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HISTORICAL SCIENCE
STEPHEN JAY GOULD AT THE NSTA

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The Central Role of the Earth Sciences in the Understanding of Science

Stephen Jay Gould, the Alexander Agassiz Professor of Zoology at Harvard University, recently spoke at a meeting of the National Science Teachers Association (NSTA) in Washington, D.C. An eloquent spokesperson for the earth sciences, Gould holds a degree in paleontology from Columbia University. The American Geological Institute has made a video tape of his talk available for purchase. This article, a review of the tape, is for the benefit of science teachers who may wish to buy a copy.

Three aspects of this tape need to be considered before deciding to purchase it. One is the audience for whom it would be best suited. The second is the content of Gould's presentation. The third is the quality of the video and audio reproduction.

Determing its benefit to the audience is a matter of deciding how the tape will be used. High school and college science teachers stand to benefit a great deal in terms of personal enlightenment. Gould's message is educational to all teachers and especally inspirational to teachers of the earth sciences who may not appreciate their subject as much as they should.

Science teachers considering the tape for class use will find it is too sophisticated for younger high school students. However, high school students with good training in science and high motivation should be able to follow Gould's presentation. College students probably have sufficient background and maturity to benefit from seeing and listening to it.

The title of Gould's talk was "The Central Role of the Earth Sciences in the Understanding of Science." His intent was to convince teachers of the earth sciences that their subject areas represent more than merely narrative and descriptive science, the common conception which suggests that the earth sciences are "soft" (or easier) while chemistry, physics, etc. are "hard" (or more rigorous).

Gould argues that the lower status afforded to the earth sciences is the result of the lack of unifying theoretical constructs for these areas that can be directly related to the usual "facts" that are used to characterize them. He mentions plate techtonics as a recent unifying principle that has changed the situation in geology.

A more serious situation that contributes to the identity crisis in the earth sciences is the general lack of understanding as to what constitutes "the scientific method." This forms the basis for his presentation.

The usual interpretation of the scientific method is that it involves experimentation to collect data, replication to verify reproducibility, and theory formulation to provide predictability. This methodology is central to the sciences in which laboratory experimentation is fundamental.

To allow this as the only methodology that is scientific short changes another approach which is fundamental to the earth sciences. This is the "historical methodology" which to them is more appropriate and valid as a means for acquiring scientific knowledge.

This method uses the historical record that nature provides to recognize the time ordering of unique events, to recognize patterns of commonality and "historical connectedness," and to develop theoretical descriptions with a value that is mainly "postdictive" as contrasted to the predictive models associated with the so-called hard sciences.

Gould offers geology as the quintessential historical science, especially in the 19th century. Hutton, Lyell and others solved the "age of the earth problem" through the development of the concept of "deep time." This portrayed the earth and universe as much older than previously thought. Their work opened the way for the theory of uniformitarianism in relation to the inorganic evolution of our planet as well as for the theory of biological evolution. Gould regards this accomplishment as comparable to any in the hard sciences in terms of its implications.

He uses Darwin as the model for the historical scientist because of his thorough and painstaking approach to the development of the theory of evolution. Darwin's approach was essentially an inductive one, contrary to Huxley's contention that it was deductive. Darwin used patterns and historical connectedness to generalize from more limited observation on smaller time scales.

The force of his generalization, based on the idea of natural selection, was that it accounted for the development of life forms over deep time by virtue of historical connectedness. This generalization did not rely on the verification of crucial single events or details that were either undiscovered or beyond retrieval from the historical record.

Vital to the historical method was the development of a suitable criterion by which time ordering and sequence could be measured. Gould says that mineral chemistry (studies of rocks) was used at one time but was not appropriate because it did not allow for any measure of uniqueness through time. Chemical processes occur at present as they have since the universe began, meaning that they tend to display no time signature. Fossil records and geologic stratigraphy, on the other hand, do provide unique time signatures and serve as a criterion.

Gould uses the Baby Fay episode (in which a baboon heart was transplanted into a human baby) as a tragic example of how the doctor in the case misunderstood historical connectedness. Knowing that baboons are only distant relatives to humans could have prevented this operation, which seemed to be based on the superficial similarities between species and not on hard genetic information. (Apparently the doctor involved didn't "believe in evolution," according to Gould.)

The last part of the presentation involves two examples of historical science. One is a detailed description of biological evolution including recent mitochondrial DNA studies that suggest that all humans alive today are descendents of a single ancestor (who was the end product of earlier evolution with all of its branching and dead ends).

The other is planetary geology which has been assisted in recent years by the

wealth of data from satellite fly-bys of the planets and moons in our solar system. The various solar objects are certainly all unique in terms of their own histories but share commonalities that allow for generalized views of the geologic processes which have been at work over time to bring them to their present condition.

The quality of the video and audio reproduction of Gould's presentation is not good. Apparently not produced by media specialists, it has a "home movie" quality about it that tends to detract. This criticism is made recognizing that a professional production was probably impossible to arrange.

Only one camera was located in the back of a large room. Gould and others were located on a dais at the front, some distance from the camera. The lighting was not sufficient resulting in a dim and washed-out image of Gould, much like watching him through a pair of sun glasses.

The camera operator had problems maintaining proper focus, especially when the camera was moved. The zoom adjustment brings Gould closer during the first part of the talk but the operator apparently forgot to re-zoom in on Gould after having panned to the screen on which Gould's slides were projected.

The transitions between Gould and the overhead screen are awkward and clumsy. The operator had trouble finding the screen and the view of the slides is not always clear. There is a delay in panning back to Gould after he finished some of his slides.

All of this is distracting, especially since his presentation requires considerable concentration.

The audio portion of the tape consists of Gould's words picked up by a microphone located on the camera, after they have left the speaker on the dais and have been filtered through considerable room noise. The coughing, murmuring, foot shuffling and occasional outbursts by a child near the microphone only add to the distractions created by the video problems.

In a sense, we are no worse off than those who were present and seated in the back of the room. We seem to share all of their problems in trying to see and hear Gould. The only advantage to having a copy of the tape is that it can be rerun for better understanding if desired.

Gould's rapid speaking style doesn't help efforts to follow his talk. He sometimes turns away from his microphone and his voice trails off at the end of some of his comments. This was probably a problem for those present and was made worse by the audio quality of the tape.

From a positive point of view, even a tape of this quality allows us to experience Gould's presentation directly, and we are fortunate to have this opportunity. He has an engaging personality and witty style that help to overcome the technical problems.

Despite the reproduction problems, teachers should consider obtaining a copy of the presentation. Stephen Jay Gould is fascinating and interesting and one of the more articulate scientists in America today. Portions of the talk appeared in Gould's article in the *American Scientists* (Vol. 74, No. 1, page 60, 1986) which should be available to teachers in college libraries. The videotape may be purchased from: The American Geological Institute, 4220 King St., Alexandria, VA 22302.

The current cost of the tape is $15 per copy.