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CHEMISTRY

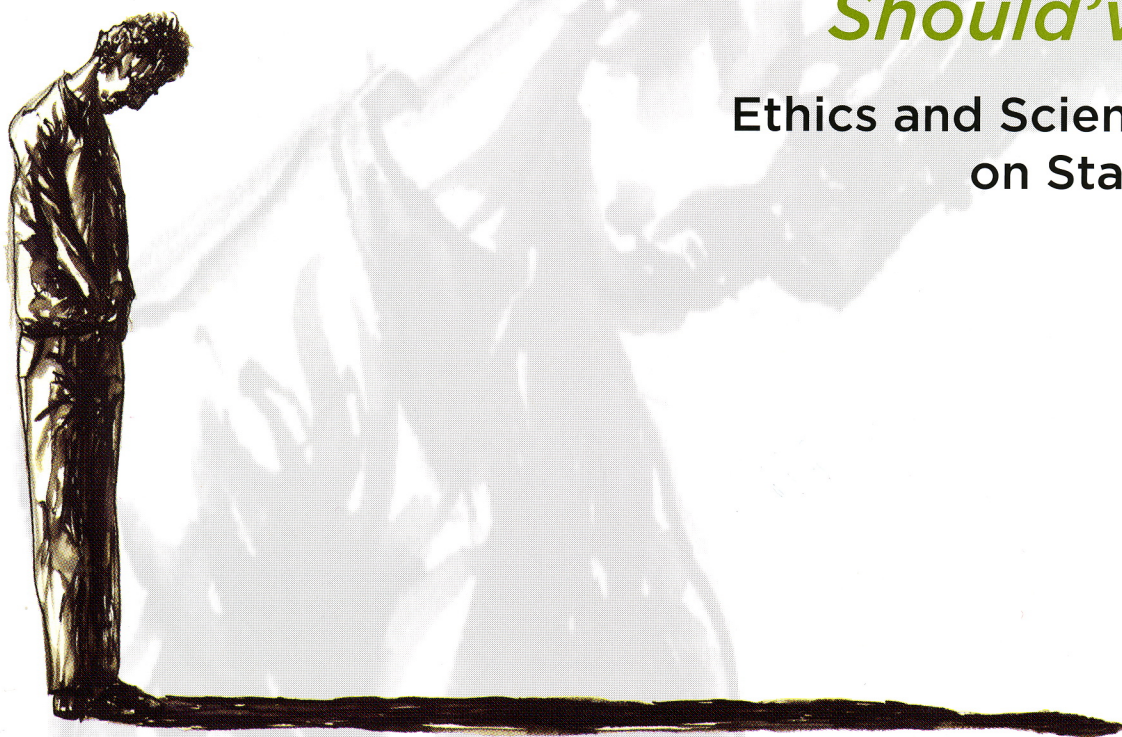
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Roald Hoffmann's *Should've*

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on Stage



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Roald Hoffmann's *Should've*

Ethics and Science on Stage

Ethics and social responsibility are not easy topics to address. However, the more the scientific community learns about nature and the world,

the more these issues will take center stage. In fact, the stage is what Roald Hoffmann uses to explore the ethical dimensions of science in his latest play *Should've*. The play is a mystery, a savant mélange (what else would you expect from a chemist?) of people from different generations and backgrounds, who have to deal with issues of the past and the present, in science, art, and life. The performance begins with a suicide offstage, which stirs up the lives of everyone involved and

leaves numerous unanswered questions. Throughout the story, various aspects of social responsibility are addressed, shedding light on conflicts and dilemma.

The chemistry of Hoffman's production is certain to catalyze discussion among those in attendance. A synopsis and full text of the drama are available on Hoffmann's website.*

C/ invited **Liberato Cardellini (LC)** to interview **Roald Hoffmann** on the topic of scientific social responsibility. Cardellini, a member of the IUPAC Committee on Chemistry Education (CCE), conducted an earlier interview with Hoffmann titled "Looking for Connections."

The play will be staged in Torino on the opening night of the next IUPAC Congress on Sunday 5 August 2007 at 17:00. Following the initiative of CCE Chair Peter Mahaffy, a symposium titled "Beyond *Should've*: Ethical Issues in Science & Education" will take place during the Congress program as part of Session 10 (Advances in Chemical Education).

As a prelude to viewing the play, we recommend taking a short journey in "Hoffmann's Land between Chemistry, Poetry, and Philosophy."*

Liberato Cardellini (LC): Friedrich Wertheim, a chemist and the inventor of the saxotonin synthesis, killed himself. Are we responsible for the misuse of the molecules we make?

Roald Hoffmann (RH): Before I answer, let me make an obvious comment: A play with all characters reflecting the author's opinion is a worthless play. Or to put it another way: In Pirandello's *Six Characters in Search of an Author*,¹ which of the six characters reflects the way the playwright feels? So, the characters in the play differ in their response to your question.

But you are asking me for my personal opinion about the social responsibility of scientists. Here's what I think (from *The Same and Not the Same*²): There are no bad molecules, only evil human beings. Thalidomide seems as harmful as they come, in the first trimester of pregnancy. But it is useful in treating inflammation associated with leprosy. And there are recent studies claiming that thalidomide can inhibit the replication of HIV-1 (the virus that causes AIDS). Nitric oxide, NO, is an air pollutant but also an absolutely natural neurotransmitter. Ozone serves an essential (to us) function in the stratosphere, a thin layer of it absorbing much of the harmful ultraviolet radiation. At sea level the very same molecule is a bad actor in photochemical smog, the atmospheric pollution caused mainly by automotive exhausts. Ozone destroys automobile tires (weak vengeance), plant life, and our tissues.

Molecules are molecules. Chemists and engineers make new ones, transform old ones. Still others in the economic chain sell them, and we all want them and use them. Each of us has a role in the use and misuse of chemicals. Here is what I see as scientists' social responsibility to their fellow human beings. I see scientists as actors in a classical tragedy. They are sentenced by their nature to create. There is no way to avoid investigation of what is in or around us. There is no way to close one's eyes to creation or discovery. If you don't find that molecule, someone else will. At the same time I believe that scientists have absolute responsibility for thinking about the uses of their creation, even the abuses by others. And they must do everything possible to bring those dangers and abuses before the public. If not I, then who? At the risk of losing their livelihood, at the risk of humiliation, they must live with the consequences of their actions. It is this which makes them actors in a tragedy and not

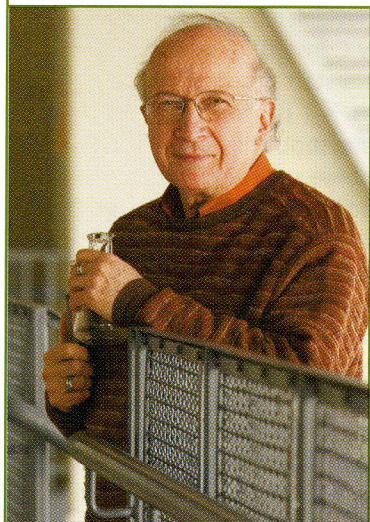


Photo credit: Creative Eye-images Photography.

Roald Hoffmann

*www.roaldhoffmann.com

About the Play

comic heroes on a pedestal. It is this responsibility to humanity that makes them human.

LC: In one way or another, all the characters in your play *Should've* are guilty. If we judge the persecutor and the victim both to be guilty, are not we doing an injustice to the latter?

RH: I agree that it is fallacious to judge the perpetrator and the victim as both guilty. And that, incidentally, is the moral failing of Michael Frayn's *Copenhagen*, to build a case that [Niels] Bohr was as guilty, if not more so, than [Werner] Heisenberg. Guilty may not be the right word for the characters in my play. I think they all have failings that are revealed as the play unfolds. That's the way human beings are.

LC: More than Stefan (see box About the Play), Julia reflects your view. How much do you two have in common?

RH: There are differences, of course, of gender and profession. But Julia and I have in common that we look for and value the middle. (see "This I Believe" box, page 6). We tend to avoid struggles, she and I, but when we are pushed we will act.

LC: In the play you raise the question of the freedom of research. Is a code of conduct necessary here? Without ethical restraint, cannot the experiments performed on Block 41 in Birkenau and Block 10 in Auschwitz be repeated?

RH: Yes, I believe that an ethical code of research is necessary, for all scientists (and the play makes the point that artists too are prone to the romantic fallacy that all they do is good). Scientists are not born with ethics, nor is science ethically neutral. I think courses in ethics, or better still discussion groups, based on case studies, should be a part of the education of all scientists, and also that discussion should be continued throughout life, even for experienced scientists. I actually would argue a stronger case, one with which many of my colleagues would not agree, that there is some research that should not be performed.

LC: Your play concerns ethics and moral behavior, which calls for judgments to be made. How do you

As *Should've* opens, Friedrich Wertheim, a German-born chemist, has taken his own life, blaming himself for putting an easy way to make a neurotoxin into the hands of terrorists. The circumstances and reasons for his death disturb profoundly the lives of three people—his daughter Katie (a scientist herself, a molecular biologist, but with very different ideas about the social responsibility of scientists), Katie's lover Stefan (a conceptual artist), and Wertheim's estranged second wife, Julia.

In 26 fast-moving scenes, these people's lives are fractured by the suicide. The motive for Wertheim's action isn't as simple as it seems; a story about his parents' survival in Nazi Germany emerges.


A play about the social responsibility of scientists and artists, *Should've* is also about three people trying to resist the transforming power of death. They are unable to do so, sundered as they are by the memories and a past that emerges from that death. And, eventually, the consequences shape a different bond among the three.

Produced by The King's University College, *Should've* is directed by Stephen Heatley of the University of British Columbia and designed by Daniel vanHeyst of The King's University College. Professional actors Robert Clinton, Maralyn Ryan, and Michele Brown are based in Edmonton. The performance will be performed on Sunday 5 August 2007 at 17:00 as part of the opening ceremony of the IUPAC Congress in Torino, Italy.

judge the behavior of the famous German Jewish chemist Fritz Haber, who is responsible for the development of chemical warfare agents? And, how, may I ask, does this judgment differ from that of the famous German Jewish physicist Albert Einstein who called for the development of the atom bomb?

RH: I think Haber was naïve, thinking that chemical weapons would be a catalyst for change, and his naïveté and arrogance led him—in this part of his life—to a terribly wrong decision. I believe in an ethics that comes out of dialogue between human beings, not prescriptive rules. So I think that Einstein's advocacy of atomic weapons, in his letter to Roosevelt, was justifiable as self-defense in the face of Nazi German aggression and immorality.

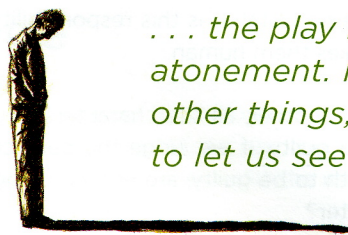
LC: Robert Oppenheimer said after the making of the atom bomb: "The physicists have known sin."³ Have the chemists also known sin? Is your play a way of seeking atonement for the sins attributed to chemists?



*Scientists are not born
with ethics, nor is science
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Roald Hoffman's *Should've*

RH: Chemists and physicists put tools of great good, and of potential destruction, into the hands of human beings. Who may abuse them, or, as in the case of the atom bomb, build it for good reason, and still become actors in a Greek tragedy. There are moments where this become clear; Oppenheimer saw such a moment. I think in chemistry we saw sin when Fritz Haber's soldiers opened up a chlorine tank on the western front. No, the play is not an atonement. It is, among other things, an attempt to let us see extremes (of Katie's view, of her father's), to see the good reasoning and perhaps the potential tragedy behind them. As I say it, I don't think that I succeed yet in showing that in



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Katie's path; I have to work more at it. I would like people to come from the play with no answer as to what to do, but with the feeling that this—the social responsibility of scientists—is worth agonizing about.

This I Believe

by Roald Hoffmann

I believe the middle is tense, the middle is interesting. It may not be what the world wants, least of all what journalists (and that includes NPR journalists) want. "Is that hurricane the worst you've experienced?" Strong opinions, extremes make a good story. And... for the teller, the extreme is a haven. Where the water is calm, where your back is secure against a wall.

Why do I then like the nervous middle? Because I am the way I am, also perhaps because I'm a chemist.

The way I am: I was born in 1937 in southeast Poland, now in Ukraine. Our happy Jewish family was trapped in the destructive machinery of Nazi anti-Semitism. Most of us perished. In my case my father, three of four grandparents, and so on. My mother and I survived, hidden out the last 15 months of the war by a friendly Ukrainian schoolteacher, Mikola Dyuk. I just learned that the foreign minister of Poland, Adam Daniel Rotfeld, living under an assumed identity in the Greek Catholic monastery in that tiny village, went to

school in exactly the house where I was hidden. I probably saw him playing outside.

Sad to say, most of the Ukrainian population in the region behaved badly in those terrible times. They helped the Nazis kill us. And yet, and yet, some saved us, at great risk to their lives.

I couldn't formulate it then, but I knew it, just knew it, from our experience—that people were not simply good or evil. The potential was there for both.

In time we came to America. I became a chemist. Chemistry is substances and their transformations, a science in the middle in many ways. Not quarks, not galaxies, molecules are intermediate. And poised along several polarities. One is of their harm and benefit, another is of being pure/impure, natural/unnatural, of being classical or quantum objects, capable of being taken apart, or put together.

Take morphine. Anyone who has had an operation knows what morphine is good for. And it is a deadly, addictive drug. Take ozone—up in the atmosphere, a layer of it protects us from harmful ultraviolet radiation (of our life-giving sun). At sea level, ozone is produced in photochemical smog, chews up

tires and lungs. Not any other molecule, one and the same molecule.

A fundamental idea in chemistry is equilibrium, which doesn't mean lying there, quietly. Chemistry is about change, it's about $A + B$ going to $C + D$. And going back. At equilibrium there's some A and B, some C and D. It just looks placid, that middle. But it's a dynamic middle, ripe with potential for change. Do you want to have the reaction go one way, or the other? We can perturb that equilibrium.

The middle is not static—my psychological middle, the chemical equilibrium. The middle has the potential, I have the potential, you have the chance of going one way or another.

I like that. Yes, I also want stability. But I believe that extreme positions—all reactants, all products, all people A bad, all people B good, no taxes at all, taxed to death—are impractical, unnatural, boring, the refuge of people who never want to change. The world is not simple, though God knows political ads (on every side) want to make it so. I like the tense middle, and am grateful for a world that offers me the potential for change.

 www.roaldhoffmann.com

Ethics and Science on Stage

LC: "I'm nothing without my science," Katie says. Are scientists different from doctors or automobile mechanics? Why is it easy for us to believe (or to cherish false hopes) that science will give us immortality?

RH: Interesting question . . . When she said it, it was almost a statement of desperation; she (like many other addicts to science) defined herself and her worth as a human being in terms of her profession. But so many things make us up—our parents, our children, our friends, the good we have done (and the bad). The interesting thing is whether an unconscious desire to conquer immortality is the driving force to make great art or science, to leave something lasting behind . . .

Acknowledgments

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and for assistance during the interview.

References

1. L. Pirandello, *Six Characters in Search of an Author*. Translated by Stephen Mulrine, Nick Hern Books: London, 2003.
2. R. Hoffmann, *The Same and Not the Same*. Columbia University Press: New York, 1995.
3. P. Goodchild, *J. Robert Oppenheimer, Shatterer of Worlds*. Fromm International Publishing Corporation: New York, 1985, p. 174.

Liberato Cardellini <libero@univpm.it> is a professor in the Dipartimento di Scienze e Tecnologie Chimiche, in Ancona, Italy, and a member of the IUPAC Committee on Chemistry and Education.

Roald Hoffmann <rh34@cornell.edu> is the Frank H.T. Rhodes Professor of Humane Letters at Cornell University, and recipient of the 1981 Nobel Prize in Chemistry (shared with Kenichi Fukui).

Guilt, the artwork on the cover of this issue, is by Martin Bolchover.



Stamps International

A Stamp Your Crystallographer Would Like

Minerals and gems are depicted on a relatively large number of stamps due to their inherent beauty, natural abundance, or commercial value. There are at least a dozen different stamps showing attractive samples of pyrite, quartz, or malachite, and many more illustrating diamonds or gold. However, particularly appealing to me are those stamps that portray less conspicuous elements or minerals, especially when pertinent information like the corresponding name or chemical formula is indicated too. A beautiful example can be seen on the stamp that accompanies this note and features a specimen of scheelite, one of the common mineral ores of tungsten.

First identified in 1821, scheelite is a calcium tungstate (CaWO_4) and is often found as relatively large golden yellow or orange crystals. Notable sources of this mineral are located in Australia, Austria, Bolivia, Brazil, the

Sichuan province in China, England, Finland, France, Italy, Japan, the Tong Wha mine in South Korea, Myanmar, Sri Lanka, Sweden, Switzerland, and the United States. It was named after the famous Swedish chemist Carl Wilhelm Scheele (1742–1786), who discovered tungsten independently from the d'Elhuyar

brothers in Spain among many other accomplishments. For example, Scheele is partially credited with the discovery of oxygen and chlorine, which he actually achieved before—but unfortunately published after—the isolation of these elemental gases was reported by Joseph Priestley and Humphry Davy, respectively.

Remarkably, the Peruvian stamp pictured herein not only includes the name and chemical formula of the mineral but accurately shows that it crystallizes in the tetragonal system, which can be regarded as an elongated cube (i.e., a rectangular prism with a square base [thus, $a = b \neq c$] and right angles between the three crystallographic axes [$\alpha = \beta = \gamma = 90^\circ$])!

Written by Daniel Rabinovich <drabinov@email.uncc.edu>.

