Recollections of Wheeler

John Wheeler's mentoring style is captured in the following quotes from his former students, compiled by Kip Thorne. To set the time frames, which span 50 years, we indicate the year that each student completed his study with Wheeler.

Charles Misner (PhD 1957): "When teaching, John focused on inspiration before content. In any course his first lecture would cover something he was very enthusiastic about. This was usually a research project he or his students were working on. He would give an impression of the questions at the forefront and then explain how they were being attacked. Then he would slowly morph that into the subject of the course and begin to get down to brass tacks."[6]

Kenneth Ford (PhD 1953): "In 1949 I took a course on classical mechanics from John Wheeler. This subject, considered dry and lifeless by some professors, came alive in Wheeler's hands, as he tried to wrest new insights from Hamilton–Jacobi theory. His lectures were rarely polished or 'elegant', which was a source of distress for some students. His approach might best be described as 'personal.' He tried to refashion each part of the subject in his own terms. . . .

We learned by watching him learn. Unafraid to stumble before students, he led us down his paths of thinking, including the twisting turns and the retreats."[1]

Wojciech Zurek (PhD 1979, postdoc 1979–81): "Perhaps the greatest lesson I learned in Wheeler's classes came when—after a half hour of carefully calligraphed derivations that covered several blackboards—John discovered an error had crept into his calculations early on. Without hesitation, and in capital letters that were larger than anything else on the blackboards, he wrote 'WRONG,' and crossed out all the boards! A sense of liberation swept the class. It was possible to be a great scientist and admit that you are WRONG, in capital letters." (Letter to Thorne shortly after Wheeler's death)

Kip Thorne (PhD 1965): "At age twenty-two I had just arrived at Princeton as a graduate student. My dream was to work on relativity with John Wheeler, so I knocked on his office with trepidation. Professor Wheeler greeted me with a warm smile, ushered me into his office, and began immediately (as though I were an esteemed colleague, not a total novice) to discuss the mysteries of the gravitational implosion of a star at the end of its life. . . . I emerged an hour later, a convert and disciple."[7]

Daniel Holz (AB 1992): "[In 1990, as an undergraduate looking for a thesis adviser,] I waltzed into Wheeler's office and asked if he had any projects I could work on. I staggered out of his office four hours later, laden with books, a clearly defined project in my hands."[8]

Richard Lindquist (PhD 1962): "I first became aware of your awesome capacity for hard work, John, during the winter and spring of 1956–1957, around the time of the Relativity Conference at Chapel Hill. No one but you would have had the audacity to co-author a dozen or so separate papers on as many separate topics, and with a like number of different co-authors, [all your students and] all for the same conference. No one but you could have had the brilliance and indefatigability to bring it off! You were determined that your students should get credit for these labors; but everyone knew, not least of all ourselves, that the ingenuity and inspiration were yours, and that your strong right arm had been pushing each of us along at the fastest pace he could manage without stumbling." (Letter to Wheeler[1])

Robert Geroch (PhD 1967): "Wheeler had a global view. He forced you to look out and not be too small. 'If you want to know the answer to this,' he would say, 'let's phone Madam Choquet in Paris right now. If you're interested in topic X, then we better fly in Roy Kerr from Texas to explain it to us.' One comes to graduate school with a kind of 'backing off' attitude, an awe of the big names. He was very good at breaking that. . . . I did not find Wheeler useful on technical things. If I wanted to know, 'Is it true that a spacetime with seven Killing fields actually has ten?' it was not useful to ask him. (But it may have been best that way.) He

Papers cited less often are classified as "well known" (50–99 citations) and "known" (10–49 citations).

Applying that classification scheme to Wheeler's students yields striking results. Eleven of his former graduate students have authored (or coauthored) "renowned" papers. They are Feynman, Misner, Thorne, Jacob Bekenstein, Hugh Everett, David Hill, Bei-Lok Hu, John Klauder, William Unruh, Robert Wald, and Arthur Wightman. Nine more have authored "famous" papers, and another nine have contributed "very well known" papers. In total, more than half of Wheeler's former graduate students have made contributions to the corpus of knowledge that are, at a minimum, "very well known" to their peers. For comparison, less than 7% of all particle-physics papers have 100 or more citations. As a group, Wheeler's students were particularly influential in the development of physics in the 20th century.

Let us examine Wheeler's impact in another way. I have analyzed the content of acknowledgments in each of the dissertations and theses submitted—not just by Wheeler's students—during his years at Princeton and Texas. Most of those acknowledgments were largely pro forma—for example, thanking the adviser "for suggesting this problem and for continued advice." A fair number offered more specific expressions of appreciation. There were also a very few superlative acknowledgments, proclaiming that a deep and profound understanding of the craftsmanship of science had been transferred from mentor to apprentice. They typically took forms like "Thanks to Professor XYZ, I now know what it means to be a professional physicist," or "I thank professor XYZ for providing me a wonderful example of how physics should be done." No professor at Princeton and only one at Texas received more of such superlative acknowledgments than Wheeler. One intriguing aspect of the superlative acknowledgments is that Wheeler received two of the warmest expressions of gratitude from students doing experimental-physics theses for whom he was obviously not the adviser.

In Homer's *Odyssey*, the goddess Athena (disguised as the eponymous Mentor) instills confidence in Odysseus's son Telemachus so that "among people he might win a good reputation." The practice continues among modern mentors. Zuckerman observes that an important aspect of scientific mentoring is the inculcation of professional standards and conduct—a process she calls socialization.[3] Dan Holz, John Wheeler's last advisee of record, summarized his own socialization as follows:

> It is a pleasure to acknowledge the tremendous support and encouragement given to me by

was very good, on the other hand, with research technique. He taught one to try different approaches to problems. You should be a little aggressive sometimes, and sometimes you should be very careful. You should keep the big picture in mind. If a problem got too difficult, you should look for simpler examples. And if your problem is too hard, maybe you should look at the broader picture in search of some other related problem that can be solved. He was great at seeing that a whole set of questions hangs on just one issue, so you should focus on that one.... I remember taking lots of walks with him, talking about this issue and that.... When you write something with him and it comes back with all those red marks all over it, and it goes through three drafts and still has red marks all over, that really brings home to you the importance of writing well.... There was a student who was difficult to talk with because he would interrupt all the time and he spoke with far more assurance than he had any right to. I watched Wheeler train him out of that. Wheeler would just lower his eyes through it all, and when the student finished, he would raise his eyes back up and say something in a completely different direction. In a remarkably short time the student was cured."[9]

Robert Wald (PhD 1972): "[You taught me that] one should always think in a completely down-to-earth manner and decide by physical intuition what ought to be true; then one should obtain a mathematical proof (or disproof) of one's physical conjecture. The first step alone is likely to result in cloudy guesswork; the second step alone may lead only to uninteresting, technical stuff. But the right combination ... can lead to inspiring physics." (Letter to Wheeler[1])

William Unruh (PhD 1971): "I had just got started working on my first research problem and had a few extremely vague ideas. I mentioned them to Wheeler one day, and he said, 'I've received this invitation to a workshop in Gwatt, Switzerland. Would you like to go and present your results?' I was torn because I didn't have any results to present. And then he said, 'Here, I'll write out this telegram,' and he wrote one saying 'Would you please invite Bill Unruh to give a talk.' He handed it to me and said, 'Please phone this in to the telegraph office.' So I wandered around for two or three hours agonizing over whether to send this telegram, because if I sent it, I was committed. I finally did send it and then had three months to get some results worth presenting."[10]

Richard Feynman (PhD 1942): "When I was a grad student with him, Wheeler was sometimes too fast for me. One day we were working on a calculation together. I couldn't see how he got from this point to the next. 'Little steps for little people,' Wheeler said, as he spelled out for me the steps he had omitted." [Comment by Thorne: Feynman told me this in about 1972. I've never heard any other student or colleague describe Wheeler behaving so impolitely; normally he was unfailingly polite. I suspect he knew that Feynman could handle such a cutting remark and thought Feynman needed it. Feynman as a student had a reputation for brashness and arrogance. Twenty percent of Feynman's 1965 Nobel Prize lecture[5] is devoted to inspirations that he derived from discussions with Wheeler and to how those inspirations led to his prize-winning formulation of quantum electrodynamics.]

David Sharp (AB 1960): "One day [when we were working together on a research problem at your summer home on High Island, Maine] a man came to see you. He had a 'theory' of something or other that he wanted to explain. It became clear after about 30 seconds that the man was a 'crackpot.'... As the discussion dragged on, I began to seethe with impatience, thinking of all we had to do. But not you. You treated the man with respect.... You met his ideas head on and quickly but kindly demonstrated the flaws in them. I'm sure that when the man left he was still convinced of the basic correctness of his 'theory.' But he did acknowledge the flaws (which were devastating) and I'm equally sure that he felt that he had been treated fairly. You never spoke a word directly to me about this incident, but the man with the theory was not the only person in the room who learned a lesson that day." (Letter to Wheeler[1])

John A. Wheeler. Over the last two years [1990–92] he has introduced me to the world of physics research and shaped the way I think about physics. I have benefited greatly, both as a physicist and as a person, from his example, and will carry this with me always. John Wheeler has had a profound impact on my life and I am deeply indebted.

A great legacy endures.

The online version of this article provides a link to the longer, more fully documented original manuscript.

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