Science in the Hands of Women: Present Barriers, Future Promise

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Introduction

AN ANALYSIS of the subject of women in science could be accomplished in several ways. It could be about the science that women make, or about the women who have made science, or about what science makes of women. It could be approached from a technical perspective, in a historical framework, or perhaps even as a statistical review. Though each of these approaches is explored below, for many women the subject of *women in science* is very personal because it involves the struggle of women to become educated in science, to practice science in spite of many odds, and to help set or change the priorities of science. Women scientists have begun to reject the myth of science as impartial or impersonal, as it has been defined over centuries, and to propose, instead, that it is especially in their personal approach to science that women will make their greatest contribution to global prosperity and peace. Therefore, the things that have sometimes been considered the chief deterrents to their practice of science (their sensitivity, their language, their childbearing and child rearing, their anger and compassion) may be their greatest strengths.

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An examination of women in science is at the same time painful and exciting, but its purpose is not so much to prescribe a formula for world transformation at the hands of women scientists as to discover the attitude of mind that will permit an actualization of women's potential as women *and* men work together to create peace and prosperity through science.

The writings of the Bahá'í Faith provide a conceptual framework that encourages the involvement of women in the scientific endeavor and delineates the unique qualities that women can bring to the sciences. Through examining the lives of early women scientists whose contributions revolutionized their field one can glimpse those unique qualities in action.

The Bahá'í writings also provide a standard for understanding the psychological barriers encountered by women who wish to enter male-dominated sciences and for validating the struggle most central to women's lives—that of balancing career and parental responsibilities. Finally, they provide the moral authority for demanding the changes that must take place in the scientific community if humanity is to benefit from women's contributions.

Future Promise: The Connection between Women, Science, and Peace

THE Bahá'í writings are not only historically unique as a religious doctrine in explicitly promoting the equality of women and men but are also explicit on the subject of women

in science. Morever, they make an unequivocal connection between the participation of women in all arenas of society and the attainment of world peace:

> The emancipation of women, the achievement of full equality between the sexes, is one of the most important, though less acknowledged prerequisites of peace. . . . Only as women are welcomed into full partnership in all fields of human endeavor will the moral and psychological climate be created in which international peace can emerge.[1]

According to Bahá'u'lláh, the Founder of the Bahá'í Faith, peace is not attainable unless unity is established, and unity is only attainable through justice.[2] For, as 'Abdu'l-Bahá, His son and appointed interpreter of His writings, explains, "Without equality this will be impossible because all differences and distinction are conducive to discord and strife."[3]

Economic justice implies the elimination of extreme poverty and the equitable distribution of wealth and resources. For this to take place social and economic development on an unprecedented scale must be fostered. It is in the connection between development and peace (peace being defined as the unity arising from equality and social and economic justice) that women scientists can bring to bear their unique influence.

'Abdu'l-Bahá expounded on numerous occasions His father's principle of the equality of women and men. In a talk 'Abdu'l-Bahá gave in Sacramento, California, in 1912, He connected women to global prosperity, saying that, "Until womankind reaches the same degree as man, until she enjoys the same arena of activity, extraordinary attainment for humanity will not be realized; humanity cannot wing its way to heights of real attainment." He went on to say that "woman must receive the same education as man and all inequality be adjusted." While enjoining both women and men to chose occupations of service to humanity, in a talk in Boston, Massachusetts, He specifically encouraged women to devote their "energies and abilities toward the industrial and agricultural sciences" and seek to assist humankind "in that which is most needful."[4]

If one wonders why 'Abdu'l-Bahá put such emphasis on women's involvement in science, His views on science itself are illuminating. "Science," He says, "is the very foundation of all individual and national development. Without this basis of investigation, development is impossible." He further testifies to the permanence of this power once it is obtained by an individual or country, stating that "All blessings are divine in origin, but none can be compared with this power of intellectual investigation and research. . . . All other blessings are temporary. . . . this is a kingship and dominion which none may usurp or destroy."[5] It follows that He wanted women, as well as men, to be empowered to bring about social and economic development and that He believed that social progress,

1. The Universal House of Justice, *The Promise of World Peace: To the Peoples of the World* (Wilmette, Ill.: Bahá'í Publishing Trust, 1985) 26–27.

2. Bahá'u'lláh says that "The well-being of mankind, its peace and security, are unattainable unless and until its unity is firmly established" (*Gleanings from the Writings of Bahá'u'lláh*, trans. Shoghi Effendi, 1st ps ed. [Wilmette, Ill.: Bahá'í Publishing Trust, 1983] 286). He also says that "The light of men is Justice" and that "The purpose of justice is the appearance of unity among men" (*Tablets of Bahá'u'lláh revealed after the Kitáb-i-Aqdas*, comp. Research Department of the Universal House of Justice, trans. Habib Taherzadeh et al., 1st ps. ed. [Wilmette, Ill.: Bahá'í Publishing Trust, 1988] 66–67).

3. 'Abdu'l-Bahá, *The Promulgation of Universal Peace: Talks Delivered by 'Abdu'l-Bahá during His Visit to the United States and Canada in 1912*, comp. Howard MacNutt, 2d. ed. (Wilmette, Ill.: Bahá'í Publishing Trust, 1982) 175.

4. 'Abdu'l-Bahá, *Promulgation* 375, 283.

5. 'Abdu'l-Bahá, *Promulgation* 50.

including world peace itself, was dependent upon the full participation of women in the scientific and social arenas.

Women and Development

ADDRESSING the relationship between women and development, the Universal House of Justice, the supreme governing and legislative body of the Bahá'í Faith, has written that "it is through educated mothers that the benefits of knowledge can be most effectively and rapidly diffused throughout society." 'Abdu'l-Bahá asserts that

> There can be no improvement unless the girls are brought up in schools and centres of learning, unless they are taught the sciences and other branches of knowledge, and unless they acquire the manifold arts, as necessary, and are divinely trained. For the day will come when these girls will become mothers. Mothers are the first educators of children, who establish virtues in the child's inner nature. They encourage the child to acquire perfections and goodly manners, warn him against unbecoming qualities, and encourage him to show forth resolve, firmness, and endurance under hardship, and to advance on the highroad to progress.[6]

Yet a brief look at the underdevelopment of women in the world reveals their plight. According to 1980 United Nations figures, women constitute one-half of the world's population and do two-thirds of the work but earn one-tenth of the income and own only one one-hundredth of the property; two-thirds of women are illiterate.[7] In *Women in the World: An International Atlas,* published in 1986, geographers Joni Seager and Ann Olson affirm that, compared to their male counterparts, "women have less power, less autonomy, more work, less money, and more responsibility. Women everywhere have a smaller share of the pie; if the pie is very small (as in poor countries), women's share is smaller still."[8] More recent assessments—for example, one published in 1997—have shown, in fact, that "the global gulf between the rich and poor has widened. . . . the poorest 20 percent of the world's population has seen their share of global income decline from 2.3 percent to 1.4 percent, while the richest 20 percent rose from 70 percent to 85 percent. Women constitute the biggest single group of the poor."[9]

Margaret Snyder, founding director of the United Nations Development Fund for Women (UNIFEM), notes that women "are the providers of food, fuel, water, and often the whole family income—the sustainers and developers of their families, communities and countries. . . . the fate of women is a critical determinant of the fate of whole societies."[10]

An article in the *Food and Agriculture Organization Review* provides a description of the daily life of rural women in India that mirrors the lives of many peasant women throughout the world and makes concrete Snyder's observation:

> Landless peasant women in India account for 70 percent of the female peasant population. They work more than 14 hours a day. In addition to work on the farm more than half their time is devoted to their children and to household chores such as

6. The Universal House of Justice, *Promise of World Peace* 27; 'Abdu'l-Bahá, in Bahá'u'lláh, 'Abdu'l-Bahá, Shoghi Effendi, and the Universal House, *Women: Extracts from the Writings of Bahá'u'lláh, 'Abdu'l-Bahá, Shoghi Effendi and the Universal House of Justice,* comp. Research Department of the Universal House of Justice (Thornhill, Ontario: Bahá'í Canada Publications, 1986) no. 41.

7. United Nations, 1980, quoted in Joni Seager and Ann Olson, *Women in the World: An International Atlas* (New York: Simon, Touchstone Books, 1986) 101.

8. Seager and Olson, *Women in the World* 7.

9. Joni Seager, *The State of Women in the World Atlas* (London: Penguin, 1997) 121.

10. Margaret Snyder, quoted in Seager and Olson, *Women in the World* 7.

> fetching water and gathering firewood. In some areas women farmhands work an average of 310 days a year and are overworked during peak periods, as during sowing, weeding, and harvesting. Overwork increases risk of miscarriages, reduces breast feeding time, and affects the mortality rate in children under five years of age. It is estimated that rural women in India work about 43 per cent more hours than their male counterparts. For women, mechanization has neither reduced the number of working hours nor made household chores any easier. And they are still paid less than the men.[11]

In Africa women produce up to 80 percent of the continent's food and in Western nations perform 30 percent of agricultural work.[12] Because many of the development policies implemented in the 1970s and 1980s failed to involve women in their planning or to be sensitive to their needs, they resulted in greater disparity. According to one FAO expert, "it is important to consult peasant women and to involve them in the development plans, for without their involvement we can only worsen their situation."[13]

The Prosperity of Humankind, a document released by the Bahá'í International Community (a nongovernmental organization accredited to the United Nations) on the subject of development, states that "It is unrealistic to imagine that the vision of the next stage in the advancement of civilization can be formulated without a searching reexamination of the attitudes and assumptions that currently underlie approaches to social and economic development." Among the issues that must be reexamined "is the roles assigned in it to the various protagonists."[14]

Therefore, the issue of women succeeding as scientists, the educated women who are a privileged elite, goes beyond their individual right to succeed. There is an intrinsic relationship between women scientists and peasant women in the third world. The success and proper orientation of the former is the key to the liberation of the latter. It is critical to the very survival of the human race, to the development of the world, to the freedom from poverty and misery of millions. It is an issue of power, the power to change the condition of humankind, and it is part and parcel of a shift in values that must take place in society eventually leading to harmony and peace. 'Abdu'l-Bahá affirms that

> The world in the past has been ruled by force, and man has dominated over woman by reason of his more forceful and aggressive qualities both of body and mind. But the balance is already shifting—force is losing its weight and mental alertness, intuition, and the spiritual qualities of love and service, in which woman is strong, are gaining ascendancy. Hence the new age will be an age less masculine, and more permeated with the feminine ideals—or, to speak more exactly, will be an age in which the masculine and feminine elements of civilization will be more evenly balanced.[15]

Science Permeated with Feminine Ideals

BUT what *is* special about women, and in what way must they be focused to help catalyze change? 'Abdu'l-Bahá affirmed that women

11. *CERES: The FAO Review*, 21:4 (Jul.-Aug. 1988): 124.

12. Women and Population, "Resources: News Archives," Apr.-Dec. 1996, http://www.fao.org/WAICENT/FAOINFO/SUSTDEV/WPdirect/WPnar496.htm#anchor2.

13. *CERES: The FAO Review*, 21.4 (Jul.-Aug. 1988): 124.

14. Bahá'í International Community, *The Prosperity of Humankind* (Wilmette, Ill.: Bahá'í Publishing Trust, 1995) 2.

15. 'Abdu'l-Bahá, in Bahá'u'lláh, 'Abdu'l-Bahá, Shoghi Effendi, and the Universal House of Justice, *Women*, no. 25.

have certain qualities in which they are strong, qualities they can bring to various human arenas that will, in fact, transform them to such a degree that the resulting climate will be conducive to harmony and peace. Among these are intuition and receptiveness, mental alertness, "abundance of mercy and sympathy," concern for "the needy and suffering," and "moral courage" greater than that of men.[16] Rather than suggesting that women emulate men 'Abdu'l-Bahá exhorts them to "strive to show in the human world" that they "are most capable and efficient, that their hearts are more tender and susceptible than the hearts of men, that they are more philanthropic and responsive toward the needy and suffering, that they are inflexibly opposed to war and lovers of peace."[17] It is the author's belief that the qualities 'Abdu'l-Bahá suggested are highly developed in women as a group are universal qualities of human character. Women's relative strength in these traits at the present time results from the divergent emphasis in the evolution of the sexes. The shift required in civilization, therefore, is for the positive female qualities to be given more prominence and acceptance in various arenas of human endeavor. By applying such qualities to science, women can encourage science to focus more sharply on the social and economic development of humankind, thereby fulfilling its most noble purpose.

But what would science look like if its primary goal were to serve unity and justice? Have women as yet demonstrated the ability to be the catalysts for change in that direction? Can one look to history for the first glimmerings of the application of those unique female qualities when women began to enter previously male-dominated fields of science? And if one encounters role models that exemplify 'Abdu'l-Bahá's assertion that women could bring a unique dimension to these fields, can they be taken as role models by *both* men and women seeking to conduct a more enlightened practice of science (one in which the male and female aspects of civilization are more evenly balanced)?

When 'Abdu'l-Bahá said that women must "especially devote" their "energies and abilities toward the industrial and agricultural sciences," He suggested a focus for women's influence in science. A review of the agricultural sciences in any reputable university catalogue will show them to include a broad range of biological and natural sciences, including botany, agronomy, genetics and breeding, horticulture, soil science, entomology, plant pathology, animal science, zoology, microbiology, public health, food processing, and so on. The industrial sciences encompass all the engineering fields, chemistry, and any and all forms of technology associated with industry.

A cursory survey of the contributions women have made in some of these fields reveals women scientists who have, indeed, exemplified qualities in which 'Abdu'l-Bahá says women excel. When entering previously male-dominated fields they have evinced ground-breaking influence not only by their accomplishments but also by methods and motivations that differed from those of their male colleagues.

Practicality and "That Which Is Most Needful." A focus on and concern for what 'Abdu'l-Bahá says is "most needful" is richly illustrated by pioneer entomologist Eleanor Ormerod, who was born in 1828 into the English upper class. When she died in 1901, she was one of the most highly honored

16. 'Abdu'l-Bahá, *Paris Talks: Addresses Given by 'Abdu'l-Bahá in 1911*, 12th ed.(London: Bahá'í Publishing Trust, 1995) 50.6; 'Abdu'l-Bahá, in Bahá'u'lláh, 'Abdu'l-Bahá, Shoghi Effendi, and the Universal House of Justice, *Women*, no. 25; 'Abdu'l-Bahá, *Paris Talks* 59.8; 'Abdu'l-Bahá, *Promulgation* 284; 'Abdu'l-Bahá, *'Abdu'l-Bahá in London: Addresses and Notes of Conversations* (London: Bahá'í Publishing Trust, 1981) 103.

17. 'Abdu'l-Bahá, *Promulgation* 284.

scientists of her day.[18] Her greatest accomplishment was to bring the study of insects out of academic halls and into the fields. Ormerod invented efficient, inexpensive methods for eradicating injurious insects and for the first time in history brought a systematic approach to saving crops and livestock from their ravages. Her pamphlets and annual reports on pest control, which she produced at her own expense, were the first published guides to farmers on the subject. She worked anonymously for decades, but in 1877, when she began publishing her *Annual Report of Observations of Injurious Insects*, it became immediately popular, and agriculturists throughout the world corresponded with her. Her research was meticulous and scholarly (she built her own meteorological observation station), but her reports also offered common-sense remedies using easily available ingredients. Her widely published remedy for maggots plaguing livestock is credited with saving half the cows in England in the late 1800s. She was also responsible for devising the remedy when the Mediterranean caterpillar threatened widespread destruction of the stored flour inventory in the United States in 1889. She was not just an entomologist but also an ecologist. When she retired, the London *Times* wrote that "she revolutionized the subject of agricultural entomology, as it was known twenty-five years ago."[19]

By suggesting that women scientists focus on that which is "most needful" to humanity, 'Abdu'l-Bahá may have been tapping into a natural propensity of that sex, as some current analysts are starting to observe. In an article on education in engineering, Joe Alper, a writer for *Science,* summarizes several researchers' observations:

> Males are interested in engineering problems no matter what, but women respond more energetically when these problems are put in the context of helping people or the environment. It's not that women aren't interested in engineering, . . . it's a question of context: 'Women aren't so interested in engineering as a technical matter, but as a practical matter.'"[20]

Lael Parrot, a writer for *Resource* magazine, recommends a strategy for attracting women into engineering: "make science relevant. Girls should be taught that science and technology can change the quality of people's lives and alter social structures."[21]

Empathy. When 'Abdu'l-Bahá asserted that women's "hearts are more tender and susceptible than the hearts of men," He may have been referring to women's capacity for empathy.[22] *Webster's New World Dictionary* defines empathy as "the ability to share in another's emotions, thoughts, or feelings."[23] History attributes the first use of empathy as a scientific research tool in the field of primatology to Jane Goodall and Diane Fossey, who are considered to have revolutionized this previously male-dominated field by their "female approach" to the study of chimpanzees and gorillas.[24]

In 1960 Goodall's patience and persistence in habituating the animals to her presence

18. Ethlie Ann Vare and Greg Ptacek, "Eleanor Ormerod," *Mothers of Invention, From the Bra to the Bomb: Forgotten Women and Their Unforgettable Ideas* (New York: Morrow, 1988) 175–77.

19. Quoted in Vare and Ptacek, "Eleanor Ormerod," *Mothers of Invention* 177.

20. Joe Alper, "Science Education: The Pipeline Is Leaking Women All the Way Along," *Science,* 260 (1993): 409–11.

21. Lael Parrot, "Women and the Culture of Engineering: Society Could Benefit from More Female Engineers," *Resource* (Jan. 1998): 6–8.

22. 'Abdu'l-Bahá, *Promulgation* 284.

23. *Webster's New World Dictionary,* ed. Victoria Neufeldt (New York: Warner, 1990).

24. See Virginia Morell, "Called 'Trimates,' Three Bold Women Shaped Their Field," *Science,* 260 (1993): 420–25, and Nini Bloch, "Mothers of Invention: What Are Women Doing to Science," *Earthwatch* (Oct./Nov.

and her perceptiveness in observation led to ground-breaking discoveries. Among other things, she found that chimpanzees were omnivorous (not herbivores as previously thought) and that they made tools from twigs and used them to extract termites from their nests. The latter discovery prompted a redefinition of the long-held belief that humans were the only toolmakers.

Contrasting the previous research methods to Goodall's approach, researchers now agree that "the payoff came from the women's capacity to empathize with their subjects, seeing them as individuals, whose life histories influenced the structure of the group." Instead of numbering the chimpanzees, Goodall "named the animals and used words like 'individual,' 'emotion,' and 'personality.'"[25]

Leaders in the field at the time considered Goodall's approach unscientific and sentimental, ostracizing her and insinuating that what she was doing was not appropriate science. Goodall persisted in this female approach to science against the discouragement of the male scientific culture. Now scientists admit that "empathy is very important in primatology. It helps you to ask questions and to predict what your animals are going to do."[26] Empathy has now become part of the scientific method in primatological research.

"Responsive toward the Needy and Suffering." In Diane Fossey's efforts one sees an illustration of the qualities of "mercy and sympathy" and "concern for the needy and the suffering" that 'Abdu'l-Bahá extolled in women and that would help scientists focus not only on the knowledge to be gained through scientific investigation but also on the needs surrounding the object under study.

When Fossey began studying gorillas in 1966 she also used the empathetic approach; for her the individuality of the apes was paramount. Because so little was known about gorillas, her dissertation became the baseline for understanding the species. According to *Science* writer Virginia Morrell, "Fossey saw things primatologists had never viewed: female gorillas transferring between groups; males killing infants to bring females into heat; gorillas eating their own dung to recycle nutrients."[27]

But Fossey became so deeply engrossed with the animals she was studying that she crossed the line from dispassionate observer and began to question the usefulness of her research in light of the fact that gorillas were so endangered (at the time they numbered only 250). Her heartbreaking and often gruesome encounters with poaching led her to dedicate herself aggressively to conservation work and to protecting the gorillas from poachers. Her anger at their condition fueled her international campaign, until she was murdered in 1983. She is credited with having made the world aware of the plight of the gorillas.

Primatologist George Shaller commented on the impact of the path-breaking work of Goodall and Fossey, saying that these primatologists "taught science that the great apes are true individuals. . . . They have given us an empathy with our closest relatives, and that is the only thing that will save these animals in the end."[28] The "empathy" that

1995), 16–22. For a more detailed description of Jane Goodall's discoveries, see Jane Goodall, *Through a Window, My Thirty Years with the Chimpanzees of Gombe* (Boston: Houghton, 1990). For a more complete treatment of Diane Fossey's work, see Farley Mowat, *Woman in the Mists: The Story of Diane Fossey and the Mountain Gorillas of Africa* (New York: Warner, 1987) 380.

25. Morell, "Called 'Trimates,'" *Science,* 260 (1993): 422.

26. Morell, "Called 'Trimates,'" *Science,* 260 (1993): 423.

27. Morell, "Called 'Trimates,'" *Science,* 260 (1993): 423.

28. Cited in Morell, "Called 'Trimates,'" *Science,* 260 (1993): 425.

was used as a tool of scientific research seems to have become transformed here into a "mercy" and "concern for the suffering" that triggered a successful conservation movement.

According to Morell,

> Fossey's [story] raises the issue of what values scientists heed. Many studies have shown that a key difference between men and women is that men often place a high value on theoretical values—knowledge for its own sake—while women tend to evaluate knowledge according to its usefulness. In Fossey's case, the two types of values were intertwined from the beginning—since her scientific interest in the gorillas was triggered by a passion for wildlife and a desire to make a difference in the world.[29]

Greater Moral Courage in Moments of Crisis. 'Abdu'l-Bahá says moral courage is yet another quality in which women excel: "The woman has greater moral courage than the man; she has also special gifts which enable her to govern in moments of danger and crisis."[30] Rachel Carson, an ecologist and the mother of the modern environmental movement, was known for her great moral courage. She is credited with having sounded the alarm in 1962 when the widespread use of chemical pesticides in agriculture threatened the ecological chain.[31] A highly successful marine biologist and writer, she spent her career with the United States Fish and Wildlife Service.

When a friend called her to witness the wholesale killing of birds and harmless insects that had taken place in her private bird sanctuary as a result of the state's spraying with DDT (under its mosquito control program), Carson responded by publishing *Silent Spring.* Because she realized there were no government agencies at the time dedicated to the preservation of the natural environment, Carson felt the issue called for a changed political philosophy. She gathered evidence from scientists in America and Europe on "not only the dangers of DDT but also other chemicals with which modern man was poisoning earth, air and water on a worldwide scale. She was questioning not only the indiscriminate use of poisons but also the basic irresponsibility of an industrialized, technical society toward the natural world."[32] *Silent Spring* was violently attacked by the agricultural chemical industry, which viewed Carson's assertions as a public-relations problem. They spent enormous sums of money to ridicule both the author and her book. Crippled by arthritis and suffering from bone cancer as she completed the book, Carson, nevertheless, defended her premise and, until her death in 1964, played an important role in the initial steps toward legislative action to limit the use of pesticides.

A unique set of factors contributed to Carson's insight: she challenged the notion that science belongs in a "separate compartment of its own, apart from everyday life." She "was not ashamed of her emotional response to the forces of nature" and "felt a spiritual closeness to the individual creatures about whom she wrote."[33] Her moral courage may have, indeed, awakened humankind in a moment of danger and crisis, steering it away from environmental destruction and toward a path of greater ecological responsibility.

29. Cited in Morell, "Called 'Trimates,'" *Science,* 260 (1993): 424.

30. 'Abdu'l-Bahá, *'Abdu'l-Bahá in London* 103.

31. See Paul Brooks, "Rachel Carson," *Notable American Women: The Modern Period,* ed. Barbara Sicherman et al. (Cambridge: Harvard UP, Belknap Press, 1980) 138–41. For a more complete description of Carson's work, see Rachel Carson, *Silent Spring* (Boston: Houghton, 1962).

32. Brooks, "Rachel Carson," *Notable American Women* 140.

33. Brooks, "Rachel Carson," *Notable American Women* 140.

Intuition and Receptiveness. 'Abdu'l-Bahá states that "In some respects woman is superior to man. She is more tender-hearted, more receptive, her intuition is more intense."[34] When asked to define the faculty of intuition, He said that

> the second sort of knowledge, which is the knowledge of being, is intuitive; it is like the cognizance and consciousness that man has of himself.
>
> For example, the mind and the spirit of man are cognizant of the conditions and states of the members and component parts of the body, and are aware of all the physical sensations; in the same way, they are aware of their power, of their feelings, and of their spiritual conditions. This is the knowledge of being which man realizes and perceives, for the spirit surrounds the body and is aware of its sensations and powers. This knowledge is not the outcome of effort and study. It is an existing thing; it is an absolute gift.

'Abdu'l-Bahá continues to develop the theme of intuition by speaking of the interrelatedness of all things:

> The most noble being on the earth is man. He embraces the animal, vegetable and mineral kingdoms—that is to say, these conditions are contained in him to such an extent that he is the possessor of these conditions and states; he is aware of their mysteries and of the secrets of their existence.[35]

In this statement one sees that it is not anathema to use intuition in the process of science, which is the delving into the realities of things, for if the conditions of these kingdoms are contained within human beings, the unraveling of their "mysteries and the secrets of their existence" is the same as understanding ourselves. Part of the scientific method, then, is to tap into this connectedness.

The use of intuition in science is perhaps most controversially illustrated by Barbara McClintock, Nobel laureate and discoverer of gene transposition. Through meticulous manipulation and observation of the inheritance of pigment patterns in Indian corn, she made what has come to be recognized as the most revolutionary genetic discovery since Mendel's in 1865.[36] In 1951 she published the theory of gene transposition, postulating that genes do not always behave in an orderly fashion in heredity but, triggered by developmental events, sometimes actually jump around on a chromosome, or from one chromosome to another. Her theory united the disciplines of cell genetics and developmental biology, paving the way for the modern sciences of molecular genetics and genetic engineering.

After McClintock's discovery of transposition, she was ostracized by the scientific community and considered eccentric, perhaps because the discovery was so revolutionary and because at the time there were few geneticists in the world capable of understanding her work. It took the scientific community thirty years to arrive slowly, through numerous other lines of evidence, at an understanding of McClintock's 1951 discovery. The theory of gene transposition is now accepted, and, though McClintock worked with plants, her discovery has made it possible to study antibiotic-resistant bacteria, to seek a cure for African sleeping sickness, and to help understand the mechanism of cancer.

Evelyn Fox Keller, McClintock's biographer, has written about the reasons for the dual themes of success and marginality char-

34. 'Abdu'l-Bahá, *Paris Talks* 50.6.

35. 'Abdu'l-Bahá, *Some Answered Questions,* comp. and trans. Laura Clifford Barney, 1st ps ed. (Wilmette, Ill.: Bahá'í Publishing Trust, 1984) 157, 158.

36. See Evelyn Fox Keller, *A Feeling for the Organism: The Life and Work of Barbara McClintock* (New York: Freeman, 1983).

acterizing her career.[37] McClintock saw transposable elements as the key to developmental regulation. Her contemporaries were not able to absorb her discovery because she was a philosophical and methodological deviant. Her concept of nature, for example, was that "anything you can think of you will find, . . . organisms . . . do everything we can think of, they do it better, more efficiently, more marvelously." This meant that one had to "listen to the material," to respect individual differences, not as aberrations, but as possible clues to the greater picture. Instead of trying to fit knowledge into a central dogma, discarding all exceptions as irrelevant, she pursued the single exception with the greatest respect. Her work on transposition began, in fact, from the observation of an aberrant pattern of pigmentation on a few kernels of a single corn plant. "The important thing is to develop the capacity to see one kernel [of maize] that is different and make it understandable," she wrote. Her major criticism of contemporary research was what she saw as inadequate humility, the scientist wanting to impose an answer on the material; "if you'd only just let the material tell you," she cautioned.[38]

McClintock's approach, now dubbed "a feeling for the organism," is illustrated in her description of chromosomes she was trying to identify through microscopic observation: "I found that the more I worked with them, the bigger and bigger [the chromosomes got], and when I was really working with them I wasn't outside, I was down there. I was part of the system. . . . And you forget yourself."[39]

McClintock's language shows her love for her object, a love that allows for intimacy without annihilation of difference. This, Keller asserts, describes a form of thought that informs her work. It is "a vocabulary of affection, of kinship, of empathy. . . . McClintock can risk the suspension of boundaries between subject and object without jeopardy to science precisely because, to her, science is not premised on that division. . . . [this] is the wellspring of her powers as a scientist." "Love revealeth with unfailing and limitless power the mysteries latent in the universe," 'Abdu'l-Bahá asserts.[40]

Furthermore, McClintock saw the anomalous corn kernels not as evidence of disorder or lawlessness but as part of a larger system of order, one that cannot be reduced to a single law. It was part of the connectedness of all things. Her interest was not so much in knowing the mechanism and structure of genes but in understanding the function and organization, the relationship to the organism as a whole. The traditional division between genetics and developmental biology was one that McClintock could not accept, her foresight perhaps presaging the development of the currently all-powerful science of molecular biology. But what was heretical in McClintock's thinking was that she saw in transposition a mechanism enabling genetic structures to respond to the needs of the organism. In 1953, two years after McClintock presented her findings, biochemical scientists James Watson and Francis Crick had elucidated the structure of DNA. This mechanism of inheritance became the central dogma, one that postulated a one-directional flow of genetic information from DNA to RNA to protein. The claim was made that the secret of life had been unraveled. This hierarchical

37. Evelyn Fox Keller, "A World of Difference," *Reflections on Gender and Science* (New Haven: Yale UP, 1985) 158–76.

38. Keller, "World of Difference," *Reflections on Gender and Science* 162.

39. Keller, "World of Difference," *Reflections on Gender and Science* 165.

40. Keller, "World of Difference," *Reflections on Gender and Science* 164; 'Abdu'l-Bahá, *Selections from the Writings of 'Abdu'l-Bahá*, comp. Research Department of the Universal House of Justice, trans. Committee at the Bahá'í World Centre and Marzieh Gail (Haifa: Bahá'í World Centre, 1997) 27.

structure of genetic organization, similar to organizational charts of corporate structures, became a textbook illustration. McClintock's views, which added another layer of complexity by suggesting that nature responded more fluidly to the needs of the organism, did not fit into that scheme. Hence she was marginalized until science slowly sorted through and incorporated that additional piece of the puzzle decades later.

One of the many lessons of McClintock's story lies in the relevance of gender not just to the questions scientists ask but in the answers with which they content themselves. Therefore, the influx of large numbers of women into the sciences must have the effect not just of adding another component to the creative vision now represented in science but of incorporating a fundamentally different view of nature and perhaps a scientific mind more inclusive of subjectivity. Although this could hardly be articulated by most women scientists, it is a fundamental component of their right to be scientists. To accept anything less would have the same demoralizing effect as being invited to sit at the men's table but having to laugh at misogynist jokes.

Yet, if one acknowledges that the contribution of women is vital, one must examine whether women are actually succeeding in entering the sciences in sufficient numbers to exact change. Time alone does not appear to have been enough to ensure this greater influx. In 1972 an education amendment, Title IX, was enacted by Congress, stating that "No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance."[41] On the twenty-fifth anniversary of Title IX, reports acknowledge the positive effect of the legislation on the advancement of women in many fields. In sports, medicine, and law, the numbers of women have steadily increased.[42] But reports acknowledge that "Women remain underrepresented among students and faculty in the sciences, technology and engineering."[43] Even legislation removing educational barriers does not appear to have created the necessary climate and incentive for women to succeed in the scientific arena. This suggests that the barriers are so deeply ingrained in the academic and corporate systems that they make progress quite difficult. As the National Spiritual Assembly of the Bahá'ís of the United States has noted in a statement on the equality of women and men, "The gains for women rest uneasily on unchanged, often unexamined, inherited assumptions."[44]

Present Barriers to Entering Male-Dominated Sciences

WOMEN entering the sciences must overcome many gender-related barriers that superimpose themselves on the normal battery of challenges attendant on such a pursuit. These barriers are like burdens placed on the back of a camel. The question becomes, "Which straw will break the camel's back?" That is, at what stage of the process will girls, young women, or older women lose interest or leave science, due not to lack of ability or performance but to nebulous depressive influences that eventually accrue to foster complete

41. Title IX of the Education Amendments of 1972, 20 U.S.C. Section 1681, in National Coalition for Women and Girls in Education, "Title IX at 25, Report Card on Gender Equity," http://www.aauw.org/1000/summary.html3anchor449199.

42. Education Development Center, "Facts on Title IX Before and After," http://www.edc.org/WomensEquity/title9/riley.html.]

43. Education Development Center, Inc., "Report Card on Title IX at 25," http://www.edc.org/WomenEquity/title9intro.html.

44. National Spiritual Assembly of the Bahá'ís of the United States, *Two Wings of a Bird: The Equality of Women and Men* (Wilmette, Ill.: Bahá'í Publishing Trust, 1997) 2.

Table 1
Proportion of Full-Time Graduate Students by Sex*

	Male	Female	Ratio
Mathematics	10,000	4,000	5:2
Computer Sciences	12,000	3,000	4:1
Physical Sciences	22,000	7,000	3:1
Biological Sciences	23,000	17,000	3:2
Engineering	54,000	8,000	7:1

*Data from the National Science Foundation, "Women in Science: Data Points," *Science*, 255 (1992): 1376.

discouragement? As some writers have noted, it behooves any parent to be vigilant, lest such forces divert what in a five-year-old girl was a keen and natural interest in science into other channels less suited to the true potentiality of that individual and less satisfactory to society as a whole.[45]

The state of the gender gap in the sciences (in the United States) was reported in a 1992 issue of *Science* magazine. Table 1 summarizes the proportion of full-time graduate students by sex and shows that in most fields of science there are still far fewer full-time female graduate students than there are males, with the biological sciences showing the least difference (two in five), while in engineering the gender gap is greatest (one in eight).[46]

Table 2 shows that women earn less than men at every stage of their scientific careers and that the disparity increases at the highest levels of experience.[47] While the disparity of pay for men and women with approximately two years experience is $7,000, this disparity can increase to $16,000 at thirty-five years of experience, with women's salary increases virtually leveling off after about twenty-five years of experience.

Table 3, which reports the underemployment rates (the proportion not working or working in part-time positions), shows that the rates are higher for women in every scientific field except computer science.[48] These data may reflect both positive and negative trends for women. If the figures reflect only higher unemployment of women scientists, they are negative, but to the extent that the figures reflect a choice and availability to women of part-time positions in the sciences (which increase their opportunity to remain involved in their careers during child-bearing years), they could reflect a positive trend.

Table 4, showing the numbers of women faculty in chemistry departments in universities throughout the United States, is representative of many other science disciplines.[49] Typically, departments having thirty to fifty male professors will have few or no female

45. See Alper, "Science Education: The Pipeline Is Leaking Women All the Way Along," *Science*, 260 (1993): 409, and Pam Penfold, "Wanted: Women Scientists," *Summit* (Spring 1991): 21–23.

46. Data from the National Science Foundation, "Women in Science: Data Points," *Science*, 255 (1992): 1376.

47. Data from the National Research Council. "Women in Science: Data Points," *Science*, 255 (1992): 1376.

48. Data from the National Science Foundation. "Women in Science: Data Points," *Science*, 255 (1992): 1376.

49. Ivan Amato, "Profile of a Field: Chemistry—Women Have Extra Hoops to Jump Through," *Science*, 255 (1992): 1372–73.

Table 2
Salary Disparities Between Women and Men Scientists*

Years of experience	Average Salary		
	Women	Men	Gender Gap
<2	$32,000	$39,000	$7,000
5–9	$39,000	$45,000	$6,000
15–19	$46,000	$55,000	$9,000
25–29	$53,000	$62,000	$9,000
35–39	$53,000	$69,000	$16,000

*Data from the National Research Council. "Women in Science: Data Points," *Science*, 255 (1992): 1376.

Table 3
Underemployment Rates of Women and Men in the Sciences*

Science	Women	Men
Physical Scientists	3.8%	1.7%
Mathematical Scientists	7.2%	2.0%
Computer specialists	2.2%	2.2%
Environmental Scientists	11.5%	5.0%
Life Scientists	9.6%	3.3%
Psychologists	7.0%	5.0%
Social Scientists	11.2%	5.3%

*Data from the National Science Foundation. "Women in Science: Data Points," *Science*, 255 (1992): 1376.

Table 4
The Numbers of Women Faculty in U.S. University Chemistry Departments*

University	Total	Female	Tenure Track	Non-Tenure Track
Utah	53	5	1	4
South Carolina	26	0	0	0
Virginia Polytech. I.	43	4	0	4
Wisconsin-Madison	44	4	4	0
San Diego State	43	2	2	0
Northwestern	30	2	0	2
Georgia	32	1	1	0

*Ivan Amato, "Profile of a Field: Chemistry—Women Have Extra Hoops to Jump Through," *Science*, 255 (1992): 1372–73.

faculty. In many cases even the few women faculty do not have tenured status.

The academic experience, therefore, for a young woman entering a male-dominated science is characterized by two general psychological barriers: (1) her relative minority status among the student population, where she may be one of every eight students in engineering, to one of every two and a half students in a biological sciences program; and (2) the virtual lack of female faculty to act as role models and mentors. Added to these factors may be attitudes and prejudices encountered from individual faculty and colleagues, which contribute to making the environment female-friendly or female-unfriendly.

As women progress further up the ladder of human attainment—that is, the scientific job market or graduate studies—the impact of male domination is likely to be more strongly felt. As the numbers of women decrease, the increased interaction with a predominantly male power structure in which the acceptable mode of communication is masculine contributes to an environment increasingly unfriendly to women. An example drawn from my own graduate school experience is that while earning three degrees at two major universities I never had a female science professor. I had many good professors who were willing to train women. But the fact that most newly hired faculty were young, white, and male, reinforced the women-unfriendly environment. As a female, I began unconsciously to internalize a message that women may be allowed to pursue their graduate studies but that they were not good enough to be professors.

Addressing the environment in the culture of engineering, writer Lael Parrott says that "women who pursue engineering are marginalized by a professional culture that, due to the predominance of men in the workplace, continues to be fundamentally masculine." The result is that, in the male-dominated scientific culture, "a male style of interaction prevails. Women fail to understand the unwritten rules of conduct and as a result, fail to effectively promote their strengths."[50]

The difference in language and communication patterns between men and women can be a contributing source of stress. Only one style, the male, may seem acceptable. In research meetings and classes, I learned to take great care when speaking, not to seem out of place in the male-dominated environment. An exchange with one of my professors that took place during my Master's defense is instructive. When I attempted to verbalize the interconnectedness of several plant hormones in affecting plant anatomy by saying, "I have a feeling that such and such is occurring inside this plant because . . . ," one of my professors interrupted me to ask, "What do you mean 'I have a feeling?' There is no room for feelings in science, only facts!" The hormone balance theory I was attempting to verbalize was more subjective and complex than a single hormone cause-and-effect relationship but seemed intuitively appropriate to the case and no less plausible (to my mind) an explanation of the observed phenomenon.

University of Pittsburgh professor Constance Carroll, in an essay about black women in higher education, talks about communication differences between women and men and the intense feeling of isolation minority and women faculty experience:

> I never come in contact with another Black woman professor or administrator in my day-to-day activities. This seems to be similar for most of the Black women in similar positions. There is no one with whom to share experiences and gain support, no one with whom to identify, no one on whom a Black woman can model herself. It takes a great deal of psychologi-

50. Parrot, "Women and the Culture of Engineering," *Resource* (Jan. 1998): 6.

> cal strength just to get through a day, the endless lunches and meetings in which one is always "different." The feeling is much like the exhaustion a foreigner speaking an alien tongue feels at the end of the day.[51]

Scientist Daniel Koshland, in an editorial in *Science*, cites several reasons for the poor representation of women faculty in the sciences: the "old-boy" prejudice preventing them from getting into the positions, and a high rate of attrition during the period between graduate school and tenure, this being an interval of intense and unequal competitive pressure for women. At no stage in the educational process is there an indication that the attrition is caused by lack of academic performance. He cited, instead, lack of role models as a source of insecurity and a decisive factor in the failure to develop the self-confidence essential for a research investigator.[52]

The "old-boy" syndrome, according to *Science* writer Ann Gibbons, includes many factors, such as men's feeling more comfortable working with men; entrenched attitudes that women are not as good at science or are less committed to research due to family responsibilities; and women's not faring well because they are isolated and lack alliances with older colleagues.[53]

Gibbons points out that because the criteria for tenure are flexible, this is an area where men can easily discriminate against women. In 1989 women held only 8 percent of the full professorships in science and engineering, a number that does not appear to change, despite the growing pool of female Ph.D.-level scientists. One researcher commented that

> If we're not going to disassemble the barriers, and if we're not going to help assure the sustained participation and performance of women in science, then you really have to question whether increasing these numbers of women in doctoral education is going to make any difference to the enterprise of science.[54]

Another aspect of the psychological battles women face may be the cultural patterns of women themselves. The graduate school experience can be an overwhelming one for both men and women. In many cases the system breeds workaholism and can lead to burnout. In *Women's Burnout*, psychology authors Herbert J. Freudenberger and Gail North make the case that women may be even more susceptible to workaholic burnout if they have perfectionist tendencies.[55]

The perfectionist has an unrealistically high standard to meet and will sacrifice important responsibilities to meet that standard. The cost she pays may be too high for her and may lead to gradual disenchantment with her work and a deadening of the real person inside. Furthermore, the perfectionist's sense of identity and self-worth is tied to how she measures up to that standard. She is constantly on parole. Her successes she views as coincidences, but her mistakes she tends to take as confirmation of incompetence, proof that there's a fraud lurking underneath.

Another personal episode illustrates the heavy toll of expectations on those who are

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51. Constance M. Carroll, "Three's a Crowd: The Dilemma of the Black Woman in Higher Education," in *All the Women Are White, All the Blacks Are Men, But Some of Us Are Brave: Black Women's Studies*, ed. Gloria T. Scott et al. (New York: Feminist Press at the City U of New York, 1982) 115–28.

52. Daniel Koshland, "Women in Science," *Science*, 239 (1988): 1473.

53. Ann Gibbons, "Key Issue: Tenure—Does the Old-Boy Network Keep Women from Leaping Over this Crucial Career Hurdle?" *Science*, 255 (1992): 1386.

54. Gibbons, "Key Issue: Tenure," *Science*, 255 (1992): 1386.

55. Herbert J. Freudenberger and Gail North, *Women's Burnout: How to Spot It, How to Reverse It, How to Prevent It* (New York: Penguin, Viking, 1986).

pioneers. A few days before my preliminary examination I became obsessed with the question of how many African-Americans had been awarded Ph.D.s in plant breeding and genetics at my university. When I learned that I was probably going to be the first (according to the recollection of an elderly professor), I panicked. Suddenly, the whole weight of the race was on my shoulders. I remember entering that exam room, with five white male professors sitting around a long narrow table staring at me, thinking that, if I failed it would be doubly disastrous, because I was a woman and because I was black.

Case Histories of Some High Achievers

'ABDU'L-BAHÁ talks about the depressive impact of being surrounded by a subliminal message that one is inferior: "the assumption of superiority by man will continue to be depressing to the ambition of woman, as if her attainment to equality was creationally impossible; woman's aspiration toward advancement will be checked by it, and she will gradually become hopeless."[56] Even the achievers, women who have done great things in science, have had to contend with this invisible depressor. The contrasting stories of two women scientists—those of Rosalind Franklin, a contributor to the discovery of the structure of DNA, and Barbara McClintock, the discoverer of gene transposition, illustrate how messages about inferiority affect persons differently.

Rosalind Franklin. The story of Rosalind Franklin is sad and tragic.[57] Some feel that to this day she has not received the recognition she deserved for being a codiscoverer of the structure of DNA. Rosalind Franklin was born into a prominent Jewish banking family in London and in 1941 disappointed her parents by becoming a chemist. She was awarded several scholarships to work in a number of laboratories under men who resented the presence of a woman. In the early 1950s, while she conducted breakthrough research in X-ray crystallography and the molecular structure of DNA, James Watson and Francis Crick were trying to elucidate the structure of the molecule through biochemical analysis. Franklin's supervisor, Maurice Wilkins, turned over her findings to Watson and Crick without her permission. With it they were able to discern the mistakes in their model and use her findings as major supportive evidence for their work. In 1953 Franklin became so frustrated with the treatment she was receiving that she left her position for another research station but, because of proprietary rights, she was forbidden to talk about or continue her previous work with DNA. She went on to work on the structure of viruses, however, and contributed significantly to the understanding of genetics. She was always a loner, and since official recognition was both too little and too late, when she died of cancer in 1958, at age thirty-seven, she was a bitter and frustrated woman. In 1962 Watson, Crick, and Wilkins were awarded the Nobel Prize for the discovery of the structure of DNA.

Barbara McClintock. Barbara McClintock's story in some ways appears to be very much in contrast to Franklin's—not in the discrimination of the male establishment but in the psychological portrait of the protagonist.[58] In 1922 McClintock received her bachelor's degree from Cornell University in botany because the plant-breeding department would not admit women. In 1927, after receiving

56. 'Abdu'l-Bahá, *Promulgation* 76.

57. Vare and Ptacek, "Rosalind Franklin," *Mothers of Invention,* 214–16. See also Aaron Klug, "Rosalind Franklin and the Discovery of the Structure of DNA," in James D. Watson, *The Double Helix: A Personal Account of the Discovery of the Structure of DNA,* ed. Gunther S. Stent (New York: Norton, 1980) 153–60.

58. See Keller, *A Feeling for the Organism.*

her doctorate with a brilliant breakthrough in cytogenetics, McClintock had only two options: to become a teaching assistant or to take a faculty position at a women's college (positions that, at that time, were also primarily teaching appointments). Though most of her colleagues acknowledged her genius, women were barred in the 1930s from holding tenured professorships. Because McClintock was primarily interested in continuing her research, she pursued neither of these options. Instead, she obtained numerous short-term fellowships to enable her to do research in various laboratories around the country. This created a precarious and unstable situation for her. In 1942, while her male colleagues were safely on the tenure track at prestigious universities, she found herself virtually unemployed. Through a male colleague's intervention, she obtained a position at the Cold Spring Harbor botanical facility, where the Carnegie Foundation gave her a small lab in which she worked quietly for the next forty years. It was not until she was in her eighties that she was accorded recognition. Since 1981 she has received numerous awards for her discoveries, including the 1985 Nobel Prize in medicine.

Although McClintock was conscious of her unequal opportunities, she appears never to have succumbed to debilitating frustration and bitterness, despite her hard times. But even though she never appeared to hold a grudge, one who studies her life is susceptible of developing one on her behalf. Although one understands that scientific revolutionaries are often outcasts, her situation was compounded by gender inequality. Given the significance of her work to genetics and medicine, one sees that prejudice can be costly to the collective well-being of humankind and retards the solution of important problems that plague it.

In examining the effect of a male-dominated culture on women scientists, one sees that the collective influence can be quite strong. Rosalind Franklin became depressed by it (perhaps hopeless) while Barbara McClintock persevered. It is important to remember, however, that such influences act not only on outstanding individuals but on every girl. Surveys show the impact of negative expectations on girls' performance in math and science. Although girls' math and science performance is similar to that of boys during early school years, girls' performance drops markedly from puberty through high school as they become more acculturated to society's gender expectations.[59] Lack of adequate preparation in math and science in high school are strong predictors of whether women will choose or succeed in science in college.[60]

In the same passage in which 'Abdu'l-Bahá talks about the depressive influence of male superiority on women's ambitions and progress, He also suggests a solution: "we must declare that her [woman's] capacity is equal, even greater than man's. This will inspire her with hope and ambition, and her susceptibilities for advancement will continually increase." In other words, all must recognize that potential precedes actuality and take this as an article of faith. To combat feelings of inferiority 'Abdu'l-Bahá urged women and men to recognize unequivocally that the relative backwardness of women (historically) stems from two simple causes: "opportunity and education."[61] This demystifies the question of why women have not contributed to civilization the same quantity of discoveries, arts, and sciences as men. No creational

59. Jennifer Nagorka, "Problem in Science: Too Few Women," *Miami Herald* (March 10, 1991): 7C.

60. Mary Beth Ruskai, "Why Women Are Discouraged From Becoming Scientists," Scientist (Mar. 5, 1990): 17, and Alper, "Science Education: The Pipeline Is Leaking Women All the Way Along," *Science*, 260 (1993): 409.

61. 'Abdu'l-Bahá, *Promulgation* 76, 135.

inferiority prevented her—only lack of education, opportunity, and encouragement. Emphasizing this point relieves women of the burden of emotional self-doubt that contributes to the current psychological barriers in entering the sciences.

Along with 'Abdu'l-Bahá's assertion that lack of "opportunity and education" have contributed to women's backwardness, He advocated that the same curriculum of education, including the sciences and arts, be adopted for boys and girls to promote "unity of the sexes." Furthermore, He enjoins women to prove by their accomplishments in the arts and sciences that their abilities and powers have "merely been latent."[62]

Difficulty in Balancing Scientific Careers and Family Responsibilities

A PARTICULARLY difficult double standard surrounds the subject of women in science. In effect, the male-dominated culture requires that women who are serious about science prove it by abdicating the option of motherhood in favor of serious science. This is an especially onerous double standard, as science does not require men to give up fatherhood to be good scientists. I know an assistant professor who hid her pregnancy until the fifth month, wearing tight and uncomfortable clothing, until the day after her tenure hearing. It was her third pregnancy in five years (one of which had resulted in a miscarriage), and, despite her solid work record, she feared knowledge of the pregnancy would compromise her chances of winning tenure.

By far the most profound psychological battle women face in the quest to become scientists is the question of how to balance scientific careers and family responsibilities. The current structure of the scientific labor market and academic environment is so inhospitable to the biological and psychological responsibilities of motherhood that it provides a severe deterrent to women's progress in these arenas. According to *Resource* writer Lael Parrot, "recent surveys confirm that professional women still maintain the bulk of child-rearing responsibilities in the home."[63]

Science writer Elizabeth Culotha notes that for corporate women scientists and engineers having children is one of the pivotal issues that separate men's and women's career experiences: "In the culture of industrial research, the trouble frequently starts with pregnancy. . . . many [women] felt they faced a no-win situation: Have a baby before promotion—and possibly lose the promotion—or have the baby afterward and manage a newborn plus heavier job responsibilities."[64] Hiding a pregnancy for seven and a half months, she reports, was one woman's way of dealing with an upcoming promotion.

Koshland, in an editorial in *Science,* notes that, for many women, childbearing coincides with a ticking tenure clock, creating overwhelming pressure, with no allowance made by the system for the fact that women not only bear the children but are also the primary organizers of their upbringing. He cites this obstacle, confronted before tenure, as sufficient to discourage a significant number of talented women scientists.[65]

Bernadine Healy, the director of the National Institutes of Health in 1992, writes that

> the punishments come to women who . . . have their children while in their 20s, at least among women in science. . . . A study of 460 National Science Foundation Postdoctoral Fellows showed that women who had their children during their postdoctoral years did not attain as high academic and leadership positions as other

62. 'Abdu'l-Bahá, *Promulgation,* 175, 283.

63. Parrot, "Women and the Culture of Engineering," *Resource* (Jan. 1998): 7.

64. Elizabeth Culotha, "Work and Family: Still a Two-Way Stretch, *Science,* 260 (1993): 401.

65. Koshland, "Women in Science," *Science,* 239 (1988): 1473.

women and men. . . . women in science eventually hit either the "mommy track" or a "glass ceiling."[66]

Many of the writings of 'Abdu'l-Bahá involve the education of children and a mother's responsibilities, addressing simultaneously the exalted position of motherhood and the seriousness of the responsibility: "The mother is the first teacher of the child. For children, at the beginning of life, are fresh and tender as a young twig, and can be trained in any fashion you desire. . . . it is she who establisheth the character and conduct of the child." In another passage He says that "to train the character of humankind is one of the weightiest commandments of God, and the influence of such training is the same as that which the sun exerteth over tree and fruit." Elsewhere He states that "This is a great and important affair and a high and exalted position, and it is not allowable to slacken therein at all."[67]

Hence it is clear why it is so difficult for women to take the responsibility of child rearing lightly. Educating their children well is for many women the central issue of their lives. This takes effort, study, reflection, and an enormous commitment of time. Many women do not lightly entrust this task to surrogates, to anyone other than themselves. Many young women scientists who are Bahá'ís have taken these injunctions so seriously that they quit their professions during early child-rearing years. Where there is a choice, monetarily, they have chosen to stay home and raise their children themselves. But because the sciences often do not value retaining the input of these women on any basis other than full time, their careers suffer severely.[68] They are forced to watch their professional gains slowly erode by the enforced isolation from their professions, which is a result of not being able to "keep one's hand in," even in a minimal capacity.

One of the factors contributing to the choice many women scientists make about staying home and rearing their children is that often "With every professional [married] woman comes a professional man. . . . It is extremely rare to have a house husband." In contrast, another writer asserts, "behind almost every successful, senior professional man is an extremely helpful wife who does not necessarily have her own full-time position."[69]

According to the Universal House of Justice, even though the primary responsibility for early child development is assigned to mothers (while primary responsibility for bread-winning is assigned to fathers), these roles are not absolute and can be adjusted (or even reversed) to suit individual family needs.[70] This would, theoretically, make it possible for families with women scientists to distribute these responsibilities in a manner that enables women to maintain involvement in their scientific careers, assuming the establishment provides such opportunities (that is, flextime, part-time appointments, and so on). Advocates suggest that "both men and women would benefit from implementing family

66. Bernadine Healy, "Women in Science: From Panes to Ceilings," *Science*, 255 (1992): 1333.

67. 'Abdu'l-Bahá, in "Bahá'í Education," *The Compilation of Compilations: Prepared by the Universal House of Justice 1963–1990*, vol. 1 (Australia: Bahá'í Publications Australia, 1991) nos. 639, 590, 641.

68. For an expanded treatment on the impact of current corporate and legal structures on motherhood and equality, see Martha Leach Schweitz, "Of Webs and Ladders: Gender Equality in Bahá'í Law," *World Order*, 27:1 (Fall 1995): 21–39.

69. Marcia Barinaga, "Profile of a Field: Neuroscience—The Pipeline Is Leaking," *Science*, 255 (1992): 1366–67; Ann Gibbons, "Key Issue: Two Career Science Marriage," *Science*, 255 (1992): 1380–81.

70. The Universal House of Justice, letter dated 9 Aug. 1984, in Bahá'u'lláh, 'Abdu'l-Bahá, Shoghi Effendi, and the Universal House of Justice, *Women*, no. 74; for a more in-depth treatment of the complementarity and flexibility of parental roles, see Constance M. Chen, "The New Family: The Role of the Father, The Role of the Mother," *World Order*, 28:1 (Fall 1996): 39–48.

policies that recognize the need to share child-rearing."[71]

Nevertheless, the reality is that it is women who undergo nine months of pregnancy and who breast-feed the child. Moreover, the natural first orientation of the infant is toward its mother. These realities strongly contribute to the fact that it is more often women who take a hiatus from their career. Compounding these considerations is the fact that multiple pregnancies increase the number of stops and starts even for women who have relatively short child-related interruptions to a scientific career.

The current academic and corporate scientific environments provide little opportunity for arrangements that are conducive to balanced, family-oriented career development.[72] Many experts agree that this seriously contributes to the fact that the percentage of women working in the sciences is not rising significantly, despite the higher numbers of women educated in the sciences.[73] The overwhelming stress of reconciling child-related concerns and the unbending scientific work environment has led to the phenomenon known as the "leaking pipeline," wherein women are being lost to the sciences due to a structure that refuses to allow for the intrinsic needs of women participants. For example, in the field of neuroscience, which has one of the highest numbers of women, 45 percent of those entering graduate programs are women, 38 percent of the doctorates are awarded to women, and 33 percent of the post-doctoral candidates are women. But only 27 percent of the jobs go to women (and only one-third of these are tenure-track jobs). "When women are completing postdocs and deciding whether to take another postdoc, apply for a tenure-track job, or settle for a non-tenure-track position," writer Marcia Barinaga reports one neuroscientist as saying, "'That's the time when your self-confidence faces the biggest challenge, . . . that challenge is compounded by the fact that combining the tenure track with family life is not for the faint-of-heart. . . .'" A second one noted, "The women who have made it and are trying to do it all are leading crazy lives, . . . that's scary [for young women] to look at."[74]

The painful fact is that if the choice is made to take a hiatus from a scientific career, the consequences can be enormous. The loss of self-confidence arising from isolation, the loss of preparedness in rapidly advancing sciences, the stigma associated with the hiatus, and the barriers to reentry may result in a permanent leave of absence and a redirecting of career aspirations. That is to say, women will often search out options more compatible with their total persona.

The maxim that "the life of a woman is different from the life of a man," though simple, has much relevance here. One begins to see, for example, that asking women scientists to attain tenure in five years, while simultaneously undergoing one or two pregnancies, is unworkable and unjust. Women cannot be expected merely to fit into the established professional world of men and still discharge family responsibilities. This becomes excruciatingly demanding on women, and it is, in fact, just another form of oppression, not emancipation. Burnout is often the price one pays for trying to live up to a standard that is not commensurate with one's real self, a standard that others have created for one. Therefore, it is imperative for

71. Parrot, "Women and the Culture of Engineering," *Science*, 260 (1993): 6–8.

72. See Amato, "Profile of a Field: Chemistry—Women Have Extra Hoops to Jump Through," *Science*, 255 (1992): 1372–73, and Betsey Morris, "Is Your Family Wrecking Your Career (and Vice Versa)?" *Fortune*, 135.5 (1997): 70–90.

73. Parrot, "Women and the Culture of Engineering," *Science*, 260 (1993): 6–8.

74. Barinaga, "Profile of a Field: Neuroscience—The Pipeline Is Leaking," *Science*, 255 (1992): 1366–67.

women to seek out their own standard, their own pace, their own alternatives to career development and balancing the requirements of motherhood. They must not let the male establishment, even one that believes itself enlightened, do this for them. But this is only a first step in resolving this difficult issue, and it is the only one over which women have even partial control.

'Abdu'l-Bahá's statements on the education of children are not meant to oppress women further, to keep them barefoot, pregnant, and in the kitchen. Rather, they assert that women scientists have two major ways in which to attack the issue of world progress and peace: to aid in the development of the world through their professions and to help train the character of humankind through the education of their children, a role He compares to the influence of the sun in the greening of the planet. Taken together with His statements on the need for women to rise to the highest degree in all arenas of endeavor, they make it imperative that changes be made in the male-dominated system of science to allow women to fulfill these double roles. However, it is not that women *must* be scientists and mothers too; but they must have the right to do so, if they so wish. This right is intrinsic to their identity as women; and the system of science must accommodate this right just as it must all other human rights.

Conclusion

IN *Reflections on Gender and Science,* physicist Evelyn Fox Keller, who is a professor of science, technology, and society at the Massachusetts Institute of Technology, makes the case that, contrary to general belief, the priorities of science and, therefore, the questions investigated by scientists, have not been determined completely impartially. They reflect, rather, the subset of the population historically practicing science—that is, primarily white males. Furthermore, she asserts that there is a

> deeply rooted popular mythology that casts objectivity, reason, and mind as male, and subjectivity, feeling, and nature as female. In this division of emotional and intellectual labor women have been the guarantors and protectors of the personal, the emotional, the particular, whereas science—the province par excellence of the impersonal, the rational, and the general—has been the preserve of men.
>
> The consequence of such a division is not simply the exclusion of women from the practice of science. That exclusion itself is a symptom of a wider and deeper rift between feminine and masculine, subjective and objective, indeed between love and power—a rending of the human fabric. . . .[75]

According to Bahá'í principles, as in all other arenas (political, social, economic), the driving impetus behind the current scientific system must be changed to reflect a "feminization" of humanity's thinking. A significant body of literature has been published during the past decade focusing on feminist approaches to science, reflecting on the impact of gender on science and questioning the assumptions underlying science, that, if it continues to grow, portends an approaching scientific revolution.[76]

A statement made by the Bahá'í International Community in *The Prosperity of Humankind* makes clear the imperative necessity for such a scientific revolution:

> A central challenge, therefore—and an enormous one—is the expansion of scien-

75. Keller, *Reflections on Gender and Science* 7.

76. See Ruth Bleier, ed., *Feminist Approaches to Science* (New York: Pergamon, 1986); Ruth Bleier, *Science and Gender: A Critique of Biology and Its Theories on Women* (New York: Pergamon, 1984); Keller, *Reflections on Gender and Science*; and Bloch, "Mothers of Invention, What Are Women Doing to Science," *Earthwatch* (Oct./Nov. 1995): 16–22.

> tific and technological activity. . . . Development strategy . . . must take as a major goal the task of making it possible for all of the earth's inhabitants to approach on an equal basis the processes of science and technology which are their common birthright.[77]

But even beyond the matter of women's equal access is that of reorienting science's values. According to social critic Lewis Mumford:

> Nothing less than a profound re-orientation of our vaunted technological "way of life" will save this planet from becoming a lifeless desert. . . . For its effective salvation mankind will need to undergo something like a spontaneous religious conversion; one that will replace the mechanical world picture with an organic manifestation of life, the precedence it now gives to its machines and computers. . . .[78]

What is needed to effect change is a different kind of orientation, the kind of orientation 'Abdu'l-Bahá invoked. Is it possible that the interplay of the qualities in which 'Abdu'l-Bahá says women currently excel (empathy, intuition, philanthropy, concern for the "needy and suffering," and a focus on that which is most needful to humanity) and their relative freedom from a need to preserve the status quo or to measure their own self-worth by those standards, would engender in women, at this time, the greater "moral courage" needed to effect a reorientation of science's priorities? A relative newcomer, with a "fresh perspective," so to speak? Yes, but only if that newcomer knows what science is about and honors its own gifts, rather than losing them. And only if that scientific community to which those gifts are offered embraces them and seeks to transform itself. Anything less will produce a delay in the needed transformation.

It is clear, however, from the current condition of the world that compassion and a concern for the needs of the suffering are paramount when developing new scientific priorities and devising new technologies.

If peace is urgent, and the contribution of women to science is a critical ingredient in establishing peace, an acceleration in women's practice of science is also urgent. Rather than the predominantly male scientific community's continuing to structure work in such a way that most women are excluded from pursuing careers, humanity in general and the scientific community in particular must facilitate an increase in the number of women in scientific endeavors. The barriers to women's participation must be broken down quickly and thoroughly. Because men are the dominant force in the world of science, it must be done primarily by men. For equality to happen, men must take ownership of the principle. If the scientific arena can transform itself to welcome women's participation as quickly as women develop themselves to fulfill their role, a synergy could ensue that would produce unprecedented change at unprecedented rates. The mind can hardly conceive of the possibilities for transformation in the material fortunes of humankind.

"It is well established in history," 'Abdu'l-Bahá asserts, "that where woman has not participated in human affairs the outcomes have never attained a state of completion and perfection."[79] Here is an intimation that science without the benefit of women participants provides an incomplete picture. This is amply illustrated in the arena of primatological studies, where, before empathy was made a legitimate part of scientific inquiry, little insight had been obtained. It is also illustrated in the case of genetic research where

77. Bahá'í International Community, *The Prosperity of Humankind* 14–15.

78. Lewis Mumford, *The Pentagon of Power: The Myth of the Machine* (New York: Harcourt, 1970) 413.

79. 'Abdu'l-Bahá, *Promulgation* 134.

the intuitive approach, "the feeling for the organism," led to a breakthrough that caused a shift in the central paradigm. But, most of all, by this statement 'Abdu'l-Bahá creates a dynamic vision of what lies in store for humankind when women come to participate fully in human affairs: "completion and perfection."