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SCIENTIFIC MISCONDUCT

Bell Labs Fires Star Physicist Found Guilty of Forging Data

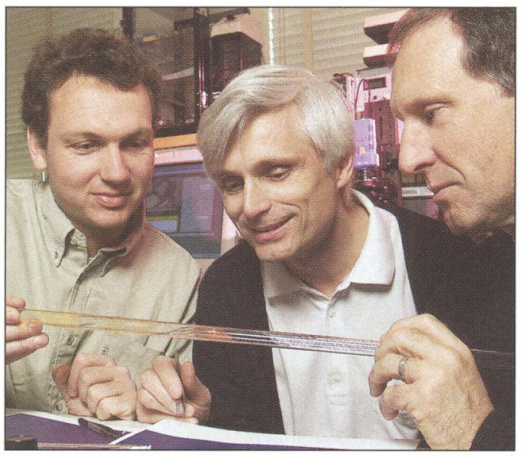
Like the mythical Icarus, whose waxen wings melted when he flew too close to the sun, the soaring career of Jan Hendrik Schön came crashing down to Earth last week. Schön, a 32-year-old physicist at Bell Laboratories in Murray Hill, New Jersey, faked experimental results in at least 17 published papers, according to a report released 25 September by a panel of independent investigators. Schön had been fired from Bell Labs the previous evening, after officials there received the report. The findings mark this as one of the most extensive cases of scientific misconduct in modern history and signal a low-water mark for Bell Labs, an institution already reeling from economic troubles of its parent company, Lucent Technologies.

"It's a big train wreck and very sad," says Lydia Sohn, a Princeton University physicist who was one of the first to point out Schön's apparent manipulation of data. "But this shows that the system of checks and balances in science works." Others were less consoled. "If this guy [had been] a little less blatant, he could have succeeded. That's the terrifying thing," says Paul McEuen, a physicist at Cornell University in Ithaca, New York.

The panel cleared Schön's coauthors of any direct scientific misconduct. But it left open questions that are likely to reverberate through scientific circles for years to come. Chief among them are whether papers Schön coauthored that were not reviewed by the committee are valid and whether Schön's coauthors, the journals that published his papers, or scientific referees should have caught the fraud earlier. "There are other questions, and they are for others to address," says Stanford University physicist Malcolm Beasley, who chaired the panel.

Bell Labs hired Schön as a postdoctoral researcher in 1998 to work with Bertram Batlogg—then Bell's head of solid state physics research—on investigating how electrical charges move through crystals of organic semiconductors. Working with crystal grower Christian Kloc, Schön and Batlogg made rapid progress. Early on, they reported a new way to inject large electric currents into their organic crystals. That advance produced an extraordinary string of effects, including superconductivity, the fractional quantum Hall effect, and laserlike behavior. "He rediscovered everything in condensed matter physics in the last 60 years" in organic materials, Sohn says.

In his 4-year career at Bell Labs, Schön's steady stream of stunning breakthroughs promised to revolutionize the fields of organic electronics, superconductivity, and nanotechnology. By the beginning of this year he had produced a string of more than 90 papers, most of which listed him as the lead author. In 2001, Schön churned out a new paper on average every 8 days, a level of productivity nearly unheard of in physics.



Shattered trust. Panel fingered Schön (left) for misconduct but cleared former partners Kloc and Batlogg.

To researchers watching from the wings, Schön seemed to be a Tiger Woods of physics, a young prodigy overwhelming the competition. "These papers came out and you'd say, 'Oh, no,' " recalls Arthur Ramirez, a physicist at Los Alamos National Laboratory in New Mexico. "It would be a monthly demonstration of how stupid you are. He was creating a new field every 2 months."

Late last year, two of Schön's breakthroughs rocked the nascent community of nanotechnologists. In the 18 October 2001 issue of *Nature*, Schön, working with Bell Labs colleagues Zhenan Bao and Hong Meng, reported a novel transistor in which a single layer of molecules carried out the critical role of switching between two electronic states, the foundation of more-complex computer technology. In the 7 December 2001 issue of *Science* they went further, reporting evidence of a single molecule acting as a switch.

The sensational results were hailed as a triumph of nanotechnology and a key step toward the ultimate in miniaturization of computer technology. In April, Schön received the Outstanding Young Investigator award and $3000 in prize money from the Materials Research Society. *Technology Review* magazine named him one of science's top young innovators in its June issue, which went to the printers before the allegations of misconduct surfaced in May. Around the same time, Schön was also being considered for the directorship of the Max Planck Institute for Solid State Research in Stuttgart, Germany.

But Schön's bold results turned out to be his undoing, attracting intense scrutiny to his work. In April, outside researchers noticed that a figure in the *Nature* paper on the molecular-layer switch also appeared in a paper *Science* had just published on a different device. Schön promptly sent in a corrected figure for the *Science* paper. But the incident disturbed McEuen, who says he was already suspicious of results reported in the two papers. On 9 May, McEuen compared figures in some of Schön's other papers and quickly found other apparent duplications. The next day, he alerted officials at Bell Labs, who immediately organized a five-member panel to review the allegations and a host of others that poured in shortly after (*Science*, 24 May, p. 1376; 31 May, p. 1584; 5 July, p. 34).

The panel ultimately focused on 24 allegations of misconduct in 25 separate papers that included 20 co-authors. In its inquiry, the panel sent each co-author a list of questions detailing concerns raised about studies in which they participated. In late July, panel members visited Bell Labs and conducted extensive interviews with Schön and his three primary co-authors, Batlogg, Kloc, and Bao. They also reviewed computer logs and data files. After sifting through all the evidence, they concluded that Schön had either falsified or fabricated data in 16 of the 24 cases. He had also deleted his original data files, making it impossible to check his

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scientific claims. "The evidence that manipulation and misrepresentation of data occurred is compelling," the report concludes.

Despite repeated attempts, Schön could not be reached for comment. But in a response included in the report, Schön said, "I have to admit that I made various mistakes in my scientific work, which I deeply regret. … However, I would like to state that all of the scientific publications that I prepared were based on experimental observations." Schön apologized for his mistakes but added that he was confident that the underlying physical effects are "real, exciting, and worth working for." In a telephone interview the week before the report's release, Schön said he had been trying all summer to confirm his earlier results, but to no avail.

The Beasley committee found no evidence of misconduct by any of Schön's co-authors. But the report raises pointed questions about the role of Batlogg, Schön's initial supervisor, who left Bell Labs last year to become a professor at the Swiss Federal Institute of Technology in Zürich. It asks, "Should Batlogg have insisted on an exceptional degree of validation of the data in anticipation of the scrutiny that a senior scientist knows such extraordinary results would surely receive?" Says Beasley about the responsibility of co-authors: "That's a very difficult issue and one that the scientific community has not thought deeply about."

Few other researchers seem ready to let the matter rest there. "Batlogg was certainly happy to bask in the glow when things looked wonderful. But you can't have it both ways and not accept some level of the burden of responsibility," says one physicist who asked not to be identified. Ramirez agrees. "This is something he is trying to wash his hands of, and I don't like it," he says. "It's really tragic. He's had 25 years of research. He's lost that standing. He's going to have to work hard to regain a level of credibility."

Batlogg acknowledges that he should have done more to confirm the accuracy of the papers he co-authored. "I have learned, with the deepest of regrets, that the verification measures I have followed in this extraordinary case were not adequate to prevent or uncover scientific misconduct," he wrote in an e-mail message to *Science*. He says he plans to redouble checking procedures in the future but that "trust in colleagues shall and must remain one of the foundations on which we build future research endeavors."

Other critics are equally hard on higher-ups at Bell Labs. "They should have said, 'Look, Hendrik, these are extraordinary claims being made. We need to see what is going on,' " McEuen says. Cherry Murray, the labs' vice president for physical sciences research, argues that when concerns began surfacing late last summer, Schön's supervisor John Rogers and other Bell Labs officials did begin asking for more information, which Schön readily provided. But when asked whether the misconduct should have been caught earlier, she acknowledges that "with 20/20 hindsight the answer is yes."

Murray says that Bell Labs officials are now taking steps to head off similar problems in the future. Precautions include an internal preprint server that will allow all researchers at the labs to review and comment on papers before they are sent out for publication, in hopes of ferreting out dubious science before it is made public.

Perhaps the biggest question the report leaves hanging is the fate of Schön's papers. Murray says that Bell Labs management is working with the authors to submit retractions for the papers that were red-flagged by the committee. But that could be difficult. Donald Kennedy, editor-in-chief of *Science*, notes that all of a paper's authors must agree for *Science* to issue a retraction. "We have been in continuing discussion with the Bell Labs leadership to bring that about promptly for each paper," Kennedy says. "We have also agreed that if those efforts fail, we will invite co-authors to issue their own statements and publish them together with an editorial announcement of *Science*'s position with respect to each paper."

Nature's head physical sciences editor, Karl Ziemelis, says *Nature* might not wait for the authors to act. "It's absolutely clear, given the verdict of the panel, that the papers need to be retracted," Ziemelis says. "But if that doesn't happen quickly, we almost definitely will take other actions," such as publishing a notice to readers informing them of the committee report and its specific conclusions involving *Nature* papers, Ziemelis says. He adds that *Nature* will invite Schön and his colleagues to retract two other *Nature* papers not reviewed by the committee.

Retractions are unlikely to allay widespread concerns among physicists that journals gave some of Schön's papers expedited treatment in their eagerness to publish the sensational results. But both Ziemelis and *Science*'s lead physical sciences editor, Phillip Szuromi, say that thorough reviews of the referee reports show that wasn't the case. "The referee reports weren't supporting rejecting the papers," Szuromi says. *Nature*'s referees did raise questions about some of the papers *Nature* published, Ziemelis says, but those centered almost exclusively on the interpretation of the results. "What was almost unanimous was overall praise for the data presented in the papers," he says.

Now, researchers are likely to treat all of Schön's data as suspect. Many say they have no choice but to stop citing any paper bearing Schön's name, to maintain their own credibility. "For me this [misconduct] basically invalidates the whole body of work," Ramirez says. Adds McEuen: "I'm just pretending that the work doesn't exist. Actually I don't have to pretend. It doesn't." **–ROBERT F. SERVICE**

PAPERS IN WHICH MISCONDUCT WAS FOUND

"Ambipolar pentacene …," *Science* (11 February 2000)

"A superconducting field-effect switch," *Science* (28 April 2000)

"An organic solid state injection laser," *Science* (28 July 2000)

"A light-emitting field-effect transistor," *Science* (3 November 2000)

"Superconductivity at 52 K in … C_{60}," *Nature* (30 November 2000)

"Perylene: A promising …," *Appl. Phys. Lett.* (4 December 2000)

"Ambipolar organic devices …," *Synthetic Metals* (2001)

"Gate-induced superconductivity …," *Nature* (8 March 2001)

"Solution processed CdS …," *Thin Solid Films* (2 April 2001)

"High-temperature superconductivity in lattice-expanded C_{60}," *Science* (28 September 2001)

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"Self-assembled monolayer organic …," *Nature* (18 October 2001)

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"Field-effect modulation …," *Science* (7 December 2001)

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"Nanoscale organic transistors …," *Appl. Phys. Lett.* (4 February 2002)

"Sputtering of alumina thin films for field-effect doping," preprint