

THE FUZZY BOUNDARY: SCIENCE AND ART

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A conversation between Roald Hoffmann and Enrique Martínez Celaya

Enrique Martínez Celaya: I became a student at Cornell the year after you received the Nobel Prize in chemistry for your contributions to the understanding of chemical reactions. All of us—the physics majors—looked up to you and tried, in vain, to understand your papers.

By the time I knew enough quantum mechanics to take a stab at your science, I was even more intrigued by your reputation as an excellent teacher and a thoughtful human being. It was inspiring for a nineteen year old physics' student to know that someone could be a great scientist as well as effective in life. Now, as a thirty-eight year old artist aware of your poetry as well as your science, my attention turns to your incentives. And what I find is a profound belief in the possibilities of humanity—a great positive spirit. Where does this energy come from and how do you sustain it in our difficult world?

Roald Hoffmann: You're very kind in your introduction, Enrique. All I can say is that I try. At 66, the energy is not limitless, and what there is does not come without personal sacrifice; I'm not crying, it's an exciting life in so many ways, but also not a life I'd recommend to everyone. As for the belief in humanity—oh, yes—I turn sad and pessimistic sometimes; wars do that to me, and my own inadequacies. But then I look at the world, and all the wondrous things people have done, always more than they think they could have done, and I forget about myself.

EMC: It's not necessarily a contradiction, but it's nonetheless surprising to find so much optimism in someone who spent his childhood in fear. What allowed you to overcome the gloom of the Nazi atrocities and the killing of your father?

RH: Simple survival, Enrique. There seemed to be such an urge to get on with life among my family and others. People married right after the war—my mother married another survivor—and had children at a record rate. I think even as a child I felt that surge of life around me.

Was it not in some way like that for the Cuban émigrés in this country, for your people?

EMC: Yes, I think it was a similar experience for my family, but unlike the Holocaust émigrés some of us felt ambivalent about what was left behind. For some, the Revolution was a tragedy that destroyed Cuba. For me, the real tragedies were the separation of families, the loss of continuity, the displacement of language and the irreversibility of the events that follow leaving one's country. Probably because of these, I'm more concerned with the consequences of loss to the individual, and less so with broad political statements. To be an exile is both a common thing and a profoundly specific existence. Do you consider yourself an exile?

RH: No, not really. I was an immigrant to be sure, and by virtue of that forced to learn ever new languages, to be an outsider, a watcher. But this was also consistent with being an only child for 17 years. Not a lonely child, but one who learned to be alone.

EMC: When did you realize that you had a gift for chemistry?

RH: Sorry to disappoint you, in two ways. First I don't believe in gifts for chemistry, or, for that matter, for poetry, or for politics. Do you hear ever of any children who write great poems or are super chemists or politicians? Math and music and art are different.... For these it looks like you have to have talent, there is precocity.

Second, I fell into chemistry by mistake, starting as a premed, then getting up the courage to tell my parents I didn't want to be a doctor. But not having enough courage to pursue the world of humanities opening up around me, I learned to love chemistry. It's just wonderful. I think I was not sure that I was good in chemistry until my very last year in graduate school, when I was 26.

EMC: I know that your work at Brookhaven National Laboratory [a government research lab on Long Island] was important in keeping your interest in science. Brookhaven also fueled my own interest in physics. I worked with dye lasers during the day and went jogging around the lab in the evenings. The lab was good place to learn and be alone. I will always have great memories of those summers.

RH: Oh, it was wonderful to get on a bicycle from the Cosmotron—what a name!—and rush the sample down to the lab. I was carrying a thousand atoms of carbon-11, and when I got to the lab, there were only 500 left! That was magic.

EMC: What did it mean to win the Nobel Prize?

RH: A joy for my family, and for the Jews from Zloczow who survived. A sadness when one thought of so many children who didn't live. We cried, I cry, for them. It meant a lot too because my wife was Swedish, and I knew the culture and the language. In chemistry, it didn't matter much—you know, our field values what we do right after it is done. The Nobel Prize comes long after community recognition.

EMC: You have described the language of science as a language under stress and therefore poetic. Could you tell me more about this?

RH: The practice of science demands precise meanings. Which must be defined in beautifully imprecise words. Mathematical equations and chemical structures are required to be explained in words. All the time, new concepts, begging for new words, force themselves on us.

EMC: What about the importance of aesthetics in science. Is the concept of beauty of significance in science?

RH: The concept of beauty is extremely important, even as you're not allowed to talk about it in our stock-in-trade, the scientific paper. There's an associated problem in that beauty gets confused especially in the minds of reductionist physicists, with simplicity. So some say: this equation must be right because it's beautiful, simple. But the world is beautifully complex, and the problem is how to find beauty in messy complexity.

EMC: Faced with complexity, the hold of a simpler world is hard to resist—a simpler world where everything can be resolved with solutions that are familiar. Where everything that looks different can be reduced to something I already know. Perhaps, there are only two kinds of philosophical approaches; looking for sameness in things that look different and looking for difference in things that appear the same.

RH: It's one of the great dualities, perhaps the most important one. And, subconsciously, the question of identity powers chemistry. This is why I entitled one of my books *The Same and Not the Same*. When I was younger I was more inclined to see the likeness in things—using one theoretical approach to explain all molecules. As I got older, I found ways to favor difference.

EMC: Do you think the removal of mystery a condition of science?

RH: I think so. Science is a process of demystification. But not desacralization One finds new, wonderful, deep things.

EMC: Discoveries that enrich your relationship with the world.

RH: Yes. Knowing how a hawk's wings work aerodynamically adds to admiring its soaring flight. Science does make you think of intrusive tests of understanding—if I want to know how this works, let me trap that molecule, perturb the system in some way. This intrusiveness is sometimes problematic.

EMC: When is it problematic?

RH: When it is overtly invasive, as in dissection [I said I escaped being a doctor...]; even when that may be the only way to learn how things work. It may also be that intrusive science encourages a too mechanistic view of the world.

EMC: Perhaps science is at its best when it keeps mind of the whole while working the part. But even accounting for its shortcomings, isn't science an intrinsically good bridge between nature and mind?

RH: A most natural bridge, uncovering how nature works. But does one need science to ponder a sunset or think about olives and their need to be cured?

EMC: Is your relationship to the world different as a poet?

RH: Sometimes. I let nature, holistic as it is, come in. I don't find science a way to express myself about emotions, love and grief, loss and gain. Poetry can be like science, observational. But more than science it can be reflective.

EMC: I long for holistic reflection, but most of the time, I find myself working with fragments of experience.

RH: That sounds like a scientist at work!

EMC: An uncomfortable scientist...for me, the only thing that seems to reconcile the whole and the fragment is art. In that unity I begin to find what others describe as spirituality—like in Celan's poetry. Do you find spiritual content in chemistry?

RH: Sure, beautiful molecules, intricate functions, the splendor of variety—substitutions. The way a synthesis could reach a goal, the intuitive leaps in a structure determination. The logic of catalysts and intermediates. Just knowing how things work.

You've asked me, Enrique, about the spiritual in science. Let me invert the question: if it is a given that art is spiritual, where is the material in it?

EMC: It's not a given—especially not in the contemporary climate. For many, a claim of spiritual content in art has become a sign of confusion or obsolescence. These arguments often come from a mistrust of the possibilities of art compared to other disciplines, and it seems that their proponents would like art to do what science, philosophy and entertainment are already doing well. I don't think there's anything to gain from this insecurity. For me, where these other disciplines end or fail is where art begins. Once we depart from this point, there is little guidance and we have to engage things that resist explanation. And that's all we can say about that.

Your question about materials is an interesting one, because it's very related to what I am talking about. I think the role of the materials is to ground the artist by bringing the earth into the art. Without materials, like in a purely conceptual piece, one can become very free, but also very confused. You work in a theoretical manner—equations, models, simulations. What do you use to ground you when you find yourself lost in your head, confused or without direction?

RH: No different than when I feel depressed. I would focus on one thing or several, routine, mundane, and follow that through, see what a calculation gives. Even if nothing striking comes out, the existential act of working it through, and writing it up would lead me out of confusion. You mentioned Paul Celan, who also appeals to me, in part because he comes from near where I came from. In one poem, called in English *The Straitening*, he has a couple of lines:

"Do not read any more – look
Do not look any more – go."

These are also ways to overcome what pulls you down.

EMC: These lines are a demand to go back to the world, which immediately makes me want to ask you about models. Models are abstractions of reality and science's paradoxical way to get intimate with the world by idealizing it. Do you see art and poetry also as abstractions of reality?

RH: Models in science are also part of the struggle to get closer to reality. So rather than abstractions they are realizations. So in poetry and fiction: not just an abstraction, but a creation of a universe.

EMC: But there are differences. Perhaps the biggest one is verification—the ability to verify one's theories or intuitions.

RH: It's just that the conditions or categories that one wants to "verify" are different. In science one touches with reality—of matter—all the time. There are checks. The ground of poetry are the emotions, and the sounds—of a language. One has always to run checks on poetry, but its verification is in its feeling: "this sounds right" "This is a poem!" So one verifies poetry in the souls of the reader.

EMC: I find it refreshing that you speak of feelings so unselfconsciously. For many contemporary intellectuals avoiding talking about feelings is a sign of mental rigor.

RH: I know, Enrique. One day I spoke at a conference full of modern-day humanists, and talked about the beauty of a molecule or a painting. I was told that beauty had died in the 19th century. And I had not heard of the demise!

EMC: I thought that as a scientist you were spared these annoyances. I am grateful that, unlike some other people, you have put your understanding at the service of communicating rather than isolating.

RH: Well, it's all about the importance of teaching, of reaching out across the spectrum of audiences, from freshman to other scientists. So why is it important for me to teach? Maybe something in my Jewish background—*avinu morenu*, "our fathers, our teachers"—those were rabbinical scholars back there. Maybe it's just caring that others understand. And not being afraid to introduce the personal—teaching as not distancing.

EMC: You have been teaching at Cornell for almost four decades. I wonder if you would have stayed on "the hill" this long as a poetry professor. I think teaching art and poetry is difficult because many of the limitations that the students need to overcome cannot be addressed within the university. Rather, they're limitations of experience and spirit.

Do you think that you could or would want to teach poetry in the future? And can the teaching of poetry and science aim at the same level of success?

RH: I could teach poetry; no one has asked me to – I rise to what's asked of me. Actually, I wish they would ask, my colleagues in the literature department.

Teaching is an act of awakening in a person the ability that is in him or her to learn; the facts I teach are of little relevance. I feel I open doors, I empower. I think that is not very different from science and poetry. People will write poems that they could not imagine—and neither could I—they would write. I love it when that happens, or when a light goes on in a chemistry student's eyes.

EMC: That act of awakening is one of the great rewards of teaching, but it seems to be more a function of subjective sensitivity to the needs of the student than anything else. So, it doesn't surprise that you are an effective teacher—you move between objective analysis and sustained subjective engagement with rare grace. I think this is partly because you don't seem afraid to examine the intangibles and immeasurable qualities of life that may intimidate some scientists. In fact, in your poetry you often go where the currents of subjectivity are most dangerous—to the most difficult moments in your past.

RH: I suppose I could try therapy for those [smiling]. I chose to write. The writing is empowering. When a poem works, when a phrase seems complete, I feel in touch with other human beings who make things.

The writing, as difficult as it is, is a spiritual if not religious experience. And since I'm not conventionally religious, poetry and essays are a substitute. A way to the spirit.

EMC: The content of the poems in your recent book *Memory Effects* moves freely between history, personal memory and nature as seen by science. Do you feel that there is something that unifies these ideas? I know that you consider a sense of unity important in scientific work. Is a sense of unity in your art important?

RH: At times I long for a unity. But I think that the only unity is that I have written these poems. They are dispersed attempts to deal with a world of love, science, memory, loss. And laughter. Perhaps there is an underlying unity—in my science and in my attempts to do other things. This is a belief that everything in this world is connected to everything else. I think it's that way for many poets, for instance Pasternak.

EMC: Pasternak wrote, "creation calls for self-surrender." This requirement of surrender is one way in which writing may be different than chemistry. Perhaps, you want to be known in a way that you can't be known through science—without protection.

RH: Well, part of the bargain is that I do reveal more of myself if I write poetry. So I certainly have to be brave enough to do that.

EMC: Do you think that your fame as a scientist limits or expands the appeal of the poems?

RH: I think others have to answer that. Occasionally, I know I worry too much about getting the science right in a poem, as if that is what mattered most. I think I'm worrying about my colleagues looking at my poems, criticizing them. But as long as I'm honest to the science, I'll be OK.

EMC: In my own artistic career, my few patents and publications in science, have been sources of interest and a rare currency in a market constantly searching for something special. Do you ever feel that your fame as a scientist may create an aura around the poems, which prevents an honest read, or worse yet, make the poems into curiosities?

RH: Perhaps, in small part. As far as I can tell, submitting my poems on chemistry department stationery has no effect at all on their being read or accepted. The poems about science do a little better in getting accepted than the others. I don't think they're better. So maybe they have some curiosity value.

EMC: What is poetry giving you that you can't get from science?

RH: The answers of science, as beautiful as they are, I see as answers to a set of questions that admit only of delimited answers, of solutions. But much of the meaning of life, the questions we face, are in a way impossible—they do not hold open the promise of solution, only of resolution. And that for a short time only.

Don't you feel something like that in your art?

EMC: I would like to be satisfied with the little I know, but I haven't been able to give up my desire for solutions—for answers—to those fundamental questions that you speak about. I approach my work as a way of clarifying life. For Kant, the first condition of art is that it is disinterested, but for me, art is connected to need.

RH: Well, Kant and much aesthetic theory is off here, in stressing disinterest and not allowing utility to enter a judgment whether an object is beautiful. I think art comes from deep interest—involvement—with the object. And utility can be transformative.

EMC: Yes, and utility can also guide what can and cannot happen within the work, and in turn, define the way it looks. For me, the "face of the work" is more or less defined by some ethical criteria that are not distinct or separable from beliefs I hold in the rest of my life. For you, I think, form is more organic.

RH: The poems each take on some form. Sometimes it is simply that what I have to say is prosaic, or emerges as such, and I need to fragment it into lines, gaining strength from that. Every poem just seems to generate its own form. I suspect it is similar for painters.

EMC: Each artwork does exert some pressure on its form, but, for me, that pressure would have to be great in order to expand the ethical band in which the work can exist. Although I think that way about my poems as well, in painting and sculpture, matter is very influential.

You mentioned earlier that in science one touches with reality all the time. I understood this to mean that matter is a constant reality check for the scientist. And I think it is the same way for many artists. Practically speaking, even the time that it takes to master materials influences form by narrowing the typical range of artists.

Which makes me wonder if we could make a similar sort of comparison between the typical range of the experimentalist versus the theoretical scientist?

RH: I think so. Though there is much of simple labor in theory. The ideas somehow get solid, and so do the figures and pictures that a computer gives you, and the mathematical techniques one used to represent reality. I think there is a grounding even in the realm of theory, in ideas.

EMC: You have spoken about the value of poets and poetry in a society enamored and intimidated by science. As a scientist and a poet, you're in a privileged position to see the similarities and differences between them. One telling difference, I think, is the way they encompass progress.

Your own scientific contributions will be superseded as more research unveils new knowledge. But no one will supersede your poems or their spirit—they can't be engulfed or improved by anyone else. The understanding of electricity and magnetism is better today than at the time of Maxwell, but we couldn't say the same thing about art or Manet, because art doesn't evolve in the way science does. I think art has no history, it's all a continuum.

RH: You're right, Enrique. This is one of the differences between art and science. Even as I believe that science creates, as much as it discovers. So what does art discover?

EMC: Art discovers the artist before dissolving him. Sometimes, it also reveals what experience may be in its fullness. At least these are my incentives and what keeps me looking—what keeps me intrigued about my future work.

Roald, for someone that has given form to electron orbitals and days without mercy, what could be left to do—what's in the future?

RH: Oh, so much writing. I want to write about telling stories in science, about my land between poetry, philosophy and chemistry, I want to write plays, of collective and individual guilt, of Marie Curie and Paul Langevin. I want to write poems which are not sad, I want to write a libretto to an opera about Mme. Lavoisier, I want to see the tree growing through the temple in Angkor Wat...

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