Scialog (Science Dialog): A Methodology for Accelerating Breakthroughs for Solving Complex World Issues

by Martha Gilliland and Richard Wiener

Solving today's increasingly complex problems in science requires transformative ideas leading to transformative research. The scientific community is adept at incremental research—taking the next step on an existing line of research. We are not so adept at generating major breakthroughs, especially for complex interdisciplinary problems. Yet we need breakthroughs and transformative outcomes in energy, climate, poverty, disease, management of natural resources, terrorism, nuclear disarmament, education, and more. Scialog—the compound of science dialog—is intended as a methodology for producing transformative ideas for solving complex problems. Research Corporation for Science Advancement (RCSA, http://www.rescorp.org/) is focusing its first Scialog on the complex problem of solar energy conversion to fuels and power.

The National Science Foundation (NSF), a primary funder of basic research in the U.S., has added the phrase "potentially transformative outcomes" to its review criteria. In 2007 Arden Bement, then NSF Director, titled a major speech "Transformative Research: the Artistry and Alchemy of the 21st Century" (http://www.nsf.gov/news/speeches/bement/07/alb070104_texas.jsp). Transformative research is now defined by the NSF and other agencies as that "which is driven by ideas that have potential to radically change our understanding of an important scientific concept, or lead to the creation of a new paradigm, or a new field of science. Such research is also characterized by its challenge to current understanding or by its pathways to new frontiers." (http://www.bsf.org.il/bsfpublic/ViewAnnounement.aspx?msgNum=31).

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While the NSF has taken a strong stand for transformative research, proposals from researchers are often rejected unless the research has already generated some results. Feasibility must be demonstrated in the proposal; yet demonstrating feasibility ahead of the research is counterintuitive to transformation. Using the tried and true reductionist scientific methodologies, academic scientists methodically test incremental ideas; validate, prove, or disprove them; and then keep testing—making steady but often small advances. Indeed research, as it is often conducted at U.S. universities, is not focused on generating transformative ideas.

How can we create the conditions for transformative ideas to emerge? How can we create the conditions that trigger scientific breakthroughs? Bement implies it is alchemy and art. We do, however, understand some aspects about the needed conditions, perhaps more than we realize.

Scialog aims to create the special stew of people, place, perspectives, knowledge, process, and interactions that generates creative energy—that stew that unleashes the human imagination, as Einstein described imagination: "Imagination is more important than knowledge. For knowledge is limited to all we now know and understand; imagination embraces what we will know and understand."

What we consider feasible is rooted in our own assumptions. These very assumptions and the limitations they impose can be artificial. The history of science is riddled with examples: the solar system must be geocentric, continents could not possibly move relative to each other, there cannot be atoms, and so on. Reductionist scientific methodologies, though remarkably useful, still embrace the notion: "I'll believe it when I see it." The human imagination embraces quite the opposite: "In order to see it, I must first conceive it."

While our assumptions allow us to navigate efficiently through the clamor of daily life, ultimately, like blinders on a horse, assumptions limit vision. Assumptions often outlive their usefulness. Are there today beliefs, analogous to "the Earth is flat," which we do not question, because we simply have not conceived otherwise? Where are those dogmas we do not recognize in the solar energy conversion domain?

Many scientists, while alone or in dialogue with others, have experienced insights that led to significant advances, sometimes even transformative breakthroughs. While alone, during times of reflection, we often experience the power of our imagination, that mysterious source of creativity we think of as uniquely human. For some people creative ideas materialize in the shower, or when they are jogging, daydreaming, or writing. Friedrich Kekulé reportedly realized the structure of the benzene molecule while dreaming of the Uroboros symbol—a snake swallowing its tail. One of Einstein's epiphanies is said to have occurred as he imagined a boy riding alongside a light beam.

The creative energy leading to transformative ideas also seems to flow in certain group situations, through dialogue, often over coffee, tea, or beer with colleagues

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after work. The venue and "feel" of the coffee shop or pub, experienced with friends and colleagues, opens the creative channels in the mind. We suspend judgment about what others say and listen without the need for debate. In such a setting, we may share an "off the wall" idea about solving a problem, engaging others in "what if" conversation that leads to a breakthrough. Metaphorically, it is a quantum entanglement of minds and knowledge—transparent and flowing without the impedances imposed by the daily pressures and assumptions about appropriate conversations, behavior, and boundaries of knowledge.

Organizational development theorists, sociologists, management scientists, and even some neuroscientists study this kind of process. Conferences, such as the Gordon Research Conferences, try to emulate it. Corporations sometimes form "innovation hubs." The physicist David Bohm wrote a book, *On Dialogue*, suggesting some guidelines for productive dialogue to solve big problems.

Drawing on our own experiences and from the body of research on collective creativity, we believe that science dialogue should bring together freshly minted innovative thinkers, as yet not constrained by beliefs about what is possible. Worldwide leaders in the field of solar energy conversion should be added to the mix. The dialogue must include interdisciplinary perspectives and an opportunity to share one's own perspective, ideas, and research questions with others. It must embrace a process that allows for that special form of human interaction, which occurs in the coffee shop, to emerge—interaction in an environment of transparency, with no judgment about what is possible. And, we believe it benefits from a venue that embraces, facilitates, and manifests risk, research, openness, and dialogue.

Our three-year goal for the first Scialog is to accelerate substantially the pace of solving the solar conversion problem, so that solar energy can substitute for fossil fuel consumption in fuels and electric power production in a cost-effective and reliable fashion.

Our objectives for the first conference, which was held in October 2010, were to:

- Identify and analyze bottlenecks in achieving more efficient and durable solar energy conversion and develop approaches for breakthroughs.
- Build a creative cross-disciplinary community that is more likely to produce breakthroughs.
- Form teams to write proposals for supplemental funding based on ideas that emerge at the conference.
- Engage in authentic dialogue and help determine if such dialogue is effective for accelerating cross-disciplinary, high-risk/high-reward research.

We believe that the ingredients for a successful science dialogue that meets these objectives are:

- Recently tenured researchers (RCSA awardees), whose ideas have withstood rigorous review against the criterion of innovation—ideas viewed as potentially transformative by a distinguished review panel;
- Senior researchers who are leaders in the field and accomplished scientists funded by the NSF, the DOE, and Science Foundation Arizona;
- Interdisciplinary perspectives, since complex problems are often not amenable to solutions within the assumptions of a single disciplinary framework or methodology;
- A pragmatic process of sharing, in which individuals discuss their current work from the framework of the problem on which they are stuck and the outcome about which they dream;
- Adequate time and a process for creative dialogue, using an approach inspired by the ideas of physicist David Bohm, to stimulate open creative thinking in an environment of transparency with no predetermined judgments about what is possible;
- Opportunity to work with colleagues on emerging ideas, continuing the dialogue through network support provided by RCSA between annual Scialog gatherings;
- A venue that promotes interaction, manifests scientific risk-taking, and helps us dream: Biosphere 2.

In short, the Scialog process aims to generate the conditions for transformative ideas to emerge and new collaborations to be spawned. The conference did create that special stew of diversity and interaction that generates creative energy. New collaborative teams were formed and eight highly innovative proposals were submitted for additional funding. Our challenge now is to produce breakthroughs collectively that we have not yet been able to produce individually.

As RCSA has been doing for nearly a century now, we invite you to join us in this spirit of openness and collaboration at the frontiers of science; together we can build a better future.

About the Authors

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