"So, what did you measure?" Henry W. Kendall and Physics Junior Lab

by Sean P. Robinson

All students traverse uncertain territory as they push back the limits of their experience, but some routes through this landscape are notably more demanding than others. "Junior Lab" is the advanced laboratory sequence for third-year physics majors at MIT[1]. The Lab's teachers show young physicists how to develop their skills in new directions by testing them against the reality of nature rather than the contrived problems of textbooks. By the semester's end, Junior Lab students learn that nature can reveal exhilarating truths to those who explore it carefully and honestly. The Lab itself is an accumulation of apparatus, ideas and educational traditions collected from generations of instructors. Among these legacies is a spirit of bold exploration, something the Lab shares with one of its most famous teachers: the quietly extraordinary Henry W. Kendall (1926–1999).[2]

KENDALL'S BROAD LEGACY is both remarkable and well documented.[3,4,5] He is remembered as a world leader in experimental particle physics, having received a share of the 1990 Nobel Prize in physics for observations of electron scattering experiments that confirmed the reality of quarks in the substructure of protons and neutrons. He was also a leader in issues of social and environmental policy, as exemplified by his position as a founding member of the Union of Concerned Scientists. On top of all this, Kendall was an accomplished outdoorsman, pilot, photographer and adventurer. He made several pioneering rock climbs in the Yosemite Valley, which are noted in the historical timeline maintained by the Yosemite Climbing Association.[6] As one former student put it, "He was hell to go hiking with."

For many at MIT, however, Kendall is remembered as an effective teacher of experimental physics. Through much of the 1990s, he introduced first-year undergraduates to science in MIT's Freshman Physics Lab. In the years prior, he was in the Junior Lab, and it is there that his teaching style may have had the most lasting influence. When he taught freshmen, he was a gentle guide at the trailhead of experimental physics. When he taught junior physics majors, he was not just the guide, but the mountain as well, a tough piece of New England granite.

"I learned physics in the classroom, but I learned how to be a physicist in Junior Lab."

—Amit Lath

Like nature itself, Kendall's teaching style was demanding and sometimes dispassionate, but it was neither unkind nor uninvolved. He could appear taciturn, but in fact he enjoyed chatting with both students and coworkers, sharing his personal insights into everything from particle detectors, background noise and systematic uncertainties, to hiking, photography, airplanes, marine salvage and politics. For students in particular, these conversations were a kind of reward for having made it a little further up the mountain, to progressively clearer glimpses of what the view from the top must be like.

"So, what did you measure?" he would ask. It's an uncomfortable question for any student hoping to hide the fact that he has no idea what he measured, despite having followed the bullet points in the lab guide. Kendall's expectations in the classroom were no different than those in his research. He treated the experiments performed in Junior Lab as real science, not just some

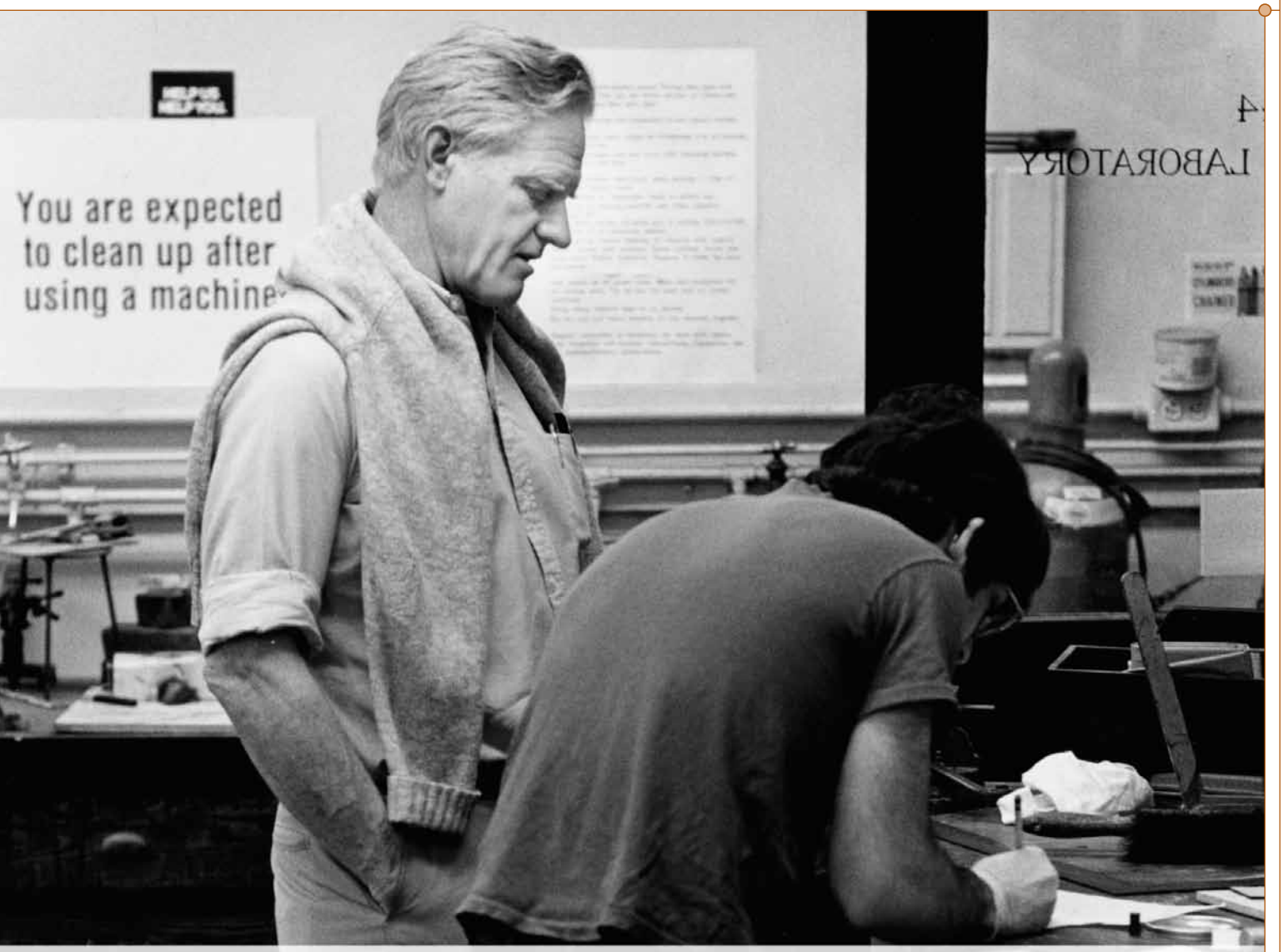
pro forma pedagogical exercise, and he held students to professional standards. Simply going through the motions of an experiment to produce an expected result did not meet these standards. He showed students that science requires them to understand what they had measured, uncertainties and all, and that doing so is just as much art as algorithm.

AMIT LATH WAS HENRY KENDALL'S Junior Lab student in the spring of 1987. Things were not always easy, of course, but Lath made his way far up Kendall's physics mountain trail. After Junior Lab, Lath began an undergraduate research project with Kendall, and then continued on with him to a earn a Ph.D. in 1995. He is now a professor of physics at Rutgers University and a member of the CDF[7] and CMS[8] collaborations at Fermilab and CERN, respectively. "He turned us into physicists," says Lath. "I learned physics in the classroom, but I learned how to be a physicist in Junior Lab." Now a teacher himself, Lath learned from Kendall that he sometimes needs to make himself unpopular with students by exposing the holes in their understanding, and poking at the soft bits that they would have rather kept hidden from their professors.

Kendall was never unkind in his methods, though. Quite the contrary, Lath says, Kendall could be extraordinarily supportive of his students, even when the challenges of Junior Lab were at their peak. On one occasion, he became aware that a group of students — desperate for data but without access to a certain rooftop Junior Lab apparatus over a weekend break — had been employing questionable methods of entry to complete an experiment after hours. Upon learning of this, Kendall is reported to have assured them, "If you get arrested, we will come bail you out." Even before being told this, however, the students already knew what needed to be done. Kendall expected data, not excuses.

With guidance of Kendall's caliber on hand, students could set expectations similarly high for themselves. As explorers of nature, Junior Lab students largely retrace the paths of legendary figures who achieved the first ascents of what have since become essential landmarks on the mountainous skyline of physics. Although the challenge of discovery lies in the past with the lauded trailblazers, the challenge of the ascent itself is no less diminished for the generations who follow. The journey is just as real for them, even if it is not

Henry Kendall supervises a student in the MIT Physics teaching laboratories, circa 1987. (Courtesy MIT Museum.)



The Henry Kendall Teaching Awards

The MIT Department of Physics has recently established the Henry Kendall Teaching Awards, to be granted each semester to a small number of graduate students in recognition of work as a Teaching Assistant that goes beyond the standard expectations of good performance. The award recalls the outstanding commitment to education of Professor Henry W. Kendall and represents the Department's continued commitment to providing physics instruction at a very high level. The award was first granted in February 2010 for work done in the Fall 2009 semester, carrying a monetary prize of $750.

original. As long as the guides in Junior Lab continue to show students how to explore with confidence, without simply leading them through the paces, students will be able to follow the still-echoing footsteps of pioneers like Henry Kendall towards honest results at the trail's end and spectacular views of nature from the top of the mountain.

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ENDNOTES

[1] MIT subjects 8.13 Experimental Physics I and 8.14 Experimental Physics II, hosted since 2006 in the Helena Foundation Junior Physics Laboratory.

[2] Julias A. Stratton Professor of Physics. PhD 1955 (MIT), Thesis supervisor: Martin Deutsch.

[3] Kendall, H. W. (1991). Autobiography. In T. Fränsmyr (Ed.), *Les Prix Nobel 1990*, Stockholm: Nobel Foundation.

[4] Sales, R. J. (1999, February 16). MIT Nobelist Henry Kendall dies at 72 while scuba diving in Florida lake. *Tech Talk*. Retrieved from http://web.mit.edu/newsoffice/1999/kendall.html.

[5] Altschul, B. (1999, February 19). Nobel Laureate Professor Dies in Diving Tragedy. *The Tech*. Retrieved from http://tech.mit.edu/V119/N6/kendall.6n.html.

[6] Hartouni, E. *Yosemite Timeline*. Retrieved April 5, 2010 from Yosemite Climbing Association website: http://yosemiteclimbing.org/content/yosemite-timeline.

[7] CDF: Collider Detector at Fermilab.

[8] CMS: Compact Muon Solenoid.

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