

Unfashionable continua

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An Idiot's Fugitive Essays on Science: Methods, Criticism, Training, Circumstances.

By C. Truesdell.

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TO DESCRIBE Clifford Truesdell as a theoretician specializing in the mechanics of continuous distributions of matter would, although strictly correct, be misleading. It would fail to convey what this collection of reviews, prefaces and lectures abundantly does convey, the broad scale of Truesdell's researches in mechanics and its history and his concern for and lack of sympathy with the way science is practised today, all so intensely felt and expressed with such mastery of language that my attention was gripped and held.

It is important to study continuum mechanics because

Matter is commonly found in bodies consisting of materials. Analytical mechanics turned its back on this fact, creating the centrally useful but abstract concepts of the mass-point and the rigid body... "modern" physics likewise turns its back, since it concerns solely the small particles of matter, declining to face the problem of how a specimen made up of such particles will behave in the typical circumstances in which we meet it. Materials, nonetheless, continue to furnish the masses of matter we see and use from day to day: air, water, earth, flesh, wood, stone, steel, concrete, glass, rubber,.... All are *deformable*. A theory aiming to describe their mechanical behavior must take heed of their deformability and represent the general principles it obeys.

That theory is continuum mechanics. In renovating its foundations during recent decades, Truesdell and his colleagues have reversed the customary approach:

From the time of NEWTON until recently, many natural scientists considered the mass-point the fundamental quantity of nature, or at least of mechanics. They believed that matter was composed of many small particles obeying the laws of classical mechanics, and that, consequently, the behavior of gross matter could be predicted, in principle, to any desired accuracy, from a knowledge of the intermolecular forces. Thus continuum mechanics appears as an approximate or at best secondary theory within classical mechanics. While this tradition clings on in physics teaching today, it defies reality.... The smallest units of matter are no longer believed to obey Newtonian mechanics.... In fact it is almost the rule that *Newtonian mechanics, while not appropriate to the corpuscles making up a body, agrees with experience when applied to the body as a whole...* Only paedagogical custom has hindered the realization that *as a physical theory, continuum mechanics is better than mass-point mechanics.*

This has been an unfashionable view:

... "physics", by definition, is become exclusively the study of the structure of matter, while anyone who considers physical phenomena on a supermolecular scale is kicked aside as not being a "real" physicist. Often "real" physicists

let it be known that all gross phenomena easily *could* be described and predicted perfectly well by structural theories; that, aside from the lack of "fundamental" (i.e. structural) interest in all things concerning ordinary materials such as water, air, and wood, the blocks to a truly "physical" (i.e. structural) treatment are "only mathematical".

It is curious that these same persons are often sympathetic to non-structural theories on the borders of physics. They do not suggest that a mathematical physiologist investigating models for behavior would do better to try to integrate the equations of motion for the elementary particles making up a rat.

That was written in 1962. Although the point is still worth making, its thrust is blunted by the increasing readiness of physicists to apply theories where they are appropriate, with less fundamentalist prejudice against the macroscopic. One of several reasons for this is the renewed appreciation and extensive development of Poincaré's discovery of great complexity (including chaotic behaviour) in the solutions of the equations of mechanics, even when, as with mass-points, the equations themselves are simple. I would have liked to learn Truesdell's opinion of this new branch of mechanics, but was disappointed to find no mention of it.

Penetrating reviews of books about the Bernoullis, Euler and Newton illustrate Truesdell's insistence that criticisms should be based on detailed study of original sources rather than the writings of commentators. It is a pity that he fails to live up to these standards when attacking "applied catastrophe theory" as a misuse

of mathematical modelling; apart from a brief quotation (without reference) from Zeeman, his remarks are all based on articles by other critics of the theory, and he fails to mention those cases (even in continuum mechanics) where the mathematics has found valid application.

More generally, Truesdell laments the decline of scholarship:

The world of "learning" has become a federation of hives of frightened bees, who so as to maintain their little waxen prisms sting all strangers, be they lions or mice or only bees from the next-door office.

He detests the way science has become a large-scale organized enterprise, that is:

... science for, by, and of the demos, in a word, *plebiscience*. Plebiscience demands what POST has called "inevitable research: ... research which is bound to yield *some* results"... Plebiscience is *big science*. Small science was done by a few great men. Big science calls for many little men.

Worse might be to come:

Plebiscience is an intermediate stage. The next and last is *prolescience*. In it not only is all research inevitable research, but also only outcomes previously known and accepted are allowed. The function of prolescience will be to confirm and comfort the proletariat in all that it will by then have been ordered to believe. Of course that will be mainly social science.

But after pages of splendid raging, with sour prejudice alternating with flashing insight, he is not without hope:

Even now, I think, there are men who live for science, men who strive to bake not witches' mess but giants' bread. What they deliver may be as tedious to the plebs as a lute, but let us not forget that while a cure for cancer may raise the mean age of the population to ninety, a good lute may last to make beautiful music under the hands of men and women yet unborn.

Amen. □

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Celebration of mass on the back of a whale, from an engraving dated 1621. The picture is reproduced from a reprint of the original, 1925 edition of *Whale Ships and Whaling: A Pictorial History*, by George Francis Dow. Publisher is Dover, New York, price is \$8.95.