

Goodstein ends each story with a brief “where are they now” that perhaps illuminates the role of contribution. For example, Kumar, whose claims that he “had just been trying to prepare a more compelling figure” and was “green and naive” were met with considerable skepticism, was nevertheless given the benefit of the doubt. After being dismissed from Caltech, “he served out a three-year banishment from National Institutes of Health funding” and has since resumed his career in science. The unrepentant Ninov, however, after dismissal from LBNL, “found a job as an adjunct professor of physics at the University of the Pacific, which apparently was unaware of his recent history. He is no longer listed on the faculty of that institution.”

Above all, Goodstein is pragmatic. He rejects romantic (“inductivist,” he calls them) myths that see the scientist as insulated from the real world. Scientists want to make careers for themselves; they want to be first with discoveries.

In the last analysis Goodstein, the consummate scientist, comes across as an advocate of humanism—odd as the term may seem. It’s no accident that he cross-listed his immensely successful course with Caltech’s humanities and social sciences division and has cotaught it with a philosopher. Goodstein’s humanism expresses itself as a fundamental belief that scientific honesty is, ultimately, an ethical issue. Scientists, like Caltech’s undergraduates, must live by an internalized honor code. It’s a noble idea.

This, then, is the moral of David Goodstein’s cautionary tales: be good; and if you can’t be good, you’d better be very, very cautious.—JS 

#### A MINE FOR DARK MATTER

*In “A Mine for Dark Matter” in the Spring 2010 issue of E&S, we described the late Caltech astrophysicist Fritz Zwicky using a choice of words to which the Zwicky family strongly objected. They sent us this letter, which we publish exactly as received.*

Dear Editor:

My grandfather, Fritz Zwicky, was a brilliant cosmologist and visionary who courageously forged into the unknown universe and discovered Dark Matter. His morphological methodology, Zwicky Box, allowed him to envision as yet unseen phenomena and realize those in this dimension. *Directed Intuition in Astronomy* - “We shall be concerned here mainly with the prediction and visualization of the existence of as yet unknown bodies in cosmic space.” (Zwicky xi). I can appreciate the attention his historical accomplishments have garnered, Dark Matter, Supernovae, Gravitational Lensing, Sky Survey, and inventor of numerous jet propulsion prototypes holding patents in SQUID Solid Propellant, Thrust Motors with High Impulse, Two Piece Jet Thrust Motor, and Device and Method Jet Propulsion Through a Water Medium, that remain without parallel. The entire scientific intelligentsia, the renowned institutions in the world are spending enormous sums of money, including the greatest minds in science, have all thus far failed to explain Dark Matter 80 years after it was first identified.

My grandfather identified an extravaganza of precedent-setting observations that were not understood by many benighted ignoramus of his time. Therefore, he no doubt invoked

great animosity by telling his colleagues that they were missing 99% of the universe, and that they were only looking at the dustbunnies in front of the door. No conductor wants to be told he has lost his caboose. Hence, there arose great resentment against his genius, and a resulting incessant campaign to suppress his work, extinguish the rightful credit due and transgress his memory upon his passing. Their voices remained remarkably silent during his lifetime.

It is becoming more clear to me that his shining superstar will always illuminate the heavens, and will never be surpassed by those of dimmer luminosity. As a scientific prophet, he will continue to suffer the literary assaults by self-serving authors, propelled by an embittered scientific establishment that continues the siege commensurate with their failure. His memory and work will be respected and accepted by a new generation that is not bound by fossilized paradigms no longer relevant in the sciences. He will be recognized and honored for his professional accomplishments on the world stage.

My grandfather’s words identify the corrosive elements that he encountered on a continuum in the the scientific establishment.

*“I first presented the possibility of neutron stars in my lectures on astrophysics at California Institute of Technology in spring of 1933, suggesting that they are formed by implosions from ordinary stars, with resulting liberation of tremendous energy. In November 1933 I present the theory of the origin of supernovae and of cosmic rays as being caused by the implosion of stars in to neutron stars.” (xiv Zwicky).*

This review was written by John Sutherland, who was on the faculty from 1984 to 1992 and was a visiting professor of literature, and then of English, until 2007. He is now a professor emeritus at University College London.

Engineering & Science welcomes letters. Send correspondence to Douglas L. Smith, editor, E&S magazine, Caltech mail code 1-71, Pasadena, CA 91125, or email [dsmith@caltech.edu](mailto:dsmith@caltech.edu). We reserve the right to edit any letters selected for publication for length, content, and clarity.

*"In contradiction to the professional astronomers, who ignored my views for thirty years, the reporters kept going strong on supernovae, neutron stars and cosmic rays. In the Los Angeles Times of January 19, 1934, there appeared an insert in one of the comic strips, entitled "Be Scientific with Ol' Doc Dabble" quoting me as having stated*

*"Cosmic rays are caused by exploding stars which burn with a fire equal to 100 million suns and then shrivel from 1/2 million miles diameters to little spheres 14 miles thick."*

*Says Prof. Fritz Zwicky, Swiss physicist (xv Zwicky).*

*Galaxies - Galaxies in order to achieve a fruitful meeting of the minds among astronomers who, at the present time seem to be highly confused on the subject of galaxies." (xv Zwicky).*

*"The scholar's mission requires the study and examination of unpopular ideas, of ideas considered abhorrent and even dangerous.*

*"Timidity must not lead the scholar to stand silent when he ought to speak.*

*"In matters of conscience and when he has the truth to proclaim the scholar has no obligation to be silent in the face of popular disapproval.*

*A Statement by the Association of American Universities 1953*

Sincerely,  
Christian Zwicky

### **SOME SUNLIGHT IN YOUR TANK**

It is always nice to see a letter to the editor that I submitted to the Winter 2009 issue elicit a response from other readers. I would like to respond to Phelps Freeborn and Pierre Jungels, who submitted letters to the Spring 2010 issue.

Pierre Jungels:

I can't possibly forget that science and engineering never stand still. I spent my entire career in industry working on long-range research. I even briefly did some Fischer Tropsch chemistry following the Arab oil embargo in the 1970s.

It is not enough to make continuous improvements in your process, especially if you are starting out behind. You must also make improvements relative to *all* the other contenders.

Let me tell you a story illustrating the point. I coined a new process to make an organic compound called aniline. After a few weeks' work, an engineer interviewed me and evaluated the process's potential, giving us some challenging goals to meet. . . .

It took us 12 months to optimize a catalyst and then another six months to demonstrate its life in a pilot plant.

The existing process used a lot of energy to boil water. That was where our new process had a major advantage. There hadn't been any progress in 75 years, but once threatened by us upstarts, the people running the existing process learned how to boil water more cheaply in just those 18 months. When the two processes were compared again, we found that we no longer had any advantage over the existing one. . . .

Heat transfer is indeed a significant problem with the Fischer Tropsch re-

action. A better reactor design would have an impact on the economics. . . .

If you have a spare afternoon and a small test reactor, I suggest you try passing your synthesis gas mixture over a zirconium oxide catalyst. I used Harshaw ZR-0304, 98 percent zirconia and 2 percent alumina. Although the alumina is added primarily to strengthen the pellets, it also adds acidic sites. If you get the same results that I did, you might ask your oil company friends how much more they would pay for the product from the zirconia catalyst than from a conventional iron-based material.

I wish you luck. May the best process win.

Phelps Freeborn:

It is not enough to consider only energy conversion. What's just as important is the investment required to accomplish that goal.

Sunlight is free, but energy from the sun is expensive because humanity does not yet know a cheap way to collect and store solar energy.

Consider the simple case of photovoltaic cells made out of silicon. They come in two varieties: amorphous and crystalline. The crystalline cells are much more efficient, but also much more expensive. The net result is that the two types have similar economics. Neither competes well with fossil fuels.

In my opinion, the winning process to replace fossil fuels will be the one that requires the least new investment. That will involve biology, not physics.

Frank Weigert [PhD '68]  
Wilmington, DE 