A television series exploring the inner workings of science

The Ring of Truth

Philip Morrison
Public Broadcasting Associates.
Six 1-hour-long programs (also available on videotape)

Reviewed by Gerald F. Wheeler

The pace of broadcast television inhibits it as a serious vehicle for promoting public literacy. The steady flow of images and ideas without any possible rescanning by viewers leaves television's content inherently superficial. This results in a "complementarity principle," the "noncommuting pair" being truth and clarity. Clarity is no problem if you don't care about truth; or conversely, with truth comes a loss of clarity for most of the nonscientific public. Because of this attribute television has been a frustrating medium for physicists; our ways of knowing do not come across well on the tube. Very few physicists have the courage or patience to accept the challenge of the medium by finding the right balance between those two factors.

Philip Morrison examines the way instruments such as Galileo's telescope change how we perceive the world in "Looking," the first program in *The Ring of Truth.*

Philip Morrison has accepted the challenge with his six-part series *The Ring of Truth*. This series of one-hour programs debuts 20 October 1987 over the Public Broadcasting Service. While from the same high-quality tradition as its science-on-TV predecessors, this series stands alone in its very serious attempt to share the depth of our physics world view. In the first program Morrison declares: "You, the viewers, have a role to play; you must attend to what is going on. Then you can decide whether what we present has the ring of truth." There are times when, in reaching for the truth, the viewers will find some material confusing. And there are other times, as in the discussion of weight and mass units, when the program goes for such clarity that some physicists may quibble over the precise meanings of certain sentences. I think Morrison and his cowriter and wife, Phylis, have done a superb job balancing this tension.

Morrison's joy in doing science has uncompromising clarity and truth. Over the course of the series viewers will see Morrison genuinely excited about a magnified image, a self-contained mass–energy box and the weight of the dot on the letter "i" in his first name. Emotions come across very well in the series. Another message that comes through strongly is the process of science. Morrison takes the viewer through the steps of arriving at his points, from a jelly-donut energy analysis of bike riders to measuring the size of the Earth with a rental van and some simple astronomical observations. And in the last program, the host and his guests magnificently share with the viewer the work of two women scientists.

Finally, one message that is stated clearly but which I fear will not be heard, or at least not remembered, is the absolute honesty of the sights and sounds the viewer is experiencing. After beginning with a piece of trick photography, Morrison promises never again during the series to play any tricks on the audience. This style, which has common roots with the old PSSC high-school physics films, adds a profound credibility to the series and I'm sure gave the producers a number of headaches. (It's a producer's nightmare to be required to burn 36 jelly donuts in a campfire scene bright enough to look "real" for television; a little lighter fluid would have helped.) I'm certain that physicists will be very comfortable letting Philip Morrison speak for them.

The first episode, "Looking," examines the way we see and how it influences what we understand. Morrison cautions against the dangers of uncritically accepting input from the eye as evidence. Later, he exclaims, "Hurrah for instruments!" as he guides

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us from the common radio to an illuminating tour of Renaissance Italy. The series doesn't digress with distinctions between science and technology; the word "technology" is mentioned only once during this first program.

The second program, "Change," presents science's grand conservation laws of mass and energy. Morrison carefully measures mass changes in a self-contained box of Rube Goldberg devices at San Francisco's Exploratorium and then looks at the constancy of energy in the Tour de France bicycle race. (Incidentally, the number of "jelly donut units" consumed by a Tour de France racer is astounding.)

In the third program, "Mapping," Morrison measures the size of the Earth with a rental van named "Eratosthenes." He takes his attentive viewers through the entire process, and ends with a generalization to mapping data of all kinds, showing how transforming numbers into visual shapes gives new insights.

The fourth program, "Clues," presents a special type of experimentation: reconstructing the past with the evidence of the present. The search begins in Yellowstone National Park and ends with an impressive collection of clues to a new and dramatic hypothesis about the history of the Mediterranean Sea. This program moved the most slowly for me. I am so fond of Morrison's style and insights that I tired of others telling of their experiences.

Everybody accepts that atoms exist. Morrison shows the viewers why this statement makes sense in the fifth program, "Atoms." In one scene Morrison covers a portion of a pond with olive oil and uses the oil spot's size to calculate an upper limit on the size of the molecule. He enlists Julia Child's expert help and dry humor to show that gourmet soufflés and gem diamonds have a lot more in common than appearance would suggest.

The last program in the series, "Doubt," covers the birth and death of ideas and the continued presence of doubt in science. Beginning with light dispersed by a prism, Morrison sets the stage for learning about the composition of stars. He retraces the footsteps of Cecilia Payne in her stellar spectrum research in the 1930s, which concluded that the universe was 90% hydrogen. Next we visit at Kitt Peak with Vera Rubin [see the news story on page 17], whose work casts doubt on Payne's conclusion. Morrison concludes: "If you ask me now what the universe is made of, I would say that right now we just don't know. What I do know is that we will try very hard to find out."

I highly recommend this series. My only concern cannot be answered until the series is broadcast: Will the balance between truth and clarity chosen by the Morrison writing team keep the viewer's interest? I don't have their faith in the general public's desire to work at learning more about how science knows what it knows. In that same vein, I wish the decision-makers would break out of the one-hour format for these programs. Are the academics fixed in the classroom mode, or are the public television people insisting on some programming consistency? Research shows that even with *Nova* a large percentage of viewers change channels by a half-hour into the program. There are plans to make *The Ring of Truth* videotapes available for individual and classroom viewing in the near future.

Random House is publishing a companion book that follows chapter by chapter the six parts of the television series. It includes personal anecdotes on the making of the series.

Numerical Recipes: The Art of Scientific Computing

William H. Press, Brian P. Flannery, Saul A. Teukolsky and William T. Vetterling
818 pp. Cambridge U. P., New York, 1986. ISBN 0-521-30811-9 $39.50 hardcover

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As a graduate student I took pride in programming all of my subroutines—no "canned" software for me. I also learned from the experience: Although it took me over three solid weeks to complete, the nonlinear least-squares fitting routine I developed taught me the theory behind the fitting process. This understanding was in striking contrast to what those who blindly used canned packages learned. It wasn't until my routine started to diverge as it tried to separate a Lorentzian contaminating component to give a Gaussian spectral line shape that I started to wonder: Wasn't there some merit in using software packages despite not knowing how the routines actually worked?

Numerical Recipes by William H. Press, Brian P. Flannery, Saul A. Teukolsky and William T. Vetterling offers the perfect compromise between the desire to write your own software and the necessity to ensure that the programs you use actually work. In a chapter on modeling data, the authors explain nonlinear least-squares fitting by minimization of chi squared using the method of steepest descent, motivate the Levenberg–Marquardt method that prevents the divergence problem I encountered, and derive the confidence intervals of the fitted parameters by referring to the chi-squared surface. A subroutine that implements the numerical method described accompanies each subchapter. After reading the text, I had a sufficient understanding of the theory behind the numerical method and the way it is implemented to feel comfortable using the book's subroutines "out of the can."

Numerical Recipes describes the theory and practice behind numerical methods in 16 different areas together with over 200 subroutines in FORTRAN and PASCAL that implement the numerical methods described. The subroutines are available in machine-readable form (IBM PC or Macintosh) as a separate purchase. The text itself is written in pleasantly informal prose (complete with a few jokes), which makes the book fun to read despite the massive amount of information in its 818 pages. But what is truly impressive is the insight the authors offer throughout into various aspects of the numerical methods presented.

This book can be used as a supplementary text to extend a course in mathematical methods to include computer applications. It would be difficult, however, to use *Numerical Recipes* as a stand-alone text in any one field. The mathematical analysis, although complete, needs to be supplemented by more encompassing descriptions for those students unfamiliar with a particular topic. For example, in only 70 pages on Fourier-transform spectral methods the book covers discrete data, the fast Fourier transform, multidi-