Kenneth R. Fleischmann[1]

# Frog and Cyberfrog are Friends: Dissection Simulation and Animal Advocacy

ABSTRACT

Although at first glance it may seem an unlikely alliance, frogs and cyberfrogs certainly benefit from an unusual friendship that connects the virtual world of dissection simulation and the physical realm of nonhuman animal advocacy. This paper focuses on the symbiotic relationship of dissection simulation designers and animal advocates. Dissection simulation manufacturers benefit from this relationship through the purchasing and promotion of their products by animal advocacy organizations, and also they benefit from policy changes that encourage the use of dissection simulations as alternatives to dissection. Reciprocally, animal advocacy organizations benefit by saving animal lives, gaining a new tool for convincing teachers to stop dissecting, and demonstrating that they are a pro-technology movement. The knowledges and values embedded in cyberfrogs make them both boundary objects and cyborgs.

Much like the characters Frog and Toad from the popular children's book (Lobel, 1970), dissection opponents and dissection simulation designers have overlapping goals that they pursue through interaction and cooperation to their mutual benefit. My first goal is to demonstrate how both dissection simulation designers and animal advocacy organizations benefit from their strategic alliance. Next, I will compare

Society & Animals 11:2

the values of the two groups in order to explore the limitations and conflicts of this alliance. Finally, I will show that this case is an example of the potential for constructive relationships between social movements and technological experts as well as between physical and virtual worlds.

Over the past 15 years, a large controversy has emerged concerning the potential for replacing animal dissection in the classroom with dissection simulation software. Discussion thus far has centered around issues such as animal suffering and respect for animal life (Fadali, 1996; Balcombe, 2000, 2001; Rasmussen, 2001; Marr, 2001; Nobis, 2002), the scientific case for alternatives (Kinzie et al., 1993; Strauss & Kinzie, 1994; Akpan & Andre, 1999; Balcombe, 2000, 2001; Valli, 2001; Rasmussen, 2001; Nobis, 2002), a student's right to choose not to dissect (Francione & Charlton, 1992; Orlans, 1993; Barr & Herzog, 2000; Cunningham, 2000; Parker et al., 2000), and the impact of dissection on the quality of biology and anatomy classes (Barr & Herzog, 2000; Balcombe, 2000; Valli, 2001; Rasmussen, 2001; Moore, 2001; Marr, 2001; Nobis, 2002). Yet it seems that academic researchers have paid little or no attention to the impact of this controversy on the animal advocacy movement itself. Here, I explore the symbiotic relationship that has developed between dissection simulation designers and animal advocacy organizations and its effects on the behaviors and perceptions of the two groups.

## Background: The Frog Dissection Controversy

Frog dissection is a widespread practice in North American middle and high school biology classes. The National Association of Biology Teachers (1990) justifies dissection by stating that "the dissection of animals has a long and well-established place in the teaching of life sciences . . . [and] can illustrate important and enduring principles in biology" (p. 72). Akpan and Andre (1999) explain that biology teachers defend dissection as the primary hands-on way of learning about anatomy and physiology. Thus, many biology teachers believe that dissection is an essential part of biological education.

Yet, not all educators, students, and parents agree with dissection. Animal advocacy organizations have long been critical of the use of animals in education, especially in cases involving the unnecessary death of animals. Although some educators feel that dissection at the K-12 level is an invaluable teaching tool that cannot be replaced, many students, teachers, and animal advocates

have strong objections to dissection. Dissection opponents believe that a student should have the option of avoiding dissection (now enshrined as state law in several states), and in some cases they even argue that dissection should be removed entirely from K-12 classrooms. One fascinating result of this struggle, as we will see below, is that animal advocates have an incentive to encourage technological innovation designed to create alternatives to dissection.

Numerous studies have compared animal dissection simulations to actual animal dissection. Youngblut (2001) and Balcombe (2000) review a broad range of published research on this topic and conclude that dissection simulations almost always have been found comparable or, in several cases, even superior to actual dissection. Kinzie, Strauss, and Foss (1993) designed and evaluated an educational simulation of frog dissection on interactive videodisc (available online at http://curry.edschool.virginia.edu/go/frog/). Their statistical analysis indicated that their dissection simulation was at least as effective as actual dissection in promoting learning about frog anatomy and dissection procedures (Kinzie, Strauss, & Foss, 1993, 1998). Youngblut (2001) reports similar findings, while also finding that dissection simulation can be more efficient than its off-line counterpart is through achieving similar results with significant savings of instructional time. Balcombe (2000) also finds that dissection simulation can be more economical than actual dissection, depending on the quality of actual frogs used for dissection, the number of alternatives used to replace dissection, and the availability of computers within the classroom or school. Thus, research, to date, indicates a strong potential for dissection simulation to replace actual dissection in K-12 education, a scenario that would significantly benefit both frogs and cyberfrogs.

## Research Methods

This paper is part of a larger project exploring the values and knowledges embedded in educational computer simulations. As I will demonstrate below, the relationship between dissection simulation designers and animal advocates' values is based on shared peripheral values that contrast with distinct and potentially conflicting core values. Data collection and analysis are primarily qualitative, relying most heavily on interview data and analysis of promotional materials. As argued by Barr and Herzog (2000), qualitative methods are a particularly appropriate tool for exploring issues involving

personal values such as feelings about animal advocacy and experimentation on animals.

Interview data for this study come from 18 interviews (Table 1) with frog dissection simulation designers and animal advocates, all of whom volunteered to be identified in my research. The 10 designers interviewed for this study include 6 designers of The Digital Frog™, 3 designers of DissectionWorks™, and the designer of Froguts™. I also conducted 8 interviews with animal advocates affiliated with 7 different animal advocacy organizations. Semi-structured, all interviews followed a standard list of questions—with additional interrogation of lines of questioning and ideas developed during the specific interview—and took place between August and December 2002.

**Table 1. Designers and Activists Interviewed (Including Product/Organizational Affiliation)**

| | Organization | Interviewee |
|---|---|---|
| Dissection Simulation | Digital Frog International | Jim Bridges<br>Celia Clark<br>Sarah Clark<br>Simon Clark<br>Rob Van Vlaenderen<br>Jeff Warner |
| | ScienceWorks | Jim Moose<br>Lewis Newton<br>Dick Shaw |
| | Froguts.com | Richard Hill |
| Animal Advocacy | Humane Society of the United States | Lesley King<br>Cheryl Ross |
| | National Anti-Vivisection Society | Jodie Wiederkehr |
| | American Anti-Vivisection Society | Andrew Knight |
| | New England Anti-Vivisection Society | Ann Stauble |
| | Physicians Committee for Responsible Medicine | Jonathan Balcombe |
| | Association of Veterinarians for Animal Rights | Nedim Buyukmihci |
| | Doctors for Kindness to Animals | Nancy Harrison |

I conducted the interviews with Digital Frog International employees during a three-day field site visit to their headquarters in Puslinch, Ontario, Canada: the interview with Hill by e-mail; and the interviews with DissectionWorks designers and animal advocates by telephone.

Promotional materials also serve as an important data source for this investigation. This study is based in part upon an analysis of texts such as websites and printed material produced by the dissection simulation companies and animal advocacy organizations that my informants represent. Thus, materials used included those produced by educational simulation manufacturers publicizing their dissection software and animal advocacy organizations opposing the practice of dissection. Data analysis for both interviews and textual materials is based on the grounded theory approach to qualitative data analysis (Strauss & Corbin, 1998).

## Organizations and Interviewees

DissectionWorks, produced by ScienceWorks, Inc., was one of the first commercial frog dissection simulation software programs. Its four designers, Louis Newton, Dick Shaw, Jim Moose, and Stan Hill, were all high school science teachers. DissectionWorks also includes four other animal dissections—earthworm, crayfish, perch, and fetal pig—but the frog, started in 1988, was the first animal dissection simulation produced by ScienceWorks. The Digital Frog, produced by Digital Frog International, has won several multimedia awards since its development in 1994. The Digital Frog is divided into three main components: dissection, anatomy, and ecology. Among the designers of The Digital Frog and its 1998 upgrade, The Digital Frog 2, are Simon Clark, Sarah Clark, Celia Clark, Jim Bridges, Rob Van Vlaenderen, and Jeff Warner. The Digital Frog was one of the two frog dissection simulations (along with DissectionWorks) that Balcombe (2000) used as examples in his economic comparison of actual frog dissection to alternatives. One of the most recently developed frog dissection simulations is the website Froguts, created by high school teacher and educational software designer Richard Hill. Located at http://www.froguts.com/, Froguts is an interactive Flash-based simulation of frog dissection.

The eight animal advocates interviewed for this study are affiliated with seven important organizations opposed to the practice of killing animals specifically

for the purpose of dissection. Opposition to the scientific and educational harming of animals has a long history in North America, dating back to the founding of the American Anti-Vivisection Society (AAVS) in 1883 (Lederer, 1995). Andrew Knight, Director of Education of AAVS's education division, Animalearn, is also a veterinary doctor trained in Australia with connections to the Association of Veterinarians for Animal Rights, which was co-founded by Nedim Buyukmihci. A similar professional organization supporting animal advocacy issues is the Physician's Committee for Responsible Medicine, which has just acquired the services of Jonathan Balcombe, former Education Director of The Humane Society of the United States (HSUS). The current education director of the HSUS is Lesley King, and Cheryl Ross is the coordinator for their Humane Education Loan Program (HELP). Similarly, Jodie Wiederkehr is the Dissection Alternatives Loan Program Coordinator for the National Anti-Vivisection Society, where she is also in charge of the Dissection Hotline and e-Hotline. It was through the NAVS e-hotline that I was able to contact Nancy Harrison, a pathologist who presents at teacher conferences about dissection simulations and who is a co-founder of Doctors Against Dog Labs. Finally, Ann Stauble is the Director of Research and Investigations at the New England Anti-Vivisection Society (NEAVS).

## Profiting from Animal Advocacy: How Dissection Simulation Designers Benefit

Dissection simulation designers benefit both directly and indirectly in a variety of ways from cooperation with animal advocacy organizations. Perhaps the most direct benefit that dissection simulation designers receive because of their relationship with animal advocacy organizations is the purchasing of their software by animal advocacy organizations. In some cases, animal advocacy organizations make large purchases of dissection simulation software and donate it to teachers at local schools. For example, according to C. Clark of Digital Frog International, Niagara/Brock Action for Animals purchased a copy of *The Digital Frog* "for every high school in their district." In this case, Digital Frog International benefited even more significantly because soon after the donation, "the school board upgraded it to lab packs for all of their schools." Digital Frog International also benefited when a chapter of the Physicians Committee for Responsible Medicine in Dallas gave copies of *The Digital Frog* to every high school in the Dallas Independent School District.

J. Bridges, a Clark colleague states, Digital Frog International's relationship with animal advocacy "helps boost our sales". DissectionWorks designer L. Newton refers to animal advocacy organizations as "good customers". One of his co-founders of ScienceWorks, D. Shaw, relates a similar story in Florida concerning DissectionWorks. Yet, direct purchasing is just one way that dissection simulation designers benefit from the efforts of animal rights groups.

Animal advocacy organizations have worked to increase awareness of, and interest in, these dissection alternatives among teachers, students, and parents. For example, The Digital Frog was incorporated into an advertising campaign against frog dissection sponsored by the animal advocacy organization People for the Ethical Treatment of Animals (PETA). Loan programs run by animal advocacy organizations are also an important form of promotion, since they increase awareness of frog dissection simulation software among teachers, students, and administrators. NEAVS's Stauble argues that her organization's dissection alternatives loan program is evidence that her organization is "definitely promoting [dissection simulation software packages] and want to get them into people's hands, since we feel that once people use these products they will realize their educational quality." These dissection loan programs can lead directly to new purchases of dissection simulation software, according to C. Ross, coordinator of HSUS's Humane Education Loan Program. In addition, at conferences such as the National Association of Biology Teachers and the National Science Teachers Association, animal advocates such as Stauble, Ross, Harrison, and Wiederkehr demonstrate dissection simulation software to teachers and school administrators.

Not only are dissection simulations featured in the advertising of animal advocacy organizations, but dissection simulation designers are also able to make use of animal advocacy issues in their own marketing. For example, The Digital Frog is frequently referred to as "frog-friendly software," a phrase that attempts to increase sales by using sympathy for, and association with, animal advocacy. ScienceWorks, Inc. goes even further in its promotional materials, arguing that their software eliminates problems with dissection caused by "ethical concerns associated with sacrificing life to study life." The DissectionWorks CD is sold with the following message on its back:

> Another way in which [DissectionWorks] may be used as an alternative to regular dissection. Many students and teachers object (often on moral

grounds) to the sacrificing of animals for dissection. This software fully supplements, and may often replace, "wet lab" dissections in cases where there are legitimate concerns about animal welfare.

Thus, dissection simulation manufacturers make use of animal advocacy and its associated issues to increase interest in their products among potential buyers.

Although publicity is important, awareness of the software is only a partial contribution. As Digital Frog International's C. Clark explains, "it's one thing having [potential buyers] know about it, and the animal advocacy organizations are very helpful there, it's another thing actually getting them to buy it." Actually getting schools to buy the software, on a massive scale, probably requires broad-scale policy changes, another domain where dissection simulation designers benefit from the contributions of animal advocacy. She and J. Warner both assert that dissection simulation manufacturers such as Digital Frog International benefit significantly from policy changes that increase the demand for their products. As Warner explains, many teachers and students already have a commitment to animal advocacy, and policy changes in state legislatures and teachers' associations to man or encourage the availability of alternatives in the classroom are already boosting sales for The Digital Frog and other dissection alternatives.

Thus far, statewide student choice policies are among the most important policy changes promoted by animal advocates. These laws usually are the result of students with animal advocacy values being forced to participate in dissection by their biology teachers. As A. Knight of Animalearn explains, "We're not necessarily the ones on the cutting edge of making the changes. It's often the students in the schools that are directly confronted with the issue." For example, one of the earliest such policies, the 1988 California Students' Rights Law, was passed largely because of a successful lawsuit brought on by one such student. In 1987, California high school student Jenifer Graham sued the state educational system after receiving a punitive low grade as a result of her refusal to dissect (Orlans, 1993). Other states with laws against dissection include Florida (1985), Pennsylvania (1992), New York (1994), Rhode Island (1997), and Illinois (2000). Louisiana passed a state resolution requiring student choice in 1992, while Maryland has had a consen-

sus of county policies guaranteeing students the right to choose since 1997. In Maine, an effort to pass a state law requiring student choice was unsuccessful, but the state department of education subsequently developed a policy requiring student choice in 1989. Legislation is currently pending in Massachusetts and New Hampshire. NAVS's Wiederkehr attempts to take the issue even further, arguing that since no states require dissection in order to graduate from high school, there is an implicit student choice policy already in place nationwide. As animal advocates work to broadly promote student choice legislation, the market for dissection alternatives such as dissection simulations increases, and their acceptability and popularity as classroom tools grows, clearly benefiting the designers of dissection simulations.

Dissection simulation designers thus benefit greatly from their interactions with animal advocacy organizations. These interactions are not a one-way street, however, and animal advocacy organizations certainly have much to gain from this relationship. In the following section, I will explore the flip side of these interactions to find out how dissection simulation designers contribute to the cause of animal advocacy.

## Saving Lives and Reversing Stereotypes: How Animal Advocates Benefit

Involvement with animal dissection simulation designers benefits animal advocacy organizations as well, both directly and indirectly. The most obvious and direct benefit of dissection simulation to animal advocates has been the saving of animal lives through the replacement or reduction of dissection. D. Shaw of ScienceWorks, Inc. explains that DissectionWorks "provides an alternative that does not require sacrificing an animal." Digital Frog designer J. Warner argues that dissection simulations can "cut down on the number of frogs" used, and his colleague, R. Van Vlaenderen, believes that dissection simulation potentially "reduces the impact" of animal dissection. R. Hill, creator of Froguts, goes even further, positing, "Froguts has perhaps done a better job at saving more frogs globally than some animal rights organizations have done in the past." Animal advocates agree that dissection simulations play an important role in saving animal lives. For example, NAVS Dissection Alternatives Loan Program Coordinator J. Wiederkehr asserts that when a student uses a dissection simulation instead of dissecting, "by not dissecting

that one frog, even though it's just one frog, they're making a difference." Similarly, NEAVS's A. Stauble explains that, "most animal rights or animal welfare people certainly feel that using computerized technology to simulate dissection is a wonderful way to stop killing animals unnecessarily." Thus, dissection simulation designers and animal advocates agree that use of dissection simulations as an alternative to dissection reduces the number of animals killed for educational purposes, a primary goal of animal advocacy.

Another benefit to animal groups is that they can use dissection simulations as a viable alternative to dissection to convince teachers and policy-makers that actual dissection is not a necessary exercise and can effectively be replaced by dissection alternatives. As Digital Frog International's C. Clark explains, "biology teachers are comfortable using dissection as a teaching tool because that is the way they were taught. They didn't have these other great alternatives . . . until very recently." Digital Frog designer J. Warner argues that animal advocacy organizations can now say to teachers, "don't dissect, and here, we have a real alternative for you," which Warner asserts is a "really powerful argument." ScienceWorks's Inc.'s L. Newton has even conducted research in his master's thesis which demonstrates that dissection simulations are "every bit as good" as actual dissection. NAVS's J. Wiederkehr agrees, explaining that dissection simulations are more appropriate than dissection in the biology classroom because biology is "the study of life," not death. She also argues that dissection simulations are superior to dissection because many incorporate information about the lives of animals, such as their ecology and lifecycles. This argument has been effective in convincing teachers and policy-makers; it also may improve public and media perceptions of animal advocacy.

Support of dissection simulations by animal advocates also helps them to escape media portrayal as anti-science, anti-technology, and anti-progress. HSUS's L. King explains that support of dissection simulations by scientists and educators is part of the "Three Rs" advocated by her organization: replacement, reduction, and refinement. She argues that support of dissection simulations as a scientifically valid replacement helps to counter the perception that animal advocates are anti-science and anti-learning and demonstrates the pro-science and pro-education stance of HSUS. NAVS's J. Wiederkehr, when asked how support of dissection simulations might affect public and media perceptions of animal advocacy, explains:

> I don't believe you can go out there and say, "stop dissecting animals, because it's cruel," and just leave it at that. You have to give an alternative, because compassionate students want to learn the same material, they just want to learn it humanely. NAVS is very pro-science and very pro-education. So I think with NAVS out there promoting these alternatives, it's showing the public that we are not just out there saying, "stop this" and not giving the students a viable alternative that is going to teach them the same material and perhaps prepare them better for college. Allowing these conscientious objectors to use non-animal alternatives will likely encourage students who are more compassionate to pursue careers in the sciences and medicine.

Wiederkehr also argues that NAVS is a pro-technology organization because they promote dissection simulations that teach students "computer skills" as well as biology. She explains that students will be more prepared for the high-tech workplace by computer simulations of dissection than by actual dissection, an added bonus of replacing dissection with simulation software. Animalearn's A. Knight agrees, asserting that support of dissection simulations "has the potential to portray us as being very technologically up-to- and also very scientific." He also argues that it is "some of the biology teachers who are from the old school way of thinking who are resistant to the introduction of humane alternatives; it's those people who are actually dragging their feet." Thus, according to King, Wiederkehr, Knight, and other animal advocates, dissection simulation alternatives have the potential to increase public support for their movement by demonstrating that the movement is progressive and can be used to support and encourage science, technology, and learning.

## Latching onto Values: Exploring the Limitations and Conflicts of the Alliance

In further exploring the mutually beneficial relationship between educational simulation designers and animal advocates, it is important to look closely at the values held by the two allied groups. Although their core values are at odds, their peripheral values are potentially complementary, insofar as important members of the respective groups are able to latch onto values of the

other group. This process of latching on, facilitated by individuals within the groups who serve as bridges between the two groups and who interact professionally in situations such as those described above, makes their close relationship possible. At the same time, the contrast between their core values puts limits on the alliance between the two groups and can create conflicts placing the two groups on opposite sides of a potential development. For an explanation of the process of latching onto complementary values, see Figure 1.

The top diagram of Figure 1 shows the distinction between core values and peripheral values of the two groups. The middle diagram shows the process of members of one group latching onto the values of the other group. Individuals and organizations within the two groups thus form a bridge between the groups by latching onto complementary values. The bottom diagram shows the result of the latching onto complementary values. Here, we see the intersection of the value-sets of the two groups. Their intersection is the subset of complementary values described above. Although their respective core values are still distinct, they now share many important peripheral values.

This relationship is not ironclad; it is subject to both limitations and conflicts. J. Balcombe of PCRM describes some aspects of the relationship as "opportunistic." This term is quite appropriate for this analysis, insofar as the relationship is only viable while it continues to benefit both groups and might break down in the case of strategies that would benefit one group but harm the other. To illustrate the limitations of the relationship, I will now explore several potential conflicts between dissection simulation and animal advocacy.

Dissection simulations can be used either as complements or as alternatives to dissection. Alternative use of dissection simulations is clearly beneficial to animal advocates, yet complementary use does not necessarily work toward the values of animal advocacy. In some cases, dissection simulation designers may prefer the use of their products as supplements to dissection as a way of expanding their market. A Digital Frog designer, J. Warner, argues that alternative use of simulations is frequently limited to a few isolated students in specific situations such as students who object to dissection or who were absent for the dissection exercise, resulting in a relatively small number of purchases (potentially none, if dissection loan libraries are used in the

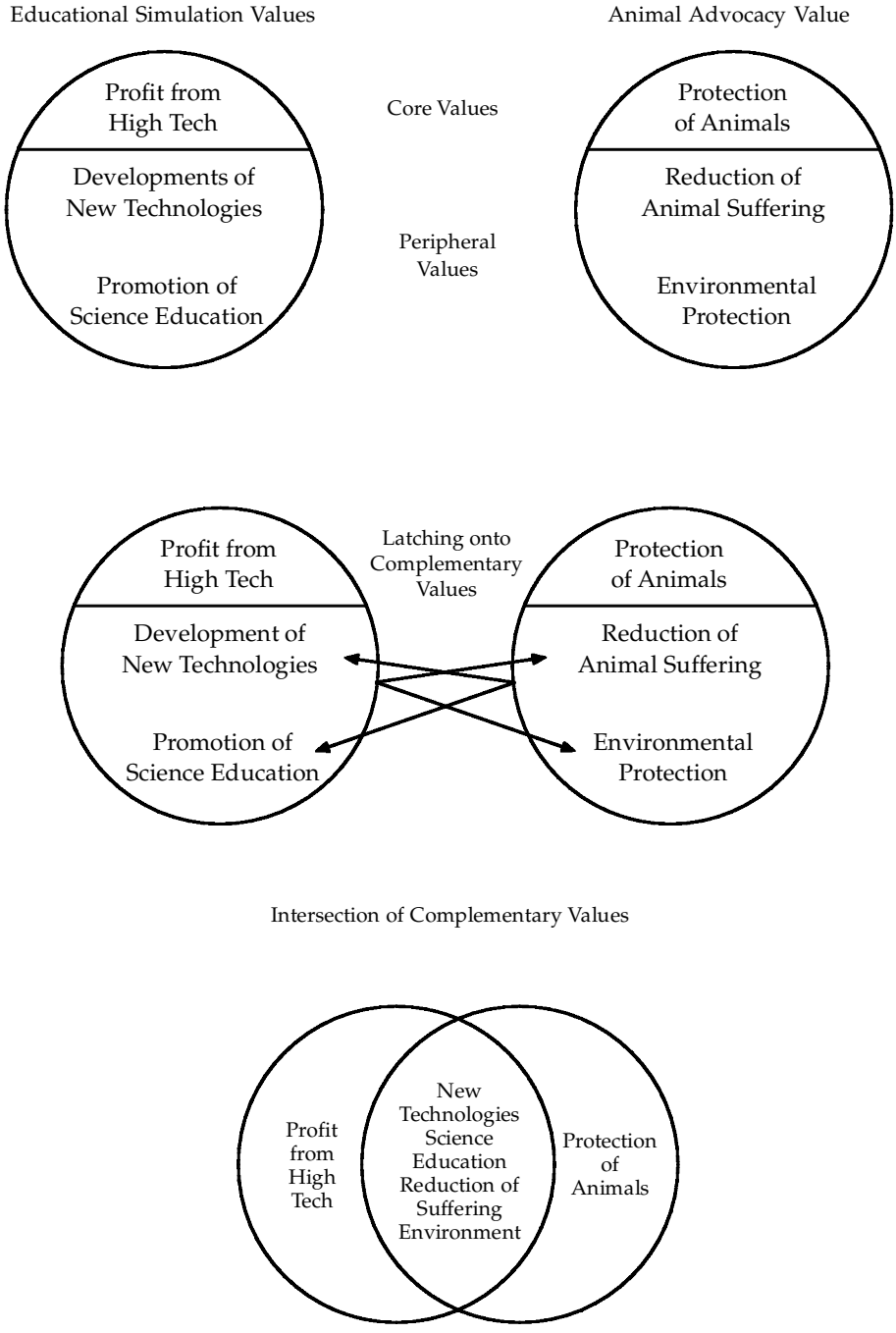


**Figure 1. Intersection of Educational Simulation and Animal Advocacy Values**

former case). In contrast, the use of dissection simulations as supplements to dissection, if widespread, may lead to copies of dissection simulation software being purchased for all students who participate in dissection. Thus, if teachers remain firmly pro-dissection, promotion of dissection simulations as supplements to dissection may be the best way, at least in the short term, for dissection simulation designers to reach large numbers of students, teachers, and classrooms. Teachers, even those who also are dissection simulation designers, may be unwilling to abandon completely the practice of dissection, preferring to use dissection simulations as an additional pedagogical tool rather than a substitute. DissectionWorks designers Shaw and Moose used their product in this way during the time that they were working both as educational software developers and as teachers. J. Moose explains:

> In my classroom, during my last teaching years, I used a multitasking type of environment, where there were various, to use the term elementary teachers often use, centers. One of those was a computer technology center. In biology and anatomy in particular, those centers were used for dissection. In addition to the technology center we also did dissection using an actual specimen.

In such a classroom, both physical and virtual dissections take place, thus serving to profit dissection simulation manufacturers while not necessarily achieving the goals of animal advocacy.

Dissection simulation manufacturers also emphasize the potential for use of their products as complements to dissection because their livelihood also depends on maintaining cordial relationships with dissection supporters such as pro-dissection teachers and biological supply companies. Carolina Biological Supply Company is both the largest supplier of preserved animal specimens to North American K-12 classrooms and a reseller of many dissection simulations including DissectionWorks and The Digital Frog 2. Several dissection simulation designers related to me that they attempt to maintain a moderate position between the extremes of pro-dissection teachers and biological supply houses and anti-dissection teachers and animal advocates. For dissection simulation designers, all these individuals and entities are potential buyers, distributors, or marketers; thus, it is important to avoid alienating any of them. Advocating the use of their dissection simulations as either an

alternative or a supplement allows these software designers to enjoy the best of both worlds without closing any doors to potential sales or collaboration.

Computer simulations, for animal advocates, are only one of many different alternatives to dissection, further complicating the precarious quality of the symbiotic relationship. Lending libraries of organizations such as NAVS, AAVS, NEAVS, and HSUS also include other types of dissection alternatives such as anatomy charts, videos, and models. N. Buyukmihci of AVAR argues that models may be even more useful for secondary biology education than dissection or dissection simulation software. As a result, dissection simulation designers see models and other dissection alternatives as competitors. J. Warner states that, "A big competitor to software isn't other software applications; it's other models of things." This advocacy of other dissection alternatives is similar to dissection simulation designers' marketing of their product either as an alternative or as a complement to dissection.

The findings of this study are compatible with the advocacy coalition framework developed by Sabatier and Brasher (1993) and Sabatier and Jenkins-Smith (1993). In their work, Sabatier and his colleagues hypothesize that actors and coalitions are reluctant to change their core values and more willingly will change their peripheral values. The cyberfrog study appears to support their hypothesis, since it demonstrates that educational simulation designers and animal advocates are able to latch onto complementary peripheral values while maintaining their own distinct core values. Although these groups are willing and able to compromise on some issues and latch onto new peripheral values, they do this without changing their core value orientation.

To summarize, perhaps the most interesting aspect of this case study is that dissection simulation designers and animal advocates are able to maintain a mutually beneficial relationship despite differences in their core values. Their collaboration in promoting the use of dissection simulations in classrooms, despite its boundaries and contingencies, still unites the perhaps seemingly unlikely pairing of an advanced technology and a social movement. Of importance, however, is that both groups recognize the potential for realizing an ethical goal while at the same time profiting economically. Much like the eco-pioneers (Lerner, 1997) and natural capitalists (Hawken, Lovins, & Lovins, 1999) of the environmental movement, dissection simulation designers and animal advocates collaboratively have found a way to improve the world

according to the values that they hold most deeply within the context of our high-tech capitalist society.

## Cyberfrogs as Boundary Objects: Knowledge-Based Social Movements and Value-Based Technologies

The field of science and technology studies (STS) challenges common understandings of the relationship between science, technology, and society. Typically, social scientists treat social movements as driven by core values, while techno-scientific experts believe that technologies are based directly on scientific and engineering knowledge. Yet, social movements and technologies may have more in common than one might expect. In this section, I discuss the STS concepts of knowledge-based social movements and value-based technologies and argue that cyberfrogs are boundary objects uniting these two, perhaps unexpected, combinations.

Studies of knowledge-based social movements (Epstein, 1996; Brown, Zavestoski, & Mayer, 2002; Hess, 2001, 2002) emphasize the previously overlooked importance of knowledges to social movements. In his study of AIDS activists, Epstein (1996) argues that AIDS activism is a knowledge-empowered movement. Similarly, Brown et al. argue that health social movements are knowledge-based social movements. Finally, Hess (2002) introduces the concept of technology-oriented social movements. Technology-oriented social movements such as the five cases described by Hess are driven as much by knowledges, including—but not limited to—scientific and engineering knowledges, as they are by values. One important contribution of this paper is a symmetric addition to technology-oriented social movements: namely, social movement-oriented technologies.

As argued above, cyberfrogs also are examples of a value-based technology with strong connections to the social movement of animal advocacy. Although, historically, technology has generally been purported to be value-free and a politically neutral "tool," many STS scholars contradict that notion by arguing that, in the words of Winner (1986), "artifacts have politics" (p. 19). Sclove (1995) demonstrates that values and politics are embedded in technologies. Schuler (1996) carries this notion to the digital domain of community networks, where he argues that values are embedded in technologies and lists six core values that he advocates for community networks. Although I agree with

these scholars that all technologies have embedded values, I believe that I have made a particularly strong case for the explicit embedding of values in the case of dissection simulations, demonstrating the key role played by values in their design and use.

Cyberfrogs thus arise at the intersection of knowledge-based social movements and value-based technologies. As such, they are boundary objects (Star, 1989; Star & Griesemer, 1989) that unite the domains of information technology and animal advocacy. According to Star's categorization of boundary objects, cyberfrogs are a terrain with coincident boundaries. As demonstrated in Figure 1, cyberfrogs arise through the intersection of peripheral values of dissection simulation and animal rights. As Star notes, the advantage of this type of boundary object is "the resolution of different goals" (p. 49), which is clearly an outcome of the cyberfrog in this case study. The union of the seemingly oxymoronic combinations of knowledge-based social movements and value-based technologies yields cyberfrogs, a social movement-oriented technology that is not only a boundary object but also a cyborg.

## Cyberfrogs as Cyborgs: Symbiotic Unions of the Physical and the Virtual

Dissection simulation designers creating new virtual worlds for biology education and animal advocates operating within the physical world of animal death and suffering have much to gain from cooperation. Here, the relationship is symbolized by the friendship between the frog and cyborg alter ego (Haraway, 1991, 1997), cyberfrog. Dissection simulation designers have been able to sell cyberfrogs and other software products as a result of direct and indirect assistance from animal advocates seeking to protect frogs and other animals. At the same time, this embrace of cyberfrogs as substitutes for sacrificing frogs and other animals has helped animal advocates not only to save animal lives but also to reverse stereotypes by demonstrating that they are, at least in this case, advocates of science, technology, and progress. This collaboration across the commonly accepted physical/virtual boundary demonstrates the potential for alliances spanning this divide, especially when social movements interact with advanced technologies.

I argue that the unlikely alliance of frogs and cyberfrogs is an example of a growing trend of coalition building between the domains of the physical and

the virtual. Community networks can be created to benefit virtual and physical communities (Schuler, 1996). In his work, Eglash (2002) seeks to unite the physical and the virtual by uniting high-tech with marginalized communities across a two-way bridge. Eglash's (2001, 2002), culturally situated design tools, such as Sim-Sho-Ban, a computer simulation of life in a Native American community as well as his computer simulations of African fractals (Eglash, 1999), demonstrate the potential for mutual alliance between the virtual and the physical in confronting problems such as racism, economic inequality, and a lack of educational opportunities and role models.

The alliance between cyberfrogs and frogs is another important example of the strategic alliance of the virtual and the physical. Cyberfrogs derive their form from frogs and their place in the classroom. Frogs, on the other hand, presumably are happy to leave dissection to their cyborg counterparts so that they can continue to reside in natural habitats such as ponds and creeks. As the virtual becomes an increasingly large part of our everyday lives, hopefully the denizens of the physical world will avoid the specter of potentially apocalyptic confrontation and, instead, find more ways to enlist the virtual as an ally in causes such as animal advocacy.

* Kenneth R. Fleischmann, Rensselaer Polytechnic Institute

**Note**

[1] Correspondence should be sent to Ken Fleischmann, Department of Science and Technology Studies, Rensselaer Polytechnic Institute, 110 8th Street, Troy, NY 12180-3590. E-mail fleisk@rpi.edu. My biggest thanks go to all of the interviewees cited here who have been willing to participate in my study and to contribute to my dissertation as well as this manuscript. I would also like to thank Bo Xie, Nancy Campbell, Torin Monahan, Ron Eglash, and my advisor David J. Hess for reading and commenting on parts or all of this manuscript. Finally, I have been very fortunate to receive the support of the National Science Foundation, including an NSF Graduate Research Fellowship that supported me while I planned this research and a Dissertation Improvement Grant (#0217996) from NSF's Science and Technology Studies program that funded this research.

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