2. Java applet marrying an interactive graphic (the user sliding a transducer over a test block of stainless steel) and an oscilloscope display showing the received signal. Signal were accurately generated by software derivative of the Thompson-Gray Measurement Model.

Six nondestructive technology areas are planned; Liquid Penetrants, Eddy Current, Mag Particles, Ultrasonics, Radiography and Visual Inspection. Ultrasonics has been completed with work currently in progress on radiography and eddy current sections. Because of the diversity in the backgrounds of the students, these web pages attempt to start with very basic information leading up to more advanced material within the pages themselves. The organization of material closely follows areas for Level I, II and III Technicians outlined in "Recommended Practice No. SNT-TC-1A" provided by the American Society for Nondestructive Testing, Inc. (ASNT).

Java applets are incorporated in some pages to help visualize a concept and often serves as a working calculator. When the web page is brought up in the user's browser, Java code is down loaded and the applet springs to life. The Java code is actually processed by the user's cpu. Unless there is continuous animation, the applet sits quietly waiting for user input. The Java applet, shown in Figure 1, demonstrating Snell's Law, is an example of more that a dozen applets incorporated unto the ultrasonics pages. To view

the work on-line use: [http://www.cnde.iastate.edu/ncce/Intro\\_CC.html](http://www.cnde.iastate.edu/ncce/Intro_CC.html). The viewer is able to select material properties from a substantial list of common material encountered in NDT inspection via pull-down menus, grab incident or refracted rays with the mouse, and edit numerical fields.

The user may determine critical angle from Snell's law, by clicking the appropriate field with the mouse and substituting  $90^\circ$  for the angle of the refracted ray. For any angle of incidence larger than the critical angle, Snell's law will not be able to be solved for the angle of refraction. At the critical angle of incidence, much of the acoustic energy is mode converted to a Rayleigh (surface) wave which is displayed as a wavy line along the interface of material 1 and material 2 by the Java applet.

The "Normal Beam Inspection" applet shown in Figure 2 allows the user to move the transducer along the surface of a stainless steel test block and see return echoes as they would appear on an oscilloscope. The transducer employed is a 5 MHz broadband transducer 0.25 inches in diameter. The signals were generated with computer software similar to that found in the Thompson-Gray Measurement Model and UTSIM developed at the Center for Nondestructive Evaluation at Iowa State University.

Several other Java applets have been created to simulate angle beam inspections with and without reflected signal off of a planar surface. Additionally there are applets for estimation of crack length via crack-tip diffraction techniques and an immersion inspection similar to the applet in Figure 2 but with the transducer in a water above the specimen being tested. Other applets serve as beam spread, near-field far-field and focus transducer calculations. The applets combine graphic visualization, calculation of one unknown as a function of the other known parameters, and engage the student in interactive learning and parameter exploration. One applet's primary purpose is to show wave propagation with the applet providing the animation of different wave types.

Iowa State University students have done all of the Java programming to date with the development of several dozen applets.

## SUMMARY

The purpose of this NDE/NDT educational internet offering is to serve as complementary and resource material for NDT courses taught at technical schools and community colleges, and NDE courses offered at universities. Many of the web pages incorporate interactive Java applets to engage the students in active learning and to help the student visualize what is happening in ultrasonic inspection. These pages are considered to be a living dynamic work that can be updated over time to improve this NDE/NDT educational offering. You may access these materials at [http://www.cnde.iastate.edu/under\\_education](http://www.cnde.iastate.edu/under_education). We are eager to learn how these materials are being employed in teaching. Please contact us with your suggestions and feedback.

## ACKNOWLEDGMENT

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## REFERENCES

1. Sam Wormley, *North Central Collaboration For Education in NDE/NDT*, <http://www.cnde.iastate.edu/ncce.html>, 1997.
2. Sam Wormley, *NDE/NDT Educational Resources*, <http://www.cnde.iastate.edu/ncce/edu.html>.