

## Science for Whom? The Key Role of Women in the Next Millennium

*"Science is intimately integrated with the whole social structure and cultural tradition. They mutually support each other-only in certain types of society can science flourish, and conversely without a continuous and healthy development and application of science such a society cannot function properly."*

Talcott Parsons, *The Social System* (1951)

History is our bridge from the past to the future. History matters. We need to have a sense of the history of science in relation to women because, without that, we cannot understand the present, and so we cannot begin to shape a future that is different or better. For me, the question "Science for Whom?" is a question about women and the history of science. As I see it, the "Key Role of Women in the Next Millennium" will be stronger if we know something about the past from which we have come. There is a full history of women in relation to science culture. There also is a full history of gender ideas in relation to science culture: ideas about "masculinity" and "femininity" have profoundly shaped how we think about nature, and how we have formed our picture of what and who is a "scientist." In our day, scholars and writers have shown us how much science is a social construction, shaped by beliefs and practices that themselves arise out of history. To know about women and gender in the history of science is to have a window onto the human face of science.

We can make science "better" for the new millennium by knowing about the past: about the history of science, as it relates to women and men. You may ask at this point: WERE there women in the history of science? That we even ask the question shows how narrow a picture we have of what "science" is and what its history has been.

I like to begin our dialogue by discussing a book about women and science that came out 300 years ago, in 1686, when the new millennium would have seemed on the far edge of time. It is called *Conversations on the Plurality of Worlds*, and was written by Bernard de Fontenelle. This book explains the new astronomy of Copernicus and Galileo, and discusses Descartes's ideas about physics, using his language of vortices to explain planetary motion, and goes on to discuss ideas about infinity. The author of this work was a key player in French science of the late 17th and early 18th cen-

tures. A writer, a mover and shaker in the broad world of science culture at that time, Fontenelle was a member and administrative officer of the French Academy of Sciences. Fontenelle believed fervently in the power of science to explain things to us and to help to improve our lives. He wanted to open the eyes and minds of many peoples to the new kinds of knowledge about nature that were sweeping across Europe in what we now call the Scientific Revolution. And he believed that science needed to be written about so that it would reach new audiences. Fontenelle brings together science and broader culture. Science learning happens at home, as part of leisure, as part of ordinary life. It is linked to the personalities of his characters, and to their ways of participating in the world. Science is not portrayed as a sacred, or in overly technical language. Instead, the point is to arouse wide human curiosity about nature in all its diversity.

Women were part of the new audiences he wanted to reach with his writing. Therefore, Fontenelle would have been very happy with this discussion: "Science for Whom? The Key Role of Women in the Next Millennium." *Conversations on the Plurality of Worlds* is written as a series of conversations between two French aristocrats, a nobleman and a noblewoman. He is knowledgeable about the main theories of the day, and she

is very curious and wants to learn. I admire what Fontenelle has done in this important book. He absolutely includes women in the audience for the New Science of the 17th century. He makes the noblewoman intelligent, keen, and spunky. Fontenelle does a huge service to the spread of science in his day by writing about some cutting edge theories. He wants to make science accessible, and so he uses stories and metaphors and ordinary language, and imagination. He puts literature in the service of science.

I admire this all very much, and think that we, at the beginning of this millennium, have much to learn from how he



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writes about science. But at the same time, I have concerns about how he positions women in relation to the science culture of his time. And this, as I see it, has many important implications for us, over 300 years after he wrote his book.

In *Conversations on the Plurality of Worlds*, the noblewoman learns, but she is only the pupil, not the teacher. He is the expert, and she is on the receiving end. He learns science in the public world of scientific institutions, and she is at home. He patronizes her, and ultimately assumes that she is learning science so that she can be a better conversationalist at parties. He marginalizes her for the emerging world of High Science, and in the end sends her back into a world of domestic pleasures rather than making her a partner in further intellectual adventures. While I am glad that an influential 17th-century scientist welcomes women into science culture, I am uneasy about how he positions women there, and does not take women seriously enough. I call this the "yes--but" position.

Does it sound familiar? We are in the midst of discussions about how to increase women's roles in science, how to improve women's access, how to make science more "women-friendly." Science is one of our great knowledge tools, yet it still is in the hands of only a small proportion of our population. And there are many entrenched codes and practices that shape who becomes a scientific Authority, who has highest scientific credibility, etc. What can be done to make science more inclusive, more wide-ranging, "better" for the new millennium? One strategy is to bring more women into science. Another strategy is to draw on approaches to science that women may bring with them; it can be argued that women's different experiences in families and societies lead to perspectives on questions and problems that differ from those of men, and that women often see things in different ways. The National Film Board of Canada film, "Asking Different Questions: Women and Science" (1996) explores scientific contributions that Canadian women have made over the last few decades precisely by "asking different questions."

Before the 19th century, science was not a series of discrete professional disciplines peopled by men called "scientists" who belonged to exclusive scientific societies. Rather, science before the 19th century was part of culture. This is the world that Fontenelle was part of. Before there were professional societies and before scientific disciplines became firmly established, what we now call "science" was "natural philosophy" and "natural history." That is, enquiry into nature involved both philosophy and history. Science and the Humanities were part of one culture, not separated into two.

And women were part of the search for knowledge of nature. In early modern Europe, women were herbalists and midwives and healers. They studied the stars, used their microscopes, and did experiments. They studied the new science and the new philosophy, learning the new methods of René Descartes in France and John Locke in England.

Science in 18th-century Europe was part of general education. Scientific discoveries were among the hot topics of discussion, in coffee houses, in magazines, in public and private life. Science was fashionable. Science was part of polite society. Science was, therefore, a social skill. Social commentators actually said that young women who knew about science would do better in finding husbands! As we now trade talk about movies and music videos at parties, they traded talk about new developments in science.

Science was part of the climate of the European Enlightenment. Thinkers, writers, and educators believed that we would improve individually and as a nation, if we had more knowledge, including more scientific knowledge. As a result, there was a large public campaign in the 18th century to promote science for wider audiences, and to get that new knowledge out into circulation. Books and magazines and public lectures were called into action. Audiences flocked to science demonstrations and public experiments about gravitation, magnetism, and electricity.

Science culture embraced young people and children as pupils and readers, and as the audience for science as spectacle. Authors and publishers cultivated "the rising generation" as a market, with juvenile science titles such as *The Newtonian system of Philosophy*, adapted to the capacities of young gentlemen and ladies (1761). Books like these brought science into the family circle. At a time when there was not yet any public schooling, and when education happened in many cases at home, parents took on responsibility for teaching science to their children. Science education was often family-based, and women learned science so that they could teach it to their children.

What I am describing has little to do with who made the Big Scientific Discoveries. There were only a few individuals who made those Big Discoveries in the 16th and 17th and 18th centuries. I am speaking instead about a climate, a culture, where interest in science was widespread, and where many people -- men, women, children -- talked about science, read books about science, and participated in scientific activities.

Many books and periodicals in England specifically introduced young women, their mothers, and their grandmothers to the popular sciences. For example, the *Ladies' Diary*, an 18th-century mathematical recreation magazine, was "designed on purpose for the diversion and use of the Fair Sex." This magazine included algebra, astronomy, fluxions, harmonics, and optics, and featured "enigmas and mathematical questions," puzzles and solutions contributed by readers. Another example is Benjamin Martin's *The General Magazine of Arts and Sciences* (1755-64). It contained a series of articles entitled "The Young Gentleman and Lady's Philosophy." The articles were organized as conversations between a university student and his sister at home, and were designed to familiarize readers with recent developments in astronomy, optics, and hydraulics. There were many books that earmarked women as the audience for learning about science.

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The eighteenth century was the historical moment when women in England stepped into public writing and publishing on an increasingly large scale. Their presence as authors of novels, poetry, religious essays, journalism, book reviews, translations, science writing, and, of course, children's literature, all made for a flourishing literary scene. And science was part of the repertory of women writers. Women's science writing is part of the history of science. Women especially wrote introductory books for children and parents that spread knowledge of nature. Their books about astronomy, chemistry, natural philosophy, entomology, and botany form an important part of the early textbook tradition in science.

One example of this, from 1797, was Maria Elizabeth Jaeson's *Botanical Dialogues*, a book whose narrative introduces two girls and two boys to the science of botany. In an example of science pedagogy at the end of the 18th century, the children's mother teaches them how to classify and name plants. *Botanical Dialogues* is designed "for the use of schools"; while this may mean boarding schools or day schools, it could easily mean the home schoolroom. In a series of conversations set at home, Hortensia explains the Linnean system of botany, and shows how to dissect flowers and examine them under microscopes. In so doing, she works as mother and science teacher within the spirit of the Enlightenment.

Margaret Bryan, author of *A Compendious System of Astronomy* (1797) and *Lectures on Natural Philosophy* (1806), is another example. Her books come out of classroom experience teaching science to girls at schools in London and Margate. Unlike the science textbooks that most of us have used, Margaret Bryan's books are not written in a third-person, objective, and abstract way. Instead, they have a personal voice that is caring and enthusiastic. One book's frontispiece shows "Mrs. Bryan and her Children" surrounded by scientific instruments. The illustration represents the maternal manner of her science books, for the two young women depicted there may be her own daughters, or her pupils. Like many other popular science books of her day, Bryan's astronomy book taught more than substantive scientific information. Her "grand design," she writes, was "to excite in my dear pupils a spirit of enquiry," and many of the book's lectures end with a larger moral or humanistic topic.

It is interesting that many science books written by women before the early 19th century are organized around mothers teaching science to their children. A mother's interest in science was depicted at that time as being part of her other responsibilities. Science education was presented as a part of good mothering. The maternal science teacher served as a figure of power and expertise for her children. The Scientific Mother also represents female knowledge and intellectual authority for adult readers.

Right across the 18th century, popular science writing had brought information and scientific practices to many women, children, and general readers. Books of this kind have not

counted as "scientific" because they are not "high" science, and also because historians of science have been more interested in the creation of knowledge than in the dissemination of knowledge. But books like these play a huge part in the history of science culture. Surely, how we teach science is as important as what we teach in science.

In the history of women and science, astronomy and natural philosophy were prominent areas, but the most popular science for women was botany. Ideas of the great Swedish systematizer Linnaeus did much to bring botany into visibility and fashion in the 18th century. Perhaps because it stood at the junction of gardening, art, and science, the study of plants had wide acceptability, and social cachet. Books, magazines, essays, poetry, and handbooks about the Vegetable Kingdom proliferated. Some said that, by studying nature, one could "look through Nature up to Nature's God." Others thought that nature study was good for one's health, or good for self-discipline, or that botanizing would teach good habits of observation. The result of all this was that, in the 18th century, "science for whom" included science for women, and particularly botany for women. Many women collected plants, studied botany, drew plants, and wrote about botany themselves. Women were involved with plant classification, and also with plant physiology. Agnes Ibbetson (1757-1823), for example, was a keen plant physiologist and microscopist, who wrote botanical treatises "for the love of the science," as she put it. She also drew plants based on her observations with microscopes, and published her drawings in well-known science magazines.

I have been suggesting the richness and variety of 18th-century science culture, and indicating ways that women were active within it. This story changes during the 19th century. By the early 19th century, and moving into the Victorian decades, other communities of scientific interests began to establish themselves. Science became increasingly professionalized, and specialists and institution-builders shaped disciplinary cultures for sciences such as botany. Institutional and social changes led to more exclusionary relations between women and science culture. Women were marginalized, pushed to the periphery, relegated to arenas of "amateur" and "popular" science.

We can see what happened by looking at women and the history of botany. By the end of the 18th century, so many women were involved in botany, that botany became known as a "feminine" activity. This became a problem for some men who wanted to upgrade botany as a "science." They attempted to formalize botany in the early 19th century by pushing out women and women's botany, by de-feminizing the field. They sought to make botany a utilitarian and serious science for gentleman rather than a decorative and leisure activity for ladies. The gender features of professionalization are apparent here: to "modernize" the science it was imperative to "de-feminize" it.

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The very success of what women botanizers and botanical writers did (and how they did it) produced the climate from which a professionalizing science wanted to separate itself. The professionalization of science was hard on women because it was, as we now call it, a 'masculinization' of science. The institutionalization of science in 19th-c England was part of the culture of specialization that we find in many areas of knowledge at that time. It is not that women had no access to it -- in the later decades, small numbers of women began studying formal science. But it was science on a male model: and women were tagged, for the most part, as exceptions or as marginal. By using the terms of "femininity" and "masculinity," I am bringing contemporary gender analysis into our exploration of New Ways of Knowing for the New Millennium.

Gender is a powerful category for interpreting the history of science. Gender categories shape how we interpret the past. Gender also helps me identify how history was shaped on the ground. Gender difference was part of the 19th-century construction of what a "scientist" was and was not. The "scientist" became represented as the highly analytic male whose work takes place in a laboratory, away from family, away from ordinary life, away from emotion, away from personalities and personal connections. This model of the scientist has a history, and it is one that has excluded domestic life, family conversations, and the experiences of many women. Recently, a sociologist of science has charted the imprint of masculinity and honor codes in science and medicine. Writing in *Osiris* (1997), Robert Nye argues that scientific and medical societies in the 19th century operated on a series of informal codes and practices that had long been used in gentlemen's clubs to determine who pulls rank on whom, and who challenges whom to a duel. These practices, he says, were meant to keep out anyone who did not fit socially, who was not a gentleman, and therefore did not know how the informal rules worked. No wonder women could not enter those inner sanctums of the scientific and medical professions!

Gender features in the fundamental split in the history of modern science culture between amateur/professional. More broadly still, gender is part of the history of discipline-formation -- whether the discipline is history or physiology, or economics. How does the "identity" of "the botanist," for example, get established? Whose theories count? Who claims status? The systematizers? The field collectors? The person at home? The person who travels? These are questions about gendering authority. I would argue in this regard that the science of botany, for one, has not adequately acknowledged its "feminine" part. I would argue further that the history of this wonderful science is limited as a result.

There is exciting new work about such questions nowadays. Explorations about women, gender, and science offer us broad pathways into the new millennium. They show us that history does not just happen. It has been shaped by people who, in turn, were shaped by history. When we know that, then we can consider what we might want to do differently in the future. I have been interested in telling the story of women in science culture. I want

us to know about women's experiences in the science culture of earlier centuries so that we know where we came from, and can understand what brought us to our current circumstances. Knowledge of the past gives us power to change the future. Otherwise, we are chained to the same old wheel.

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