From the Instructor

Chantal de Bakker's thoughtful essay highlights an ongoing conundrum within society: how new technologies enlarge opportunities at the same time they expand moral dilemmas. Chantal explores this tension in her essay on the use and potential misuse of ultrasound technology in prenatal care. She deftly draws on the work of scholars of innovation and technology, most notably Everett M. Rogers, to help us understand how even the most beneficial technology may have consequences that are unforeseen by its advocates.

As a teacher, I found Chantal's work inspiring for the breadth and depth of the research, for the cohesiveness of the structure and coherence of the argument, and for its author's willingness to engage with a difficult topic. Above all, her essay demonstrates the purposefulness that connects our writing topics to the broader goals of a meaningful university education.

— Deborah Breen

Chantal de Bakker

Obstetric Ultrasound in the Developing World: An Advance in Prenatal and Maternal Health, or a Facilitator of Gender Selection?[1]

According to a Chinese saying, "It is a blessing to bear a son, a calamity to bear a daughter."[2] Unfortunately, this proverb accurately describes a view that is common in many parts of the world. Women often remain undervalued members of society, and even today, sons are considered both culturally and economically superior to daughters.[3] For this reason, most prospective parents prefer to have sons, and in families with limited resources, girls are often treated with less care than their brothers. In some cases, parents will even abandon or kill baby girls in order to have another chance to give birth to a son.[4] However, until recently, parents have had to wait until the child's birth to discover its gender, as there were no reliable methods of fetal sex determination. All of this has changed with the advancement of ultrasound technology. Ultrasound plays an important role in health improvements worldwide, as it has allowed for early diagnosis of both fetal and maternal health conditions, leading to an increased survival rate, especially in the world's poorer countries.[5] However, recent advances in image quality mean that ultrasound scans can now also be used to determine a child's sex as early as the eighteenth week of pregnancy.[6] This knowledge of the child's gender before birth leads many parents to choose to abort their unborn daughters.[7] In some parts of the world, most notably Asia, this phenomenon has become so widespread that it has led to a significant imbalance in gender ratios.[8] Although there are many positive uses for ultrasound, the combination of the technology with preexisting cultural biases has led to an inappropriate use of ultrasound scanners in sex selection, which can have a serious, negative impact on society.

The positive and negative effects that are observed in the spread of ultrasound imaging are by no means unique to this particular technology. In most cases, innovations are introduced with the purpose of improving the quality of life of the people involved. In reality, however, the growth of any new technology follows a common pattern characterized by both constructive and destructive applications. The interactions between these positive and negative factors can be analyzed in terms of the general principles laid out by Everett Rogers. In his text, *The Diffusion of Innovations*, Rogers explains some of the complex factors that determine the success of a technology in a particular culture.[9] According to Rogers, the various consequences associated with the introduction of a specific innovation into a society can be divided into several categories, including anticipated versus unanticipated, desirable versus undesirable, and direct versus indirect.[10] Furthermore, technology has often been shown to increase inequalities that were already present in a given society. Rogers argues that "a system's social structure partly determines the equality versus inequality of an innovation's consequences," indicating that the unequal spread of innovation is usually not due to the nature of the technology itself, but is instead caused by cultural ideals.[11] Because "the effects of an innovation usually cannot be managed so as to separate the desirable from undesirable consequences," each of these aspects must be considered any time a new technology is introduced.[12]

Despite this inseparability of the contradictory effects of an innovation, Kelvin Willoughby, a professor at Curtin Graduate School of Business, argues that society can, to some extent, choose which types of technologies to accept. Innovations can be selected based on their "suitability for specific purposes or situations," which can be defined in terms of the idea of "appropriate technology."[13] Willoughby describes this concept of appropriate technology, explaining that technology is not a rigid element of change, acting independent of social interests. Instead, he argues, society should play an active role in deciding which innovations become widespread. The term "technology choice" underlies this idea that people should select the technologies which are in the best interest of their culture. Willoughby explains that society's role in the acceptance or rejection of new technology is essential, and that the suitability of innovations

such as ultrasound imaging can only be ensured through regulations that actively consider the concept of appropriate technology.

In general, obstetric ultrasound was designed with the intent of improving maternal and prenatal healthcare since it allows for noninvasive and radiation-free visualization of the fetus, uterus, and placenta.[14] Depending on the age of the fetus at the time of the ultrasound scan, many pathological conditions can be screened for. Specifically, ultrasound scans made early on in the pregnancy allow the age of the fetus to be determined and also allow large-scale abnormalities in fetal development as well as possible problems in the mother's reproductive system to be diagnosed.[15] Ultrasound scans made midway through pregnancy (between 18 and 22 weeks) are important in diagnosing a wide range of fetal abnormalities, and ultrasounds made at the end of pregnancy are important in deciding how the baby will be delivered and in finding fetal health problems that need to be treated immediately after birth.[16] These applications exemplify appropriate uses of ultrasound technology, as the innovation is being used in each case to improve prenatal and maternal health by providing a clear and early diagnosis of potential problems.

Although ultrasound technology is less commonplace in the developing world than in the West, its use in poorer countries has recently expanded rapidly because the equipment is relatively inexpensive and easy to transport.[17] In the developing world, technological advances can be evaluated in terms of their applicability to the Millennium Development Goals, a set of eight objectives set forth by the United Nations in 2000 with the intent of improving quality of life throughout the world by the year 2015.[18] In particular, the appropriate use of obstetric ultrasound has directly contributed to the achievement of the fourth and fifth Millennium Development Goals: the improvement of maternal health and the lowering of child mortality.

In poorer countries, ultrasound imaging has improved maternal health through applications in the early diagnosis of pregnancy complications. For instance, ultrasound can be used to diagnose conditions of placenta previa, ectopic pregnancy,[19] and structural problems with the uterus.[20] Each of these conditions can seriously threaten a woman's life if it is not diagnosed and treated in time. According to the World Health Organization (WHO), a total of 536,000 women died in 2005 because

of complications related to pregnancy.[21] Of these deaths, 99% occurred in the developing world, often due to preventable causes.[22] The WHO also reports that, in 2005, 25% of maternal deaths were due to bleeding, and 8% were caused by obstructed labor.[23] Bleeding during pregnancy is often caused by placenta previa, and obstructed labor usually results from the incorrect positioning of the fetus within the uterus.[24] Both of these conditions can be diagnosed early using ultrasound,[25] leading to an increased chance of survival.

In addition to improving maternal health, obstetric ultrasound has also been shown to decrease infant mortality. Neonatal deaths are often caused by severe birth defects.[26] According to the WHO, worldwide "around 1% of infants have a major congenital anomaly," with a greater proportion occurring in developing countries since malformations can be "caused by diseases such as syphilis, or by nutritional deficiencies," which are more common in poorer countries.[27] Ultrasound is important in identifying structural abnormalities in a fetus and can also be used to evaluate prenatal growth.[28] In either case, early discovery of complications is essential. In the case of fetal health problems that are treatable, discovery through ultrasound allows for early intervention and for better planning of the pregnancy in order to improve chances of survival.[29] Also, if the fetus has serious abnormalities that would prevent it from surviving, early diagnosis would allow for the option of having an early abortion in order to minimize suffering.[30] Overall, the diagnosis of health problems in a noninvasive manner through obstetric ultrasound can improve progress towards achieving the fourth and fifth Millennium Development Goals relating to maternal and infant health and, therefore, constitutes a highly appropriate use of ultrasound technology.

However, despite the success of ultrasonography in health-related applications, ultrasound technology does have drawbacks. In several instances, its use in developing countries has resulted in lack of communication between the doctor and patient and abandonment of effective traditional diagnostic procedures.[31] Most significantly, ultrasound technology is commonly used inappropriately to determine the sex of a baby prior to birth so that an abortion can be performed if the baby is not of the desired gender. In many parts of the world, especially in India and China, "daughters are regarded as a liability."[32] Behind this belief lie many socioeconomic

reasons that depend on the region of the world and the economic status of the family. In some areas, notably India, daughters are expected to move in with the family of their husband when they marry and, therefore, do not contribute to their birth family after reaching adulthood.[33] In many parts of India, parents of a bride also have to pay large amounts of money for a dowry, further increasing the cost of having a daughter.[34] In other countries, such as China, parents not only have a deep cultural bias against daughters, but they also face legal restrictions in the number of children they are allowed to have.[35] The combination of cultural beliefs, laws allowing parents only one child, and disparities in the economic opportunities available to men and women, cause Chinese parents to feel a very strong preference for having a son.

In many cases, these cultural preferences for sons are so severe that they have led to skewed sex ratios. In India, there are currently 109 newborn boys for every 100 girls,[36] and in China, there were an average of 120 newborn boys for every 100 girls in 2009.[37] By comparison, the average sex ratio at birth is equal to approximately 106 to 100 when there are no outside influences.[38] The ratio of sons to daughters often becomes higher with increasing birth order (in South Korea in 1989, the sex ratio for the fourth child was reported to be as high as 199), indicating that this is a cultural problem since parents become increasingly desperate to have sons the more daughters they have.[39] Possible social causes of these shifted sex ratios include preferential treatment of sons, abandonment of daughters, under-reporting of female births, and infanticide of baby girls.[40] Additionally, the spread of ultrasound technology throughout the developing world has had the unexpected consequence of facilitating sex-specific abortion,[41] since ultrasound allows the gender of a fetus to be determined as early as the eighteenth week of pregnancy.[42]

Because it is easy for ultrasound technicians to discreetly alert parents to the sex of their child without recording the interaction, it is difficult to measure the exact effects of ultrasound technology on sex selection.[43] However, the fact that ratios of male to female births have been increasing since the 1980s (see Figure 1), when ultrasound was first introduced in Asia, indicates that ultrasound is an important factor in the current skewed sex ratios.[44] Furthermore, a 1991 study of Chinese hospitals showed a ratio of 110 male to 100 female births.[45] Because this study took place in

a hospital, it is impossible for this ratio to be caused by any other possible factors such as female infanticide, abandonment, or failure to report female births.[46] For these reasons, although other factors do add to the unbalanced ratios, it is likely that ultrasound-based sex selection is playing an increasingly large role in the problem.

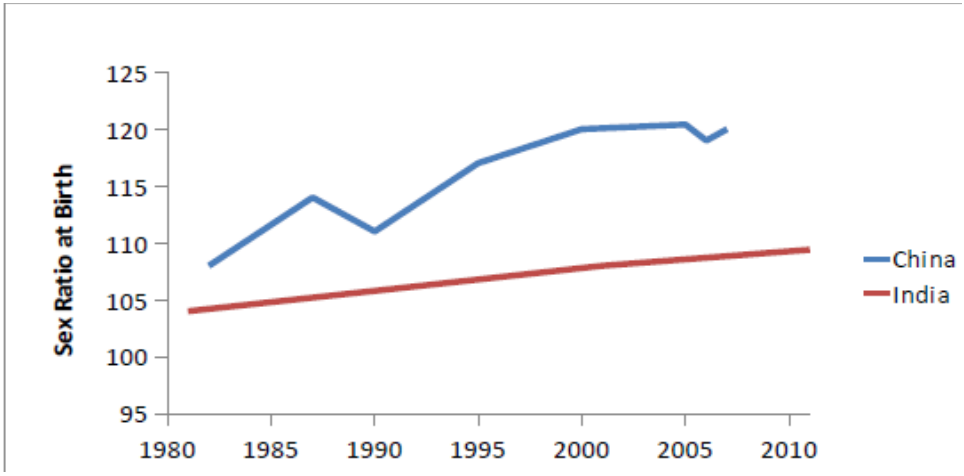

Figure 1. Trends in Average Sex Ratios at Birth. This plot indicates the increase in sex ratio that has occurred in both India and China in the past 30 years.[47]

The government of India has realized the magnitude of this issue, and, as a result, it outlawed prenatal sex determination in 1994.[48] In his description of appropriate technology, Willoughby emphasizes the importance of such regulation, explaining that "conscious human effort is required to ensure that technology is appropriate."[49] However, the difficulty in definitively proving the role of ultrasound in the unbalanced gender ratios makes it challenging for governments to enforce bans on using ultrasonography in fetal sex determination. According to a recent article in *The Times of India*, ultrasound clinics often go unregistered, and, even when the clinic is registered, information about the doctor prescribing the procedure, the fetus's age, and the mother's previous pregnancies, is frequently excluded from forms.[50] The Indian government is currently heading a strong initiative to limit sex-specific abortions in the 17 provinces with the most serious skews in gender ratios, but to date, only six

percent of doctors who are charged with being "involved with sex-selection practices" have been convicted.[51]

These challenges indicate that the appropriate use of ultrasonography can only be guaranteed if the underlying cultural practice of undervaluing daughters is eliminated. One state in India has recently started a policy of providing monetary compensation to parents giving birth to girls.[52] A similar program in China is rewarding parents with land and money if they live in the town of the woman's origin and give birth to girls.[53] It is hoped that such programs will change cultural views to make it more desirable to have daughters so that sex selection will no longer be needed.

Indian and Chinese governments are trying to limit sex-specific abortions largely because of the significantly negative impacts that skewed gender ratios have on society. For instance, large differences in the number of boys and girls lead to the problem of significant numbers of men not being able to marry.[54] In China, it is estimated that unbalanced sex ratios have caused 40 million men to be unable to find a wife.[55] According to a recent analysis by F. A. Chervenak and L. B. McCullough, this will "result in substantial social instability."[56] Furthermore, sex selection also constitutes a form of prejudice. As Chervenak and McCullough explain, by aborting girls solely based on their sex, parents are performing "discrimination against individuals that treats them unequally for arbitrary reasons," which is "ethically and legally unacceptable."[57] The role of ultrasound in increasing this type of unjust treatment is significantly limiting social progress.

These serious consequences of ultrasound technology were most likely not anticipated by the well-meaning medical workers who initially introduced ultrasonography in the developing world. This unpredictability of the negative effects of ultrasound imaging is typical of the spread of technology. As Rogers states in *The Diffusion of Innovations*, "The undesirable, indirect, and unanticipated consequences of an innovation usually go together, as do the desirable, direct, and anticipated consequences."[58] In this case, ultrasonography has resulted in the positive, predicted, and immediate consequence of improving fetal and maternal health while

simultaneously causing the negative, unpredicted, and long-term effect of adding to the gender imbalance already in place.

Besides explaining the relationship between the various effects of ultrasound technology, Rogers' theory of "consequences of innovations" also directly illuminates the negative effect of ultrasound technology on gender equality. According to Rogers, the misuse of technology can result in an amplification of imbalances already present in a society.[59] In the case of ultrasound, this means that, because the societies in India and China already had significant underlying gender biases, the introduction of ultrasound aggravated these problems. In China, for instance, it was already commonplace for parents to fail to report female births and to abandon or murder their newborn daughters even before the advent of ultrasonography.[60] The spread of ultrasound technology in recent years has only made it easier for parents to gain control in deciding the sex of their child, escalating existing problems of gender imbalances and inequalities.[61]

Overall, the use of ultrasound technology throughout the developing world has had mixed results in global development. Obstetric ultrasound has allowed for progress to be made in the Millennium Development Goals of lowering child mortality and improving maternal health.[62] However, unanticipated consequences of ultrasound imaging have also resulted in an increase in sex-specific abortions, indirectly causing a decline in progress towards the Millennium Development Goal of "promot[ing] gender equality and empower[ing] women."[63] In order to limit these negative effects, governments need to be proactive in regulating uses of ultrasound in the short term and eliminating gender biases in the long term. When used appropriately, ultrasound imaging can be a powerful tool to advance fetal and maternal healthcare, thereby improving the overall quality of life for women and newborns in developing countries.

Notes

1. I would like to thank my peer readers for their helpful comments. Thanks also to Mary Foppiani for her help during the research process.

2. Mineke Schipper, *Never Marry a Woman with Big Feet: Women in Proverbs from Around the World* (Cambridge: University Press, 2003), 94.

3. Amelia Gentleman, "India's Lost Daughters: Abortion Toll in Millions," The New York Times, January 9, 2006. http://www.nytimes.com/2006/01/09/world/asia/09iht-india.html.

4. Neil S. Katz and Marissa Sherry, "India: The Missing Girls: A Society Out of Balance," *PBS Frontline*, accessed April 9, 2011, http://www.pbs.org/frontlineworld/rough/2007/04/the_missing_gir.html.; Zeng Yi et al., "Causes and Implications of the Recent Increase in the Reported Sex Ratio at Birth in China," *Population and Development Review* 19, no. 2 (1993): 294, 295.

5. Eugene J. Kongnyuy and Nynke van den Broek, "The Use of Ultrasonography in Obstetrics in Developing Countries," *Tropical Doctor*, no. 37 (2007): 71.

6. Robin E. Weiss, "Telling Your Baby's Sex by Ultrasound—Finding Out the Sex of Your Baby," accessed April 9, 2011, http://pregnancy.about.com/od/boyorgirl/ss/genderus.htm.

7. Kongnyuy and van den Broek, "The Use of Ultrasonography," 71.

8. Gentleman, "India's Lost Daughters"; Yi et al., "Causes and Implications," 283, 284.

9. Everett M. Rogers, *Diffusion of Innovations*, 5th ed. (New York, NY: Free Press, 2003), 436–71.

10. Rogers, *Diffusion of Innovations*, 442.

11. Ibid., 463.

12. Ibid., 445.

13. All information in this paragraph is taken from: Kelvin W. Willoughby, *Technology Choice: A Critique of the Appropriate Technology Movement*, (Boulder, CO: Westview Press, 1990), 5–11.

14. Z. Papp and T. Fekete, "The Evolving Role of Ultrasound in Obstetrics/Gynecology Practice," *International Journal of Gynecology and Obstetrics* 82, no. 3 (September 2003): 339, 340.

15. Papp and Fekete, "The Evolving Role of Ultrasound," 341, 342.

16. Ibid., 341–3.

17. Kongnyuy and van den Broek, "The Use of Ultrasonography," 71.

18. The eight Millennium Development Goals are as follows: "to eradicate extreme hunger and poverty, achieve universal primary education, promote gender equality and empower women, reduce child mortality, improve maternal health, combat HIV/AIDS, malaria, and other diseases, ensure environmental sustainability, and develop a global partnership for development." See: "Millennium Development Goals," United Nations Millennium Project, accessed April 16, 2011, http://www.unmillenniumproject.org.

19. Placenta previa is defined as the implantation of the placenta over or near the cervix and can lead to serious bleeding. Ectopic pregnancy is defined as a condition where implantation of the fetus occurs outside of the uterus, and can also lead to serious

bleeding. See: "Abnormalities of Pregnancy," The Merck Manuals, accessed April 24, 2011, http://www.merckmanuals.com/professional/sec18/ch263/ch263a.html.

20. Kongnyuy and van den Broek, "The Use of Ultrasonography," 71.

21. "Making Pregnancy Safer: Maternal Mortality," World Health Organization, accessed April 16, 2011, http://www.who.int/making_pregnancy_safer/topics/maternal_mortality/en/index.html.

22. "Making Pregnancy Safer," World Health Organization.

23. Other leading causes of maternal deaths included infections (15%), eclampsia (12%), and unsafe abortion, (13%). See: "Making Pregnancy Safer," World Health Organization.

24. Ibid.

25. Kongnyuy and van den Broek, "The Use of Ultrasonography," 71.

26. *Neonatal and Perinatal Mortality: Country, Regional, and Global Estimates* (Geneva, Switzerland: World Health Organization, 2006), 2.

27. *Neonatal and Perinatal Mortality*, 2.

28. Kongnyuy and van den Broek, "The Use of Ultrasonography," 71.

29. Ibid.

30. Ibid.

31. Siegrid Tautz et al., "Between Fear and Relief: How Rural Pregnant Women Experience Foetal Ultrasound in a Botswana District Hospital," *Social Science and Medicine* 50 (2000): 698.

32. Gentleman, "India's Lost Daughters."

33. Ibid.

34. Ibid.

35. Yi et al., "Causes and Implications," 296.

36. Kounteya Sinha, "Only 6% of Doctors Held for Sex-Selection Practices Convicted," *The Times of India,* April 20, 2011.

37. F. A. Chervenak and L. B. McCullough, "Sex Determination by Ultrasound: Ethical Challenges of Sex Ratio Imbalances and Invidious Discrimination," *Ultrasound in Obstetrics and Gynecology* 34 (2009): 245.

38. Sex ratio at birth statistics are calculated based on the number of males to females at birth. Any deviation from the natural sex ratio of 106 constitutes a significant shift. See: Yi et al., "Causes and Implications," 283.

39. Ibid., 296, 297.

40. Gentleman, "India's Lost Daughters"; Yi et al., "Causes and Implications," 285-91, 294–5.

41. Kongnyuy and van den Broek, "The Use of Ultrasonography," 71.

42. Weiss, "Telling Your Baby's Sex by Ultrasound."

43. Sinha, "Only 6% of Doctors."

44. Yi et al., "Causes and Implications," 283–4.

45. Ibid., 292–3.

46. Ibid.

47. Data for this plot was compiled from the following sources: Mara Hvistendahl, "Making Every Baby Girl Count," Science, 323 (2009): n.p., accessed April 30, 2011, doi:

10.1126/science.323.5918.1164.; Riaz Haq, "Female Genocide Unfolding in India," *Haq's Musings Blog*, July 5, 2009, http://www.riazhaq.com/2009/07/female-genocide-unfolding-in-india.html.

48. Gentleman, "India's Lost Daughters."
49. Willoughby, *Technology Choice*, 7.
50. Sinha, "Only 6% of Doctors."
51. Ibid.
52. Ashley Bumgarner, "A Right to Choose?: Sex Selection in the International Context," *Duke Journal of Gender Law and Policy* 14 (2007): 1289, accessed April 9, 2011.
53. Hvistendahl, "Making Every Baby Girl Count," n.p.
54. Chervenak and McCullough, "Sex Determination by Ultrasound," 245.
55. Gentleman, "India's Lost Daughters."
56. Chervenak and McCullough, "Sex Determination by Ultrasound," 245.
57. Ibid., 246
58. Rogers, *Diffusion of Innovations*, 449.
59. Ibid., 460–7.
60. Yi et al., "Causes and Implications," 285–91, 294–5.
61. Kongnyuy and van den Broek, "The Use of Ultrasonography," 71–2.
62. "Millennium Development Goals."
63. Ibid.

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CHANTAL DE BAKKER is a member of the College of Engineering Class of 2012 and is majoring in Biomedical Engineering. Chantal would like to thank her peer readers for their helpful comments and Mary Foppiani for her help during the research process. This essay was written for Deborah Breen's course, WR 150: Technology, Innovation, and International Development.