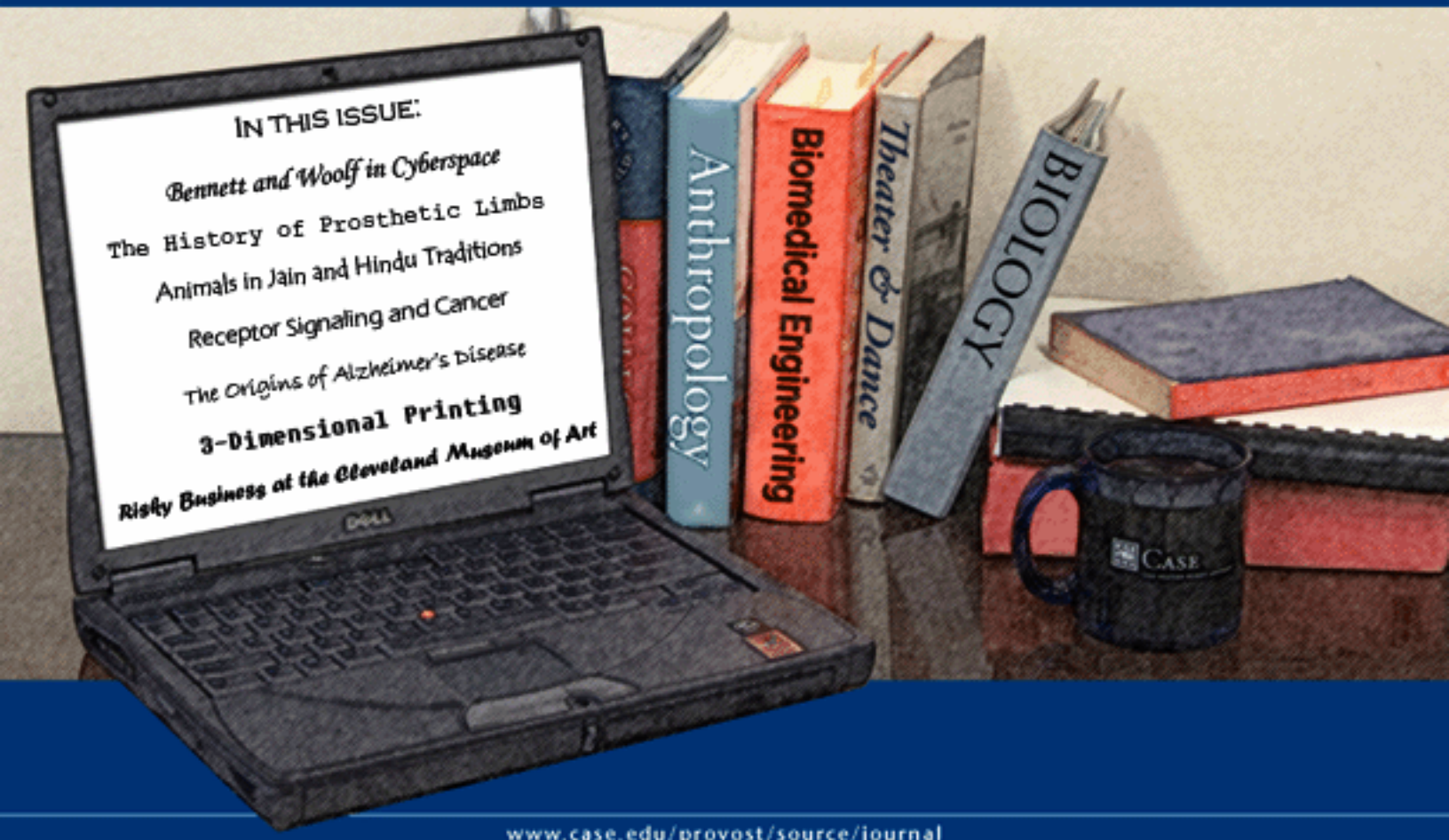
DISCUSSIONS

The Case Undergraduate Research Journal



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IN THIS ISSUE:

We are thrilled to present to the Case community an entirely new peer-reviewed, interdisciplinary undergraduate research journal. The first volume of *Discussions* is the result of three semesters' worth of dedication and hard work on the part of an incredibly talented, motivated group of students who have tirelessly pursued their goal to provide undergraduates in research a way to showcase their scholarly work.

Here at Case we have a plethora of accomplished undergraduate students, some of whom have already made their mark in their chosen fields. Among them are John Erickson, Shaan Gandhi, and Benjamin Rellinger, recent winners of the prestigious Goldwater Scholarship; Hunter Ewan, one of the youngest composers to obtain a contract with Le Duc; and Michael Henry, whose paper entitled "Uncertainty, Responsibility, and the Evolution of the Physician-Patient Relationship" will soon be published in the Journal of Medical Ethics. This is only a small selection of the many students at Case who take time from their rigorous studies to do incredible research in the laboratory, at the library, and, as you'll see in the final article in this publication, at the Cleveland Museum of Art.

Although some of the academic departments at Case publish information on departmental research, and a few of those include undergraduates' work, we believe there is a real need for an interdisciplinary undergraduate research journal. With so many students electing to pursue research under faculty advisors, and so many classes introducing undergraduates to intensive research, it is almost surprising that as of last year a venue for widespread academic dialogue between undergraduates in research had yet to emerge on campus. However, *Discussions* now aims to fill that niche: every year, we will publish exemplary research from a range of fields. The articles contained in this journal will be representative of the broadest possible sampling of undergraduate research opportunities.

With this first, groundbreaking edition off the presses, work on our next volume is already well underway. The next deadline for submissions is October 2nd. We would like to encourage our undergraduate readership to submit any work that you feel is worthy of recognition. Submissions can be made year round, and submission guidelines can be found on our website. All papers submitted after the deadline will automatically be considered for the next volume.

We would also like to invite undergraduates to be a part of our team of editors and reviewers. Elections for positions on the editorial board will be held in early September, 2006. More information will be forthcoming next semester.

We would especially like to acknowledge SOURCE for all that it has done to make this journal possible. In addition to funding this first volume of *Discussions,* Sheila Pedigo and Bethany Pope have dedicated their time and enthusiasm to make this journal possible.

As you read about prosthetics and art collecting, cancer and literary controversy, we ask you to recognize the incredible contribution that undergraduate research makes not only to the Case Western Reserve University community, but to academic culture everywhere.

Heather Greenwood and Srujana Reddy
Editors-in-Chief

Character, Politics, and Literary Controversy: Arnold Bennett and Virginia Woolf in Cyberspace

Qilei Hang

In spring 2005, as a freshman at Case, I took an English course that piqued my interest in Arnold Bennett and Virginia Woolf and the debate that surrounded their careers: a feud of the traditional versus the unconventional, of realism against modernism, of man versus woman. Through a summer English project, I further investigated the two authors' extensive literary debate, which centered on the paramounts of novel writing: character creation and plot development. Bennett emphasized the "realness" and vitality of a character. According to him, if the characters are not convincing, the novel will not survive. But what determines the realness of character? How is one character any more real than another? For Bennett, character creation had a certain concreteness, requiring craftsmanship of the complete picture with conflicts and resolutions, beginnings and endings. In contrast, Woolf emphasized the spiritual, the ebb and flow of individual perceptions, impressions, and the intimate expressions of the imagination. She was determined to "forget tradition" and the seemingly linear life-story that conventional fiction favored. If the Bennett-Woolf debate was simply about arguing for one's stylistic superiority, then what caused the debate to persist for so long, even though both seem to have proved so successful? What kept Woolf arguing for nearly two decades against Arnold Bennett, an acclaimed bestseller before she even published her first novel?

Implementing a new method to analyze the debate, I digitally mapped out the Bennett-Woolf exchange, as well as subsequent critics' interpretations, with the aid of the computer program Ivanhoe. Using this novel approach, I was able to visualize their debate in a concrete form, to see not only a timeline of the debate, but also its driving forces, its most influential essays, and I hoped, some patterns not previously noted. I found that the Bennett-Woolf discourse field, as shown on the Ivanhoe map, emanated from two works by Bennett: *Our Women, Chapters on the Sex Discord* (1920) and "Is the Novel Decaying?" (1923). While these two works acted as the key catalysts of the debate, the perpetuating arguments and rebuttals of Bennett and Woolf were fueled by Woolf's unrelenting ambition in the literary world, Bennett's condescension of her, Woolf's irreverence for him, and their stubbornness to accept each other's works, at least in the public sphere.

In her critiques, Woolf, a Georgian, stresses that Edwardians like Bennett could not sufficiently produce characters that live forever in the minds of readers. His characters, she argued, were ephemeral because readers did not know their inner thoughts or emotions, and thus could not empathize nor partake in their world. Readers could glimpse at the "material externalities," but "in none of them are we given a man or woman whom we know," writes Woolf in "Mr. Bennett and Mrs. Brown" (1923). She acknowledges that Bennett has the marvelous power for observation and would, when describing the fictional Mrs. Brown, skillfully depict her carriage in the train, the upholstery, the advertisements, but would not examine Mrs. Brown herself.

If Bennett had written about a Mrs. Brown, would he do just as Woolf proposes? While he agrees with Woolf about the importance of character – indeed, he feels that character creation is the foundation of good fiction ("Is the Novel Decaying?" 1923) – Bennett does not place an exclusive emphasis on the material externalities that Woolf so strongly specified. Instead, he stresses the realness of characters and the strong emotions they evoke in readers. To Bennett, this realness comes in part from the narrative

itself, as he feels that characters should clash with one another and thus produce interest in the reader as long as the characters remain genuine ("Is the Novel Decaying?" 1923). Consequently, Bennett's characters develop from their actions and relation to the plot, instead of being entirely dependent on the externalities that Woolf proposes.

My first task in the project was to collect a large body of material relevant to the Bennett–Woolf debate from journals, reviews, and various databases in order to chronologically organize the bulk of the debate. Information was difficult to obtain because the bulk of the Bennett/Woolf discourse is buried in volumes of antiquated journals from the early twentieth century, such as *The Criterion* and *The Nation and Athenaeum*, that have since ceased circulating. Moreover, critics' treatments of this literary quarrel have been scattered across decades, from the 1920's to the present. Finding as many relevant documents as possible was like trying to put together all the pieces of a vast jigsaw puzzle, and this puzzle began to take shape for me in the form of a website (currently at http://home.cwru.edu/~qxh4) for this famous literary quarrel that featured abstracts for each of Bennett's and Woolf's works, as well as critics' interpretations in this ongoing dispute. During the development of the website, I began to see connections between the two authors' arguments and rebuttals embedded in the documents. Finally, in order to visualize these inherent connections and to explore the debate's pattern as it progressed through time, I used the computer software, Ivanhoe, to create a digital map of the Bennett/Woolf discourse field and a map of the critics' opinion.

Briefly, the Ivanhoe software allows users to hold positions (represented as small circles) on a digital roundtable, which resembles a virtual discussion forum, where participants place text files onto the roundtable. Each text file correlates with the participant's position on the roundtable, since the text file will be shown upon a click of the mouse on the participant's "circle position." Each participant could annotate or link to any text file within the roundtable. Importantly, for each link or annotation made, Ivanhoe automatically connects and color-codes the corresponding text files, ultimately creating a "map" of interrelated descriptions, arguments, or rebuttals in each text file (a demo of Ivanhoe is available at http://www.patacriticism.org/ivanhoe). To draw valid conclusions based on the maps, I first had to define specific rules to follow during map construction to exclude possible bias or presumption. Rules were based on the nature of each document and the requirements of the Ivanhoe software. For instance, one of the most important rules for mapping was to make links among documents that were directly related (for instance, a link would be made between criticism in one document and the corresponding rebuttal in another). The first digital map had Bennett and Woolf as the "participants," and it was largely constructed from the main arguments in documents collected during the project's first stage. Moreover, debate documents were inserted into Ivanhoe in their chronological order to construct the map.

A cursory observation of the Bennett-Woolf discourse map shows a fairly random pattern of color-coded circles (blue representing Bennett's arguments and red, Woolf's). Even though every argument was placed in Ivanhoe in chronological order, no specific geometrical pattern was discernible. The discourse field itself extends in different directions depending on individual arguments and responses. This representation of the debate is an indication that the authors never really resolved any particular issue but made numerous attacks and counter-attacks on everything ranging from each other's novels to specific sentences and phrases in articles. Thus, the two authors never came to any conclusions by themselves; neither gave in and neither softened his or her stance. Woolf persistently defended her unconventional style of writing and philosophy of the individual's "inner world," while Bennett stubbornly refused to acknowledge her work and insisted on

the conventions upon which he chiefly drew in his own novelistic work.

Though the arrangement seems scattered at first glance, the Bennett-Woolf discourse map in fact shows two prominent configurations. First, the density of the blue and red circles increases across the 1920s. This pattern parallels that of the debate timeline: the two authors responded most to each other's essays and articles in the 1920s, a time when the debate caught the attention of critics and the public alike. This dense pattern of circles does not thin out; it abruptly ends when Bennett died in 1931, thus ending the debate and leaving us to wonder if the two authors could have come to terms with each other had Bennett lived longer. Certainly in the public eye, Woolf and Bennett remained archrivals, but in her diary in 1931, Woolf writes, "Arnold Bennett died last night; which leaves me sadder than I should have supposed…a lovable genuine man; impeded, somehow a little awkward in life; well meaning; ponderous; kindly; coarse; glutted with success" (*Writer's Diary*, 165-166). Her description of Bennett goes on, and Woolf concludes with regret of his passing, feeling somehow deprived of a genuine critic of her work: "[He has] some real understanding power, as well as a gigantic absorbing power. Queer how one regrets the dispersal of anybody who seemed – as I say – genuine: who had direct contact with life – for he abused me; and I yet rather wished him to go on abusing me; and me abusing him" (166). Though Woolf privately acknowledged Bennett's talent and literary success, her ambition for literary success required that she uphold the public image of Bennett's critic and competitor; she could not risk softening her stance, because that meant admitting Bennett's craftsmanship of the novel was superior to her artistic ideals.

A more distinctive configuration in the Bennett-Woolf discourse map is the convergence of circles toward two focal points, centered and built around two publications: Bennett's *Our Women, Chapters on the Sex Discord* (1920) and "Is the Novel Decaying?" (1923). After Bennett published these, the discourse field noticeably began to emanate from themes in these two publications, indicating that the arguments made by Woolf and Bennett focused and built around two major premises: character creation in the novel and gender influences on novel-writing. Character creation was the origin of their debate, as Woolf first challenged Bennett's advice in "Writing Novels" (1914), declaring that "it isn't the plot, or time and place that the situation takes place, but the author's interest in the human spirit that knits the whole thing together… there is no need that a story be intense, but it must reflect the imagination and thoughts of individuals, of life as they experience it" (Modern Novels, 1919). Nevertheless, the Bennett-Woolf debate escalated after publication of "Is the Novel Decaying?" (1923), in which Bennett remarked that the characters in Woolf's *Jacob's Room* (1922) "do not vitally survive in the mind, because the author has been obsessed by details of originality and cleverness." As Woolf increasingly isolated herself from traditional realism, she simultaneously became more confident in her criticism of Bennett. For Bennett's comment that he simply could not name any coming big novelists in "Is the Novel Decaying," Woolf, in "Mrs. Bennett and Mrs. Brown," dismissed his comment as "a symptom of the respectful hostility which is the only healthy relation between old and young." Bennett subsequently critiqued several of her novels, including *Jacob's Room* (1923) and *To the Lighthouse* (1927). He states in these critiques that Woolf's works were far too "designed" and excessively detailed (*Evening Standard*, vol.23); they were too verbose to exhibit any virtuosity. According to Bennett, even her grammar was "debatable," and her style too monotonous (*Books and Persons*, 210-212).

The Bennett-Woolf debate was not simply about novel writing. When Bennett published *Our Women, Chapters on the Sex Discord*, Woolf dispatched several letters to *The New Statesmen*, indignant that Desmond McCarthy actu-

ally supported Bennett's work that proposed that men are intellectually superior to women. In the Ivanhoe discourse map, *Our Women* was the second focal point from which other arguments branch out, as this focal point represented a shift from arguing about novel writing to gender influences on writing. In her letters to *The New Statesmen*, Woolf indignantly points out that the increased education of the twentieth century has allowed women to move into the foreground of public life. But education is not enough, as she states, "women should have liberty of experience; that they should differ from men without fear and express their difference openly; that all activity of the mind should be so encouraged that there will always be in existence a nucleus of women who think, invent, imagine, and create as freely as men do, and with as little fear of ridicule and condescension" ("Intellectual Status of Women," 339). Indeed, Bennett's *Our Women* did not only provoke retorts from Woolf, it also served to draw more public and scholarly attention to the Bennett-Woolf debate.

To accommodate the many critics' interpretations of the Bennett-Woolf literary quarrel, I created a second Ivanhoe map solely for critics' opinions. Many of the same rules were followed for the second map as for the first, with the exception of the coloring scheme for each circle, representing the arguments from participants. As in the first map, the critics' opinions did not follow a specific pattern; circles of different color mixed amongst one another. This time, however, no points of convergence could be observed, which indicates that critics followed their own arguments and did not directly respond to other critics. In other words, there could not have been specific focal points from which later writings build. Consequently, the map shows a mixture of critics who favor either Woolf or Bennett and a mixture of critics who base their arguments on either gender or creative ability (with the exception of Samuel Hynes who based his arguments on class). The coloring configuration of the map also shows that critics who favored Bennett tended to base their arguments on Bennett's creative ability, whereas critics who favored Woolf liked to base their arguments on either gender influence or creative ability, or both.

For instance, Beth Rigel Daugherty, in "The Whole Contention Between Mr. Bennett and Mrs. Woolf Revisited," points out that Woolf had to argue on two fronts: her aesthetic and feminist ideals. Daugherty believes that Woolf simply had to lash out against Bennett after his publication of *Our Women* – she had to protect the uniqueness of her own writing and defend the capabilities of women. On the other hand, Wyndham Lewis, who sided with Bennett, bases his critique solely on the authors' writing abilities and makes no mention of gender. He praises the "Bennett realists" and portrays Woolf as an "orthodox idealist" too obsessed with her version of "spiritualism" in character development ("Mind and Matter," par. 7). Interestingly, no matter what the assessment was based on – whether gender or writing ability – critics after the 1980's all favored Woolf, whereas critics during the time of the debate mainly favored Bennett.

What could have shifted critic opinion? Bennett indisputably won more public acclaim during the first quarter of the twentieth century. Now, however, American libraries often have shelves devoted to Woolf's books, diaries, letters, as well as numerous biographies and studies about her, while only a few of Bennett's works are readily available, though he published more than eighty books during his lifetime. One explanation of this trend is that siding with Woolf, and thus corroborating her feminist ideals, is simply more politically correct and socially acceptable. Indeed, the more modern critics who sided with Woolf tend to be American women professors. Several critics have pointed to Bennett's *Our Women* as the major motivation for Woolf's brazen retorts. Woolf, in turn, caught the public's attention by her unconventional writing and her audacious attitude toward the leading literary figure of the day. As Daugherty points out, Woolf would have gained much credit had Bennett favorably reviewed her

works. But as Bennett adhered to traditional realism and his "traditional" views toward women, Woolf seemed to backlash with a vengeance, the temerity of which caught many by surprise.

The conclusion of my project is reflected in the complete field of exchange between Bennett and Woolf as mapped in the Ivanhoe program. Concurrently, the project investigated the critics' treatment of this famous debate. This literary controversy has elevated Woolf's character and status among modern feminists and writers alike – she, when still a neophyte woman novelist, had the audacity and confidence to challenge the powerful norm. The debate, however, was ultimately deleterious to Bennett's reputation, though he won tremendous critic acclaim and public respect during his lifetime. A number of critics, such as Samuel Hynes and Irving Kreutz, thought that the two authors ultimately did not disagree about the fundamentals of character creation or novel writing, but rather represented clashing gender views or opposing class interests. The results of my project, however, suggest that this was not the case. Though gender views or class interests have contributed to the controversy, Bennett stressed a "conscious craftsmanship" of the novel, while Woolf called for artistic genius. However, neither genius nor craftsmanship can succeed without the other, and neither man nor woman alone can thrive, as even Woolf seems to concede that some of the masculine principles Bennett embodied – perhaps to excess, from her point of view - have their place in every writer: "some collaboration has to take place in the mind between the woman and the man before the art of creation can be accomplished" (*A Room of One's Own*, 1929). Without recognizing the duality of genius and craftsmanship, perhaps not even by Bennett, most Modernists and contemporary critics have made Bennett a victim for his "conscious craft," his views on women's writing ultimately tipping the scales to Woolf's triumph.

Acknowledgements

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Prosthetic Limb Development: A Historical Review

Lauren L. Smith

Introduction

There are currently over ten million amputees in the world, and according to the Limbs for Life Organization, more than 250,000 persons lose a limb each year due to disease, cancer, and trauma accidents. The statistics are shocking: In the United States alone, over 3000 people will lose an appendage within the week—that is more than 18 people per *hour*. Luckily, amputees have the benefit of modern prosthetics. The terms prosthetic and prosthesis describe any device that is an artificial substitute for a body part. With the current prosthetic options, amputees have the ability to lead nearly normal lives. However, amputees have not always been so fortunate; there is a long history of progress that has lead to modern prosthetic technology. Artificial limbs have been used since ancient times, but their design has changed greatly with progress in medicine, materials and attachment methods, and functional technology.

There are several historical findings that prove the early use of limb prosthetics. The first known reference to an artificial limb, according to the American Academy of Othopaedic Surgeons (AOS), comes from about 500 B.C., in Herodotus's writings on the life of the warrior Hegesistratus. When Hegesistratus was taken prisoner and condemned to death in 484 B.C., he escaped by cutting off his foot, which had been bound in shackles. He survived, and after he healed, he created a primitive wooden foot for himself and returned to battle. Artistic works also offer some insight to the use of early prostheses; amputees using peg-like artificial legs are depicted on numerous frescoes, mosaics, and pottery artifacts from the pre-Christian era. In addition, there are actual artifacts of primitive artificial limbs. The oldest existing artifact of an artificial limb was discovered in an ancient tomb in Capua, Italy, and it is believed to originate from the Samnite Wars of 300 B.C. (AOS 1-2).

Records of early artificial limbs are limited, but it is logical to assume that the disabled usually fashioned makeshift devices to aid themselves before the launch of prosthetic use. The escalation of prosthetic use is marked by the development of the "Alt-Rupin hand", which originates from the about 1400 A.D. This prosthesis, which was discovered in the banks of the Rhine in 1863, allowed for limited motion of the fingers through button control, and it had a hinged wrist (AOS 2). From the start of the fifteenth century until present day, there are countless cases of artificial limb replacement. Because of technological developments, each model offered new advantages and improvements.

Medicinal Improvements

The first area of technology to greatly impact prosthetic devices was the medical field. Proper surgical techniques are crucial for limb replacement. Hundreds of years ago, crushing procedures or boiling oil were used to control bleeding after amputation; patients who were lucky enough to survive rarely had a suitable stump for fitting a prosthesis. In the 1500's, Ambroise Paré made significant contributions to surgical techniques by using ligatures to control bleeding and considering how to choose a site for amputation. Many of Paré's drawings and descriptions correspond to techniques that have been commonly used through the twentieth century, and he is often called the founder of modern principles of amputation. Another improvement for bleeding control was Morel's tourniquet, which was developed in 1674. Amputation surgery was

aided further in the 1800's when Lord Lister developed aseptic techniques. From the 1800's to the 1900's, surgeons around the world devoted studies to the production of a better stump for prosthetic fit and weight bearing (AOS 1-7, 13). The use of anesthesia, beginning in the mid 1800's, enabled surgeons to have a longer operating time to utilize the new amputation techniques. For example, they were able to do more detailed suturing and use skin grafting procedures, both of which improved prosthetic fits (Ott et al. 13-14).

Other strides in the medical field were made through the study of human biomechanics: the function of natural limbs and joints. The University of California set up the first biomechanics laboratory in 1957, and soon numerous techniques were developed for the study of biomechanics. Researchers were able to gather useful biomechanical information from the dissection and examination of cadaver joints. In other tests, researchers inserted small pins with detectable targets into the joints of live human volunteers, and they monitored the position of the pins as the subject performed various movements. In further studies, scientists used electrodes to monitor muscle function in normal locomotion (Furman 26-28). These biomechanical tests provided insight to the workings of natural limbs so researchers could develop a better model for prosthetic devices.

Materials and Attachment Methods

While medical professionals made strides in surgery and biomechanics, prosthetic designers searched for better materials to construct the prosthesis. Artificial limbs were first built of commonly available materials with little consideration for their practicality. Numerous artifacts of armor-constructed limbs dating from the fifteenth and sixteenth century are displayed in museums today, and many of the medieval designs are quite intricate. The heavy, bulky armor was common to the time period because it was used to fashion armor suits for knights, and it was chosen as an artificial limb-maker for the proud knights who wished to hide mutilations. Iron hands were sometimes designed to provide a single function, such as clasping a sword. Still, the weighty metal would have been terribly uncomfortable; leg replacements fashioned of armor could usually not even be used for walking. During the same time that the knights used armor-based prostheses, lower-class amputees created their own crude peg legs out of wood. Wood became more commonly used with time; in 1696, a Dutch surgeon invented a lower-leg prosthetic that used a wooden foot in combination with a copper and leather leg piece. In 1800, James Potts patented an artificial leg made of two hollow wooden cones, and his design made the leg prosthetic much lighter than ever before. Prosthetics became even lighter with the introduction of aluminum parts to replace steel in 1865. Also in the 1860's, a hard rubber foot replaced the wooden foot, and James Lyons patented a rubber foot with shock-absorbing air pockets in 1895 (AOS 2-6, 9-12). In the 1940's, John Northrop developed plastic laminate, a sturdy, lightweight material for use in construction of prosthetics (Furman 11). The same plastic laminate used then is still in use today. Other materials were introduced in the past several decades, including Duralumin, polyurethane (Mital and Pierce 79), and acrylic (Ott et. al 3). Darcon, Darcon-faced leather, and Velcro were also introduced for the construction of fastening devices (Mital and Pierce 91).

New materials for fastening were not enough to fully perfect the attachment of limb prostheses. Another key area of development for prostheses was experimentation with different attachment methods. For centuries, lace-up leather cuffs and harnesses were used to attach both lower and upper body prostheses and often, a socket was formed to fit the stump. Before the eighteenth century, most sockets were fashioned of metal and lined with leather. The Verduin, a below-knee prosthesis created in the mid-1600's, used a metal socket with a thigh cuff connected by hinges, which provided more stability than had been previ-

ously available. The suction socket, which holds the prosthetic on with air pressure, was patented in 1863, but it was not until the mid-1900's that the suction socket became accepted and widely used (AOS 2-8, 10). Until the 1950's, the conventional leg prostheses used a harness system, with belts and suspender-like suspension systems. These harnesses became less common with increased use of the suction socket (Furman 27-29).

Experimentation was recently done with attachment of a prosthetic limb directly to the bone. There were some unsuccessful attempts at this technique in the 1940's, but in the last decade this method has become a realistic goal (Ott et al. 17, 19). In 2001, the University of Surrey did work with the attachment of prostheses directly to bone. According to the study, "Osseointegrated implants have been placed in the bones of the remaining stump. These implants penetrate the skin and enable the artificial limb to be attached directly."

The Ultimate Goal: Improving Function

Improvements in medicine, materials, and attachment were all steps toward the big goal of artificial limb design: to provide the best possible *function* for wearers of both lower and upper limb prosthetics. The objective of lower limb prostheses is to allow for locomotion. Articulated knee joints were developed as early as the sixteenth century, in the works of Paré (Mital and Pierce 75). Foot and ankle joints were introduced in the eighteenth century: In 1775, G. Ravan used a spiral spring to control the ankle joint of a lower-leg replacement, and surgeons Harold White and P. Addison developed jointed feet around that same time (AOS 6). Professor J. H. Brunninghausen improved on these designs by adding springs to control the movement of the artificial foot in 1796 (AOS 6). Springs were also used in the Anglesey leg, which was developed late in the eighteenth century. The Anglesey leg also featured cogs and gears for joint movement, but the model frequently broke down, made noise, and required excess oiling (Ott et al. 284).

Prosthetic designers began using cords to connect joints at the start of the nineteenth century, and this allowed for more leg motion control. Potts's artificial leg from the 1800's had cords running from the knee joint that simultaneously controlled ankle motion (AOS 6). The Bly prosthesis, made popular in the 1860's, was another model that featured cords, and it was the first device to use the ball and socket joint: An ivory ball fit into a rubber socket, and the cords controlled its movement (Ott et al 285). In 1861, cordless ankle movement was achieved by the incorporation of rubber bumpers to control flexion (AOS 10).

More recent developments reduced the effort required for walking on a prosthetic leg. In the 1950's, several options for hydraulic legs became available (Furman 3). These hydraulic prosthetics significantly lessened the energy drain of walking on an artificial leg. One model, the Henschke-Mauch wing-and-stance control leg, enabled amputees to place full weight on the prosthesis when going up and down stairs—a new feat for leg prosthetics (Furman 8). In 1957, according to Furman, engineers at the University of California developed a "polycentric knee, which changes position of the center of the knee […] at various phases of the walking cycle. The knee is both simple in action and stable-feeling." The same year, Professor Radcliffe of the University of California developed the Solid-Ankle Cushion-Heel foot. According to Furman, the foot was designed to "provide shock absorption and ankle-action characteristic equivalent to the normal ankle" (36). The foot became so popular that over 20,000 were produced in 1958 alone. By the 1970's, the hydraulic knee had been combined with a foot unit that automatically controlled flexion of the foot when lifted from the ground (Mital and Pierce). This mechanism, as indicated by Mital and Pierce, gave the amputee "gait [that] more nearly approaches normal than with any other unit [used through 1971]" (98). Another option for full-leg amputees developed in the 1970's was the Canadian hip disarticulation

prosthesis, in which hip, knee and foot flexion were controlled by elastic straps set into contraction by moving the pelvis forward (Mital and Pierce 114). In the last decade, runner's legs made for competitive athletes brought a new variation to functional leg prostheses. As said by Ott et al., the legs imitated "the flexion of the cheetah's leg and resembled the suspension band in a pickup truck more than a familiar articulated leg" (24).

Artificial arms increased in function over the years as well. The objective of upper extremity prostheses control is to give the amputee the ability to perform a variety of daily tasks with the prosthesis. As early as 1400, when the Atl-Ruppin hand featured finger buttons and a hinged wrist, arm prosthetics were designed with movable parts. Other fifteenth century metallic hand prostheses had fingers on pivots and provided a strong grip so their wearers could perform labor-intensive tasks. There are also arm prostheses from the sixteenth century that have elbow flexion controlled by pressing buttons with the opposite arm. These early movable parts offered only crude movements, and the prosthesis could not be used for more meticulous tasks. Alternatively, other hands were created that could not move, but remained in a useful fixed position; in the end of the eighteenth century, Gavin Wilson built an artificial hand that could hold a knife or fork and had an attachment for holding a pen (AOS 2-6).

A problem with early movable arm prosthetics was that the "good" arm was required to push buttons or physically move the prosthetic joints. In the early nineteenth century, the upper limb prostheses saw the first advance toward independent function. Peter Ballif created a hand with fingers that moved in unison with the motion of the remaining elbow joint (AOS 6). In the latter part of the nineteenth century, the Van Peetersen hand achieved function by using the remaining joints to move straps and cables that all joined together at a vest. In 1882, J. Condell invented an artificial arm with a similar cable system for flexing and extending the forearm (AOS 12). In the early 1900's, several different models allowed for an artificial hand to either be opened or closed by shoulder power, but a single device could not do both opening and closing until the late 1950's (Furman 6). In 1958, the Army Prosthetics Research Laboratory developed a reflex hand that allowed for one motion of the control cable to both open the fingers and then close the fingers on an object (Furman 3).

The latter half of the twentieth century brought improvements in locking devices and cable systems of arm prosthetics. After World War I, Northrop Aircraft, Inc. developed an elbow unit that could be locked and unlocked by transferring movement through straps connected to the body harness (AOS 16). The company was also responsible for introducing the Bowden cable, a steel wire encased in a cylindrical flexible metal, which replaced the use of leather thongs in the operation of artificial arms (Furman 11). After World War II, movement of upper-extremity prostheses generally relied on the cable in combination with a shoulder harness device; the shoulder harness delivered movement through the cable as the wearer arched his or her back (Ott et al. 19). By the 1970's, arm prostheses were available with elbow hinges that locked in place by the suspension system and cables that transferred motion to the prosthetic hand or hook (Mital and Pierce 93).

Also by the 1970's, various options for wrist locking and hand grasping were available. Some wrist devices locked in place by pushing the wrist against a hard surface, and others relied on pushing a button with the opposite hand (Mital and Pierce 93). Arm amputees had the option of hooks that opened voluntarily and grasped with power transferred through movement of rubber bands, or prosthetic hands that had to be forced open and used springs for gripping (Mital and Pierce 94). In 2001, N. Dechev and his colleagues created a "passive adaptive grasp" prosthetic hand. The hand was designed with fingers that could conform to the shape of an object being grasped very simply, without the use of sensors or electronic processing. The system, as described by Dechev, "results in a hand

with reduced size and weight compared to other experimental hands, and has increased mechanical function and cosmetic appearance compared to conventional prosthetic hands."

In addition to changing the physical mechanics of prosthetics, functional movement can be obtained in other ways, one of which is cineplasty. Cineplastic procedures create a skin flap and form a skin-lined tunnel under a muscle that remains above an amputated limb; a peg is inserted to allow the muscle to operate a cable that moves the prosthesis (AOS 443-445, Furman 6). The path to developing this technology began in Italy around 1898, when Vanghetti observed that prisoners with amputated hands still had intact forearm muscles. He had the idea of utilizing these muscles as a force of movement for a prosthesis; the first operation on humans was performed by Ceci of Pisa in 1900 (AOS 13). Cineplasty was not well developed or widely used, however, for some time. The surgical method was revised by E. Sauerbruch during and after World War I (AOS 15) and modified again by M. Lebsche during World War II (Weir et al. 1). In a 2001 study published in the Journal of Rehabilitation Research and Development, Dr. Richard Weir and colleagues found "small cineplasties or other surgical procedures that also externalize the force and excursion of a muscle could potentially provide […] superior control." The study addressed multiple miniature tunnel cineplasties that may be able to provide independent finger control for hand prostheses (Weir et al. 1).

Another more recent method of providing function is the myoelectric prothesis. When muscles contract, they create a detectable myoelectric signal (MES) (Finn and LoPresti 211), which can be used as a control signal for operating the prosthesis. The prosthetic wearer must contract a designated muscle, then the muscle signal is amplified and relayed to a battery control that operates the prosthesis (Ot et al., 20). The first step to developing this technology occurred in the eighteenth century, when Luigi Galvani observed that a frog's muscles contracted if electrically stimulated (Finn and LoPresti 7). Myoelectric control of artificial limbs was first used following World War II (Ott et al. 20). In the middle and late twentieth century, developments in the transistor and integrated circuit allowed for further progress. Most myoelectric control systems that are currently available can only reliably control a single function in a prosthetic limb. However, a new device developed in 2000 by B. Hudgins offers up to four types of upper limb motion, and it could allow for control by muscle contractions that are similar to the contractions used to move a normal limb (Finn and LoPresti 211). Myoelectirc prosthetics have recently achieved a greater acceptance rate than in the past; one 2001 study reveals users were up to 90% satisfied with their MES-controlled prosthetic hands (Chen 1).

Future Directions

The future will only bring further developments in prosthetics. One newly proposed technique involves transplanting the big toe for use with a prosthetic hand: Dr. Chen describes this procedure as first transplanting the toe "to the patient's forearm amputation stump. Mandates from the brain are [then] relayed by the action of the reconstructed digit, to control a special designed multidimension freedom electronic prosthetic hand." It may also be possible to interface directly with remaining nerves in the stump so prosthetics could be controlled use natural neural signals (Dario, 353). This technique could even be expanded so that the amputee receives neural stimulation to produce sensation (Dhillon, 609). The prostheses of tomorrow may even offer advantages over "natural" limbs. For example, engineers have already begun work on hand prostheses with sensors that can communicate directly with a computer instead of using a keyboard (Ott et al. 25).

Clearly, new techniques in prosthesis technology continue to be made every day, and currently, we see more improvements in a single year than were once seen over

several hundred years in earlier times. Continued strides will be made in medical procedures, materials selection, attachment strategy, and techniques for providing function. The future for amputees is bright: incredible progress has been and will be made in the designs and functions of limb prosthetics.

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The Moral Status of Animals Reflected in Jain and Hindu Traditions

Bharat Ranganathan

Introduction

When assessing the treatment of animals in modern society, it is important to contextualize contemporary views in comparison to those described in religious and secular traditions of the past. Through the course of my paper, I examine the moral status of animals as reflected in Jain and Hindu traditions and how these views have virtually disappeared in modern society.[1] I assert the responsibility of humans to recognize animals as non-human persons, with both biological and sentient needs. As such animals should not be subjected to laboratory testing, paraded in entertainment, used for testing, nor tortured by standard factory farming techniques for selfish human needs.[2]

I lay the foundations of my argument by drawing from the Eastern philosophical tracts in regard to respecting life, regardless of species. I will draw from Hindu and Jain schools of thought—two philosophies that believe in a system of *karma* and *samsara*. Furthermore, both systems hold the value of *ahimsa*, or nonviolence, as one of the cardinal tenets of virtuous living, to be practiced towards all living beings. I also examine the history of using animals in experimentation, as well as the humanist and philosophical opposition to this science.

Next I will examine present day considerations, and the use and treatment of animals in research, commercial testing, entertainment, as well as factory farming. I draw from statistical data to illustrate the magnitude of animal use in these realms, both domestically and internationally. Further, the protocol used to approve animal testing will be addressed, having attended an Institutional Animal Care and Use Committee meeting at Case Western Reserve University, including the nature of animal use and treatment.

Finally, I turn to contemporary religious and secular views regarding animal welfare and rights. I draw from modern philosophers such as Peter Singer and Tom Regan, addressing the concept of mental personhood and the moral status of animals. Christian theology and the scholarly works of Andrew Linzey, C.S. Lewis, and Albert Schweitzer will show that Judeo-Christian traditions also have an underlying animal ethic of love and compassion. Additionally, contemporary perspectives presented and analyzed from a questionnaire answered by various academics, religious, and secular thinkers regarding the current treatment of animals and the ethical concerns thereof. I will conclude by giving my own viewpoints on animal perspectives, my practices, as well as my concerns for the future.

Historical Perspectives on Animals

Hinduism

Before delving into my investigation of Hinduism and animal ethics, it is important to first make a few considerations. As with my later analysis of Christianity, it is important to recognize that there is no single "Hindu view" in regard to treatment of animals and vegetarianism. As far as compassion towards animals is concerned, it is important to presuppose that the actor is a Hindu who prescribes to and has bound him or herself to the notions of *karma* and *samsara*, beliefs that my argument is founded on. Further, the perspective of Hinduism I project is a monist Brahmanical ideal which is not adhered to by all Hindus.[3] This should be understood as meaning that Hinduism has not historically espoused vegetarianism. Further, the notion of *ahimsa* was not intrinsic to Hinduism and was appropriated from the Jain tradition, where it is far more stringent.

While later traditions, postulated in *Yajnavalkya*, dictate the internalization of the sacrifice, the earlier *Rg Veda* text is rooted in maintaining the social order through sacrifices to the gods, including sacrificing animals.

Though the term "Hinduism" has only been in existence for a few hundred years, the practices encapsulated by it can be dated back to the Indo-Aryan traditions of 2500 B.C.E.[4] Hindus have maintained a belief in the concept of an innermost self, or *atman*, that exists for all beings, from the highest god to the smallest insect.[5] This *atman* is part of a single pervasive power which is the source of the phenomenal world, the *Brahman*. From *Chandogya Upanishad*, life is understood as merely fleeting names and forms outside on underlying reality.[6] The nature of *Brahman* can be understood as: "that from which these beings are born; on which, once born, they live; and into which they pass upon death—seek to perceive that? That is *Brahman*."[7]

Hinduism is centered on four central beliefs: *dharma*, *moksha*, *karma*, and *samsara*.[8] The *dharmic* tradition, which is a guide to proper behavior specific to class, views it as necessary to uphold, preserve, perpetuate, and refine the world generally. *Karma* and *samsara* are two concepts that inform the notions of *dharma* and *moksha*. *Karma* is a universal law of cause and effect; one reaps what one sows. The concept of *samsara* has two facets: first, it is the cycle of birth and rebirth, and second, it is the flux and flow of all creation.[9] If one were to act in an egregious fashion, for example kicking a stray dog for some hedonistic pleasure, that individual would experience equal suffering later in life. The values of *karma* and *samsara* motivates nonviolence and as such vegetarianism.[10] In the path towards *moksha* it is necessary to search for an ultimate release from the world that is often accomplished by renouncing society.[11] Hindu traditions have sought to harmonize the demands placed on practitioners by *dharma* and *moksha*, and have often struggled to realize how the two are related. From *Manusmriti* 6.60, one can find that path towards *moksha* is aided: "by the restraint of his senses, by the destruction of love and hatred, and by the abstention from injuring the creatures, he becomes fit for immortality."[12]

All of these concepts suggest that the Hindu actor be vegetarian, lest he or she be locked in the cycle of birth and rebirth for a prolonged period of time. From the *dharmic* perspective, *ahimsa* is the Hindu's first obligation in fulfilling religious obligations. From a *Karmic* perspective, one must commit an act of violence, directly or by proxy, to eat meat; therefore one, in the future, will experience equal suffering. Furthermore, I would find it difficult that any human would be willing to suffer the treatment of animals later in life as repercussion for their actions now, such as being killed in the brutalized fashion that is commonplace in harvesting animals for food. Nor do I believe that as many people would consume meat if they viewed their action as being complicit with violence and murder. Given the values inherent this interpretation of Hinduism—where the actor views life as fundamentally and same and has bound him or herself to the presuppositions of my argument—it is only correct to follow the values of *dharma* and respect the reality of *karma* and such strictly adhere to *ahimsa*. This belief applies towards all life, including animals used for food, clothing, and testing. From *Yajur Veda* 12.32, the duty of man is known, not to: "use your God-given body for killing God's creatures, whether they are human, animal, or whatever."[13]

Jainism

While lacking the belief in the creating god, Jainism shares many of the core beliefs of Hinduism, including *karma*, *samsara*, *moksha*, and *ahimsa*. Jains are followers of "Jinas"—those who have achieved complete victory over attachments and aversions; they have broken free from *karmic* influence. A Jain is someone who reveres and follows a Jina and regards their teachings as authoritative. Jainism is centered on five vows: *ahimsa* (nonviolence),

satya (truth), *asteya* (non-stealing), *aparigraha* (non-possessiveness), and *brahmacharya* (chastity)[14]. In *Uttaraadhyayan Sutra*, it is articulated that, "an individual, who does not understand reality, indulges in violence, untruth, deception, eating meat and drinking liquor, and fancies that these are beneficial to him or her."[15]

Jainism has never compromised on the concept of *ahimsa*, neither in practice nor in principle, regarding it as the golden rule. *Ahimsa* is held as the supreme religion and Jains have insisted upon its observance in thought, word, and deed at the individual and social levels. Like in Hinduism, violence is seen as perpetuating the cycle of birth, death, and rebirth. Jains believe in an equality of souls, irrespective of differing physical forms, ranging from human beings to animals to microscopic living organisms, presenting a sophisticated system of ethics.[16] Humans are endowed with all six senses, and they are expected to act responsibly towards all life by being compassionate, egoless, fearless, forgiving, and rational. It is not uncommon to see Jains walking down the street with a mask covering their mouth and sweeping the path in front of them to avoid killing even the smallest of insects.

Traditionally, Jains in India have lobbied for animal welfare, promoting animal protection, building animal shelters, and providing food for lost or wounded animals. Jains have also successfully campaigned for the banning of animal sacrifices in most parts of India. Jain pharmaceutical companies that use animal testing will rehabilitate and release the test animals. Further, Jains view the practice of vegetarianism as a way of life derived from the concept of compassion for all living beings. Vegetarianism is seen as an instrument for the practice of a nonviolent and cooperative existence. From all these facets, it is evident that Jainism is a unique religion in its advocacy of vegetarianism and animal protection.[17]

Both religious traditions, explicitly in Jainism, depict a reverence for life that has been lost in contemporary society where animals are viewed as a commodity rather than as sentient beings. Each tradition posits a prolonged religious and moral understanding regarding the respect for all life and the necessity to not inflict pain and suffering unto others. To suggest that the use of animals is *beneficial* to man is, in my opinion, a flawed mindset, and can be attributed to mankind's inflated sense of self worth—that man is somehow above all other creation.

History of Animal Experimentation

The history of animal experimentation can be traced all the way back to Greek antiquity. The act of vivisection, which is cutting open an animal to observe its internal workings, was developed as a tool for methodological physiological examination by the Roman physician Galen. In his book, *Du Moto Cardis*, British physician William Harvey—who discovered the true nature of blood circulation and the function of the heart as a pump—argued that animal experimentation was an invaluable technique for physiological discovery.[18] While arguments regarding the practicality of vivisection were plentiful at the time, philosophical arguments regarding the ethics of experimentation began to emerge as well. Claude Bernard, the French physiologist, argued that it was unethical to experiment on human beings no matter how beneficial the findings might prove for others. Bernard argued that the practice of vivisection was "entirely and absolutely" a "right" for researchers.[19]

Louis Pasteur discovered the vaccine for rabies by infecting countless numbers of dogs and rabbits. All of this testing was justified by researchers by the practical good it brought for humans as well as for its contribution to the expansion of scientific knowledge. Transitioning into the 20th century, animal experimentation has spread beyond studies of physiology and pharmacology. Animal experimentation is now done for psychological testing, standardizing drug products, as well as in testing of the toxicity of cosmetics of and other consumer products. It has been said that the "laboratory animal" has become the universal tool

and symbol of medical progress and medical civilization.[20]

History of Opposition to Animal Experimentation

The opposition to animal experimentation, in a more contemporary context, is rooted in a philosophical query: *do animals deserve the same moral consideration as humans*? Opponents of animal experimentation originally focused on the immorality of animal experimentation, viewing it as a means to a human end. While animal experimenters agreed that animals felt pain while engaged in experimentation, this pain wasn't viewed as cruelty. Animal experimenters often justified their actions on two grounds, stating the practice was a practical good benefiting people as well as an intellectual good enlarging our understanding of the natural world. However, these perspectives came under increasing scrutiny during the Enlightenment.[21]

In his work, "Four Stages of Cruelty", British satirist William Hogarth depicted the barbarous treatment of animals as the first stage of descent into savagery. He believed that the values held by men of liberty, equality, and fraternity, could be interpreted as applicable to animal creation as well.[22] The father of utilitarian thinking, Jeremy Bentham, argued that an animal's ability to feel pain and suffering was enough to earn them entrance to the sphere of moral consideration, arguing, "The question is not, 'Can they reason?' nor, 'Can they talk?' but rather, 'Can they suffer?'"[23] Famed 18th century writer Samuel Johnson went so far as to deny that any practical benefits had come from animal research. He asserted that even if there had been some fruits, the knowledge was ill-gotten since it was obtained by the torture and death of innocent creatures.

The Enlightenment thinking regarding opposition to animal experimentation was based on philosophical arguments rather than empathy. Arguments were marked by assertions of inutility, immorality, as well as the corrupting influence of experimentation. The benefits of animal research were deemed to be irrelevant, as they were as sinfully earned as if they had been derived from human experiments. An important question was raised as well: *if scientists could not be made to recognize the moral claims of fellow creatures, what hope was there for educating drovers or butchers*?[24]

Two other types of scholars regarding experimentation also emerged: abolitionists and reformers. The abolitionist perspective was founded on the belief that the end does not justify the means; inflicting pain and death on an innocent being is always wrong. Since it was a commonly held belief that the possibility of advancing scientific knowledge did not justify taking healthy human lives, infliction of pain and death on animals could not be justified by the possibility of future benefits for either humans or other animals.[25] The reformer school viewed animal experimentation as a flawed but necessary system, arguing that a changed practice of animal experimentation could be defensible. They maintained that every experiment needs to undergo close and impartial scrutiny with some sufficient benefit that would offset the loss of animal life.[26]

In 1975, Australian philosopher and ethicist Peter Singer released his work *Animal Liberation*—a work that really marked the start of the animal rights movement of contemporary times. Singer introduced the term "speciesism", which he developed to parallel racism and sexism.[27] Speciesism is putting the interest of one's own species ahead of the interest of other species—something that is unjust since all species must be treated the same. Singer also introduced the concept of mental personhood, which I will discuss later, that qualified animals as non-human persons. Given these founding points, Singer argued that the use of animals in research was a morally impermissible way of pursuing science.

Singer, and his contemporaries, such as Tom Regan, contributed to a continuing public uneasiness over the morality, or lack thereof, of animal experimentation. In 1976, the Animal Liberation Front (ALF) was founded, with

chapters since opening up all over the globe. The ALF has become notorious for invading research facilities and destroying property to liberate animals. 1n 1980, the People for the Ethical Treatment of Animals (PETA) was founded, disseminating knowledge regarding the human exploitation of animals and encouraging abstinence from the use of animal products.[28]

Treatment of Animals Today: Research, Farming, and Commercially

Animal Research

Whenever the use of animals is talked about in the research setting, phrases like "for the greater good" as well the euphemism "sacrifice" are used instead of the more applicable "torture and murder". Animal testing in is research is one of the most prevalent abuses of animals found globally. In the European Union, it is believed that an estimated twelve million animals are used per year for experimentation in the fifteen member nations, including the United Kingdom. In Japan, surveys report that a total in excess of eight million animals per year are used. The U.S. Congress Office of Technology Assessment estimated that at least seventeen to twenty-two million animals are used in research annually; however this figure is believed to be very conservative.[29] Other organizations, such as the Northwest Animal Rights Network, believe that the figure is closer to fifty million. The tenets of Animal Welfare Act (AWA) aren't applicable to mice, rats, and birds, which account for 85% of animals tested upon. It is believed that more than five million animals are used for dissection by high school students in the U.S. per year.[30] That being said, there has been a move away from the use of living animals for practice surgery in medical school.

Resulting from public outcries regarding the extensity and intensity of animal research, researchers have been largely forced to adopt the "three R's". These three pronged concepts include: reducing the number of animals used in experiments, refining procedures as to lesson animals' discomfort, and replacing animals when possible with alternatives such as tissue cultures and mathematical models.[31] Despite these methods, the figures still dictate that millions of animals are being killed unnecessarily, with research laboratories being forced to move underground to avoid retaliation from factions such as ALF. Christian Barnard, surgeon and researcher, commented:

> "I had bought two male chimps from a primate colony in Holland. They lived next to each other in separate cages for several months before I used one as a [heart] donor. When we put him to sleep in his cage in preparation for the operation, he chattered and cried incessantly. We attached no significance to this, but it must have made a great impression on his companion, for when we removed the body to the operating room, the other chimp wept bitterly and was inconsolable for days. The incident made a deep impression on me. I vowed never again to experiment with such sensitive creatures."

Many research universities, such as Case Western Reserve University, have established committees to approve the use of animals in laboratory testing and research. At Case, the board is known as the Institutional Animal Care and Use Committee (IACUC). Comprised of researchers, veterinarians, and ethicists, the board meets once a month to discuss procedure and approve research protocols. Each research protocol describes the objective of the experimentation, the procedures, as well as the number of animals the researcher is requesting for use. IACUC addresses the pain level the animal will feel, and will make recommendations for approval of the protocol. However, animals are still being killed in gross numbers for nothing more than research which cannot warrant the numbers that were discussed. Having signed a waiver of confidentiality, I cannot make note of the specifics of any case, but it struck me at minimal as disturbing, that a two hour meeting would determine the fate of a large sum of life to be "sacrificed for the greater good."

Factory Farming

Factory farming is probably one of the most maniacal practices by mankind, where animals are treated as emotionless automatons; it is the ultimate practice of commodification of life. It should be noted on the onset that animal slaughterhouses were used as the model for Nazi death camps—"to animals, all people are Nazis". Despite this historical fact, people are still violently disturbed when animal exploitation is paralleled to the Nazi exploitation of people, as was the case when PETA featured their "Holocaust Metaphor" exhibit, featuring panels of slaughterhouses alongside death camps.[32]

In animal agriculture, factory farming has led to the institutionalized torture and killing of animals, resource depletion and environmental damage, as well as the mounting health risks to humans. Animals are confined to small spaces, unable to act in the way they were naturally intended to do. In her work, *Dead Meat*, Sue Coe describes the transport of animals from a slaughterhouse, writing:

> "…a train has come to a standstill. It is a cattle train. The sun is rising. A thousand eyes are reflecting in the light, staring into the motel room. I can see the cattle in wooden slats. They are silent and motionless. The temperature is below zero, and the cattles' breath makes a white mist…there are hundreds of cars, packed with thousands and thousands of cattle on their way to slaughter. Six billion animals are killed each year in the United States for human consumption. The suffering of these animals is mute. For the defenseless, the gentle, the wounded, the ones who cannot speak, life consists of an indescribable suffering."[33]

Since they are confined to such small spaces, illness and disease are rampant. Combined with the desire for a greater yield of product, animals are injected with growth hormones and antibiotics, all of which make the animals' life painful and creates increasing health risks for humans. Animals are bred, raised, beaten, mutilated, and killed in the most sadistic of fashions. "Euthanizing" a cow for slaughter, for instance, is done by a "stunning blow" which is a mechanical blow to the head—one could only imagine what the outcry would be if this was the practice in the medical process of euthanasia we attribute to humans. Other graphic examples of human selfishness include products such as veal—where a newborn calf is stripped from its mother and placed in a box as to restrict all movement, or foie gras, where a goose is force fed corn meal. If humans actually believed in and practiced a system of *ahimsa* and *karma* factory farming would have been eradicated long ago.

Commercial Testing

Another prevalent human abuse of animals comes in the form of testing for household products such as shampoos, detergents, and cosmetic products. Two commonly used toxicity tests for these products are the LD_{50} (Lethal Dose 50%) test and the Draize Eye Test. The Lethal Dose test is designed to find a dosage that will fatally poison 50% of a sample of animals. In this process all of the subject animals are likely to become ill, suffering from nausea, thirst, diarrhea, stomach cramps, and fever. The Draize Eye Test is done by placing a product in the eye of a conscious, unanesthetisized animal and is designed to assess the likelihood of eye damage. These methods are used in the testing of household products such as food coloring, household cleaners, shampoos, and conditioners. I find it difficult to believe that our fixation on luxuries such as cosmetics—something that confers no benefit to a human—warrants the use of these testing methods.[34] If someone is to argue that these methods are a "right", I believe that he or she is no better than someone who justified Nazi medical testing on humans during the Holocaust. It is only by viewing the matter in such light that the issue of animal testing may be regarded with the seriousness it deserves. Experimenters continue to regard animals as a "lesser species", much like the Nazis regarded the Jews, and refuse to include them in a system of ethical consideration, in their eyes "permitting" them to exploit animals for their own

selfish needs.

Contemporary Views, Secular and Religious

The practice of compassion towards all life is reflected in the Hindu and Jain traditions, as seen previously. However, how does this translate to the contemporary perspective on the moral status of animals? As witnessed in the past section, the current practices towards animals are a far cry from adhering to the value of *ahimsa*. Through the following section, I examine contemporary viewpoints regarding practices and beliefs regarding animals as well as making recommendations for the future.

Mental Personhood and the Moral Status of Animals

In the contemporary world, "moral status is a concept that deals with who or what is so valuable that it should be treated with special regard."[35] There has been a great deal of debate regarding the moral status of everything from the human embryo to severely incapacitated persons. However, with philosophers such as Singer and Tom Regan, the argument regarding moral status is being discussed in regards to animals as well. Singer argues that animals can qualify as "non-human persons", as they possess the qualities of rationality, autonomy, and self-consciousness. Singer further argues that an animal—such as a chimpanzee—lacks not the intelligence for recreating the human language, but rather the vocal equipment. He also cites studies where both gorillas and chimpanzees have effectively used human sign language; further, gorillas have, in turn, taught their offspring to sign as well. In addition, the known similarities between the nervous systems of all vertebrates support the close parallel between animal and human behavior.[36]

The concept of specieism has been a difficult argument for many to accept, let alone sufficiently counter. Specieism is a prejudice in favor of "our own kind" that is analogous to and no more justifiable than racism or sexism.[37] Colin McGinn, an Oxford philosopher, has referred to this perspective as a "won argument".[38] Singer argues that what needs to be looked at is individual variation, such as mental capacities. Those who practice racism and sexism are those who treat all members of a group in the same way. For example, a sexist would assume that all women cannot perform heavy physical labor as well as man can. It should be understood that the interests of beings with different mental capacities vary, and these variations are of moral significance.[39] As such, decisions need to be made based upon mental capacity and not species membership. From this, it can be qualified that an anencephalic newborn does not have the same moral standing as a healthy thirty-year old female nor does it have the same moral standing as a fully functioning orangutan, which possesses the attributes that qualify it as a non-human person.

Christian Perspectives

While vegetarianism is not formally endorsed by all traditions of Christian faith, many have adopted the practice as a spiritual discipline.[40] The Benedictines, for example, have eliminated meat-eating as part of their ascetic regime. Other traditions eliminated consumption as part self-denial on the path towards moral perfection.[41] As early as the first chapter of the Book of Genesis, the idea of a harmonious vegetarian world is postulated as a Judeo-Christian theology.[42] However, many Christians have argued a case of dominion—that God created man, not animals, in his image, citing Genesis 1:26.[43] On the other hand, scholars, such as Albert Schweitzer, interpret this "dominion" as stewardship—looking after something or someone's welfare that is not ours to possess—much like Christ looked after the welfare of other persons, especially the oppressed and vulnerable. The first chapter of the book of Daniel also offers biblical support for vegetarianism, and even espouses the health benefits of the diet.

Compassion towards animals, and vegetarianism, could be interpreted as a more Christlike response to the evils of animal exploitation.[44] From the time of St. Francis

of Assisi, a thread of compassion towards all life is found. Francis declares, "if you have men who will exclude any of God's creatures from the shelter of compassion and pity, you will have men who will deal likewise with their fellow men". C.S. Lewis, through his literary works, described dogs going to heaven. Lewis offers the illustration of a Great Lady, writing, "every beast and bird that came near her had its place in her love. In her they became themselves. And now the abundance of life she has in Christ from the Father flows over into them."[45]

One of the most influential humanists and proponents for animal rights was Albert Schweitzer, a doctor and theologian. Schweitzer was very influenced by the Jain's reverence for life, so far as to write a piece of the same title. In his work, *The Philosophy of Civilization*, Schweitzer writes, "we must fight against the spirit of unconscious cruelty with which we treat the animals. Animals suffer as much as we do. True humanity does not allow us to impose such sufferings on them. It is our duty to make the whole world recognize it. Until we extend our circle of compassion to all living things, humanity will not find peace." Through Schweitzer's scholarship one can see the threads of the Hindu and Jain views on reverence for all life being reverberated, adjusted according for their own religious traditions.

Contemporary Perspectives on Animal Ethics

In an attempt to present a more complete depiction of contemporary perspectives regarding animal ethics, I devised a questionnaire covering topics such as the concept of soul, moral status, and afterlife and how all these concepts applied to animal life. Of the fifty questionnaires mailed out, I received thirty back. Respondents varied in age from eighteen to fifty-seven years of age, and religious backgrounds included Hindu, Jain, Lutheran, Christian, Baptist, Catholic, as well as non-denominational theistic and atheist viewpoints. The series of questionnaire concluded with the following query: *Do you feel a sense of complicity when an animal is tested upon, butchered, or otherwise used, for your human needs?* Of the thirty, only ten said they felt no complicity. However, of this ten, nine of the respondents stated they believed in the concept of a soul and/or an afterlife. When asked to justify his answer, one respondent answered: "the process is so far away that it does not really affect me." This is the kind of response that is reverberated amongst those who said they felt no complicity, and is the exemplification of the age old adage of "ignorance is bliss".

The results of the questionnaire largely demonstrated a lack of understanding as to how a factory farm operates, how animals are abused in circuses via their "training", as well as the number of racing animals that are put down each year simply because they cannot run fast enough. Other respondents put human worth over that of the animal, grotesquely demonstrated by one response regarding the ethical nature of veal and foie gras production, as the respondent writes: "I don't believe it's unethical. These animals are being bred for the sole purpose of being consumed; I think there is no loss in the potential". The respondent fails to recognize that the end, which in this case is frivolous product for consumption, does not justify the means which is a tortured life in a veal crate or daily force feedings. One respondent excellently summed many people's thinking—and the overwhelming problem—when he responded, "Nothing gives a human greater moral worth. All living things have a right to live…I am very guilty of turning my head to all of this. The worst thing about it is [that] I know most of the facts about animal cruelty, but I've yet to change anything in my daily life to help stop it**."**

Personal Perspectives on Animal Rights

After being born into a Brahmin Hindu family, I have grown up in a society that heralds triple-patty hamburgers as a "real man's meal", paying no attention to the harm that it caused to get that burger nor the effect it will have

upon the consumer's body. In a society that exists on the unnecessary and is fixated on the convenient, I am told that the animal rights movement is at worst ridiculous, and at best pointless. Such a statement is quite fatalistic, and furthermore is unsupported by fact. To this I respond, how can someone suggest that there has been no change and no evolution in our treatment of animals? While those growing up on rural farms, perhaps, are more desensitized to the killing of animals and have accepted it as a part of life, suburbans, such as myself, are extremely turned off when they view footage of fur production or the highly publicized KFC-contracted chicken farm controversy. Those who are able to watch films such as "Meet Your Meat" or "A.L.F.: The Frontline" and continue their practices have an air of arrogance about them which can only be attributed to ignorance about the value of life and an air of overinflated self-worth. Are someone's desires for gastronomic pleasure so great that another has to suffer and die?

There are an increasing number of vegetarians and vegans, especially in Western society. In the 80s, the animal rights movement was limited to underground circles and was a laughing point by mainstream society. Modern society is seeing more and more high profile figures, such as 2004 Presidential candidate Dennis Kucinich, come into the limelight not only for their effects on human society, but their equal regard for animals as well. It is increasingly easier for someone to endorse a cruelty free lifestyle, whether that means becoming vegan or no longer using fur and leather products. In the past, only obscure mail-order stores carried non-leather shoes or animal-testing free household items. However, with the growing concern around animal rights and the advent of internet technology, one can easily acquire these products online or at the local grocery store. Despite the minimal effect of such things as IACUC, AWA, or the "Three R's", all are steps in the right direction. Society has seen what an expansive effect the efforts of people such as Albert Schweitzer and Peter Singer can have on a society such as ours, and, in turn, on the globe. Society needs to embrace traditions that held animals in high esteem, not only for our own humanity, but for the future of our global ecosystem as well.

Conclusion—What is the Human Responsibility to Other "Persons"?

Given the continuing and growing public uneasiness regarding animal exploitation, the future of the animal rights is headed slowly down the right path—towards abolition. Adopting the value of *ahimsa* and reverence for all life will have so many positive effects it is amazing that people have not adopted it already. The resources that are used for raising farm animals can be used elsewhere. By stopping the consumption of animals, man's health will increase multifold by no longer consuming diseased flesh and the man-made antibiotics fed to the animals, which will ultimately bring the end of unwarranted and unethical research. If the research is that important, would it be so impossible to have human volunteers? Society would also have greater wellness of mind and being since we are no longer complicit with the torture and killing of innocent creatures, making us fit for salvation. There is no need for continuing down the path of death and destruction for our selfish human needs. Compassion for life should be total—for all creation, not limited merely to our own species.

[1]I formally introduce and define the concept of "moral status" later in my paper. However, given that I use the concept several times before arriving at section dealing with the secular ideology of modernity, I offer a definition now. In his entry to the *Encyclopedia of Bioethics*, James W. Walters defines moral status as "a concept that deals with who or what is so important that it should be treated with special regard."

[2]The word "selfish" is perceived as a contentious word by animal rights detractors and, perhaps, its use in this paper may be as ambiguous to the reader. I intend it to connote the achievement of our (human) ends over the rights of all others (animals, the environment, etc.). For example, John Doe's *selfish* eating habits are responsible for the death of ninety-five animals a year and the suffering of countless others. The example violates the principle of utility, held by philosophers such Bentham and Singer, which will be discussed at length later in my investigation.

[3]Please note that my examination of Hindu perspectives is largely an analytic exercise. I believe it is important to start considerations of animal ethics with Hinduism since Jain ideology stemmed from and reconciled Hindu ideologies. My focus in this paper is to present a cross-section of views not only regarding respecting animals but a history as well.

[4]Mitchell G. Weiss, "Bioethics in Hinduism," in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 1142

[5]Ibid, p. 1142

[6]*Chandogya Upanishad*, 6.1-3. R.N. Dandekar, "The Ultimate Reality in Upanishads," in *Sources of Indian Tradition*, 2nd Edition, ed. Ainslie T. Embree (New York: Columbia University Press, 1988), p. 36

[7]Ibid, p. 36

[8]When I use the term Hinduism, I am referring to the monist Brahminical tradition which is rooted in adherence to the codes written in religious scripture. These scriptures were most likely written by Brahmin scholars and through the hegemony of the class system, others classes such as the ksatriyas, vaisyas, and sudras may have been instructed to adhere to such a diet. However, as the religion has secularized over time, vegetarianism has mainly only been practiced by the textual Brahmin school. Also, with the Hindu Diaspora and the movement from *karmabhumi*, it is difficult to strictly apply ancient religious tenets to an increasingly secularized religious base.

[9]*Chandogya Upanishad*, 8.7-12. R.N. Dandekar, "The Ultimate Reality in Upanishads," in *Sources of Indian Tradition*, 2nd Edition, ed. Ainslie T. Embree (New York: Columbia University Press, 1988), p. 35

[10]Mitchell G. Weiss, "Bioethics in Hinduism," in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 1143.

[11]Daniel J. Meckel. "The Upanishads and Renunciation." 2004 Religions and Cultures of India course. Case Western Reserve University, 5 February 2004

[12]Georg Buhler, "The Laws of Manu," in *Sacred Books of the East*, 3rd Edition, ed. F. Max Muller (Delhi: Motilal Banarsidass Press, 1970)

[13]Paul Turner, "Hinduism and Vegetarianism," International Vegetarian Union, March 2000

[14]Christopher Key Chapple, "Jainism in Bioethics." in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 1339

[15]Sunita Jain, "Vegetarianism: Good For the Self and Good for the Environment," The Jain Study Circle.

[16]Christopher Key Chapple, "Jainism in Bioethics." in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 1339

[17]Ibid, p. 1340

[18]James C. Whorton, "Animal Research: Historical Aspects," in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 166

[19]Ibid, p. 167

[20]Ibid, p. 167

[21]Ibid, p. 168

[22]Ibid, 168

[23]Peter Singer, *Practical Ethics*, 2nd Edition, (New York: Cambridge University Press, 1993), p. 57

[24]James C. Whorton, "Animal Research: Historical Aspects," in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 168 - 169

[25]Peter Singer, "Animal Research: Philosophical Issues" in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p.174

[26]Ibid, p. 175

[27]James C. Whorton, "Animal Research: Historical Aspects," in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 169

[28]Ibid, p. 169

[29]Peter Singer, "Animal Research: Philosophical Issues" in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 171

[30]Ibid, p. 172

[31]Ibid, p. 172

[32]P.R. Wolpe, "The Holocaust in Bioethics," in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 1152. The quote "to animals, all people are Nazis" is attributed to Isaac Bashevis Singer, a Jewish Nobel Laureate.

[33]Sue Coe, *Dead Meat* (New York: Four Walls Eight Windows, 2003), p. 63

[34]Peter Singer, "Animal Research: Philosophical Issues" in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 171

[35]James W. Walters, "Moral Status," in Encyclopedia of Bioethics, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 1855

[36]Peter Singer, *Practical Ethics*, 2nd Edition, (New York: Cambridge University Press, 1993), p. 111-112

[37]Ibid, p. 55-56

[38]Peter Singer, "Animal Research: Philosophical Issues" in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 175

[39]Ibid, p. 176

[40]Andrew Linzey, "Animal Welfare and Rights: Vegetarianism," in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 198

[41]Ibid, p. 198

[42] New Oxford Annotated Version, Genesis 1, [29] God said, "See, I have given you every plant yielding seed that is upon the face of the earth, and every tree with in its fruit; you shall have them for food. [30] And to every beast of the earth, and to every bird of the air, and to everything that creeps on the earth, everything that has the breath of life, I have given every green plant for food."

[43]New Oxford Annotated Version, Genesis 1:26: Then God Said, "Let us make humankind in our image, according to our likeness; and let them have dominion over the fish of the sea, and over the birds of the air, and over the cattle, and over all the wild animals of the earth, and over creeping thing that creeps upon the earth."

[44]Andrew Linzey, "Animal Welfare and Rights: Vegetarianism," in *Encyclopedia of Bioethics*, 3rd Edition, ed. Stephen G. Post (New York: MacMillan Press, 2003), p. 199

[45]Andrew Linzey, "C.S. Lewis's Theology of Animals." Anglican Theological Review, (4), p. 3

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Receptor Tyrosine Kinase Signaling and Cancer: A Review of Current Therapies

Shaan C. Gandhi

Abstract

Signal transduction pathways are crucial cell regulatory mechanisms for maintaining normal cell growth and division activities. Recent advances in receptor tyrosine kinase (RTK)-mediated cell signaling research have revealed numerous strategies for targeting and treating cancer that exploit these pathways. Starting in 1996, with the development of the CGP 57148 Abl receptor tyrosine kinase inhibitor, later known as ST1 571, cancer biologists have begun to discover and create novel molecular inhibitors of RTK pathways implicated in tumor growth and angiogenesis. Such inhibitors are often more effective and have fewer side effects than standard therapies. This review discusses the roles of cell signaling pathways in the etiology of cancer and assesses the uses of three current pharmaceuticals that target these pathways: imatinib mesylate, trastuzumab and bevacizumab.

Introduction

In 1996, Dr. Brian Druker and his research colleagues published a paper in the journal *Cancer Research* concerning a new avenue of cancer therapy. They described a novel inhibitor of the Abl and platelet-derived growth factor (PDGF) receptor tyrosine kinase (RTK) that could be used to repress the oncogenic activities of Abl (Buchdunger, *et. al.*, 1). The enzymatic inhibitor, CGP 57148, that Druker was testing was revolutionary in that it was one of the first instances of applying emerging research in cell signaling pathways to the intractable challenge of cancer treatment. Before this discovery, clinical oncology was focused on three major therapeutic strategies: surgical resection, radiation therapy and chemotherapy. For primary localized tumors that have not metastasized, surgical removal of the tumor was often the best therapy. Liver tumors (Schoppmeyer, *et. al.*, 449) and colon cancer lesions (Blumberg & Ramanathan, 15) can be removed, thus ridding the patient of the cancer (theoretically). However, there are many disadvantages to surgical treatment. Often, the tumor was located in a precarious position, such as within the brain or embedded in vital bodily tissues, making the procedure extremely difficult to conduct without causing further damage (Russell, *et. al.*, 1010). In addition, the surgery often does not remove all cancerous cells, leaving a few behind to recolonize the primary site and spread (Schoppmeyer, *et. al.*, 449). For such cancers, radiation therapy was used. Since the discovery of X-rays by Wilhelm Roentgen in 1895, radiation oncologists have used targeted radiation to induce fatal mutations in cancerous cells. Nowadays, with magnetic resonance imaging and computerized axial tomography imaging, physicians have access to advanced three-dimensional imaging data of the tumor, allowing them to focus the radiation much more accurately on the tumor. However, significant side effects for radiation therapy still exist, including the risk of developing a secondary cancer (Travis, *et. al.*, 17). Thus, during the 1940s and 1950s, scientists began developing cytotoxic agents in an effort to focus the therapies even more so on cancerous cells. Beginning with the development of aminopterin, an inhibitor of dihydrofolate reductase, an enzyme critical in the synthesis of nucleotides in DNA replication (Kufe, *et. al.*, 1), cytotoxic drugs are agents that target actively-dividing cells (a common characteristic of tumors) by disrupting the normal cell division processes. Drugs, such as cisplatin, methotrexate and vinblastine, all take different approaches toward halting cell division (Culine, 32), such as inhibiting DNA replication or the formation of the mitotic spindle. With the development of such powerful antineoplastic

agents, physicians also began using the drugs in conjunction with surgical resection or radiotherapy, a procedure known as adjuvant therapy (de Gramont, 11). However, this avenue of therapy also leads to debilitating side effects, as the treatments also destroy normal cells that divide quickly, such as those in hair follicles, stomach mucosa and bone marrow. Thus, many patients undergoing cytotoxic drug therapy suffer from hair loss, nausea/ vomiting, fatigue and anemia. In addition, chemotherapy also has the propensity to cause secondary cancers as well (Travis, *et. al.*, 17). These three elements of cancer therapy have been the standards of clinical oncology for the past half century, yet today, there are new strategies available that take advantage of the growing body of knowledge surrounding the roles of cell signaling pathways.

Receptor Tyrosine Signaling

The RTK pathways are a unique web of intracellular protein interactions that lead to cell growth and division; approximately 200-300 RTKs are present in a given cell (Traxler, *et. al.*, 500). When a ligand, often a growth factor such as vascular endothelial growth factor (VEGF) or platelet-derived growth factor (PDGF), binds to its respective RTK on the plasma membrane, a conformation change is induced, cause the two intracellular domains of the RTK to dimerize and autophosphorylate, leading to their activation as a kinase. Once activated, intracellular adaptor proteins, often bearing SH2 (*Src* homology region) protein domains bind to the activated RTK. This process of intracellular proteins binding to other continues downstream toward the endpoint of gene expression, where specific transcription factors are activated or repressed to regulate the level of synthesis of proteins influential in cell division and growth (Alberts, *et. al.*, 877). One prime example of the process of intracellular signaling is the Ras/MAPK pathway. In this pathway, Ras, a small monomeric intracellular protein, acts as the adaptor protein, linking the activation of the RTK with downstream targets, such as Grb2 and the mitogen activating protein kinase (MAPK). Because of their roles in the growth and proliferation of cells, many scientists have identified the RTK pathways as potential influencing factors in causing cancer. The malfunction of certain key regulatory proteins within these pathways can lead to excess and unchecked cell growth and mitosis, the classic characteristics of cancer.

Three RTK pathway proteins with oncogenic properties have recently attracted interest because of their involvement in the etiology of cancer: the Abl kinase, human epidermal growth factor 2 (HER2) RTK and vascular endothelial growth factor (VEGF). The Abl protein is a monomeric protein that has the ability to dimerize to become an active kinase to stimulate the production of hematopoetic cells (Alberts, *et. al.*, 1359). However, when the *bcr* gene is fused to the *abl* gene, a mutation known as the Philadelphia chromosome, the resulting Bcr-Abl chimeric protein is always activated, leading to excessive proliferation of myeloid cells (Traxler, *et. al.*, 507). Of all cancer patients afflicted with chronic myeloid leukemia (CML), 95% possess the Philadelphia chromosome. The HER2 RTK, a receptor similar to epidermal growth factor receptor (EGFR), dimerizes with an EGFR to activate mammary cell growth. When regulation of HER2 expression is lost, such as the loss of the extracellular ligand binding domain (Drevs, *et. al.*, 118), the HER2 and EGFR molecules tend to stay in their dimer form, leading to excessive activation of the resulting pathway and mammary cell proliferation (Christensen, *et. al.*, 4231). The HER2 receptor is present in high concentrations in approximately 25% of breast cancer patients (Alberts, *et. al.*, 1358). The VEGF protein, a ligand that binds to the VEGF receptor-1 RTK, stimulates the growth of blood vessels, a process known as angiogenesis. VEGF is under the control of the hypoxia-inducible factor 1 (HIF-1), a regulatory protein that stimulates VEGF protein production in tissues that are hypoxic. The resulting increase in blood vessel density compensates for the lack of oxygen in the tissues (Alberts, *et. al.*, 1282).

Normally, this mechanism is part of normal homeostasis, but in cancer, loss of HIF-1 or VEGF gene transcription and translation control allows many solid tumors to thrive by tapping into the blood vessel growth processes to draw their own blood supplies (Midgely & Kerr, 999).

Imatinib Mesylate

In the late 1990s, the work of many scientists in academia and industry led to the discovery of a novel inhibitor of the BCR-Abl chimeric protein: CGP 57148, later known as ST1 571 or imatinib mesylate. Currently manufactured by Novartis under the trade name Gleevec® in the United States, imatinib is a small molecule derived from the phenylamino-pyrimidine class of lead compounds that has been shown to inhibit the activity the activity of the BCR-Abl fusion product by impeding autophosphorylation of the BCR-Abl intracellular domains (Traxler, *et. al.*, 508). As 95% of patients suffering from CML and 10-15% of acute lymphoblastic leukemia (ALL) patients have overactive BCR-Abl receptors, imatinib has been tested extensively for its therapeutic properties in these patients (Traxler, *et. al.*, 507). Clinical trials conducted from 1998 to 2002 have shown imatinib to be safe, producing fewer side effects than standard leukemia therapy. Clinical trials assessing the efficacy of imatinib have shown remarkable results, with a 1998 study reporting a 100% remission in hematological leukemia effects. Further studies reported in 2002 showed similar results: 88% of patients experienced a complete hematological remission. A comparison of survival rates of patients taking imatinib with standard therapy versus patients on standard therapy only showed that imatinib improves such rates: 78% of patients on imatinib were living after one year after the start of treatment compared to only 65% on standard therapy alone (Drevs, *et. al.*, 114). Current clinical trials are focusing on studying the effects on imatinib on other hematological and epithelial cancers whose etiologies closely match those of CML and ALL.

Trastuzumab

The work of cancer biologists indicated that the HER2 RTK was overexpressed in approximately 25% of metastatic breast cancer patients, indicating a role for a medication in selectively targeting and disabling cells with such a characteristic. In 1992, a research group headed by Paul Carter developed a humanized murine-derived monoclonal antibody named trastuzumab that could perform such a task (Vogel & Tan-Chiu, 4249), an antibody manufactured and marketed by Genentech under the trade name Herceptin®. Although the specific mechanism of action is not completely understood, it is believed that trastuzumab induces an increase in receptor endocytosis and degradation as well as marks cells with excess HER2 for immune cell-mediated destruction (Molina, *et. al.*, 4744). For breast cancer patients with cells expressing high levels of the HER2 receptor (HER2+), trastuzumab has been shown in many clinical trials to increase the effectiveness of standard chemotherapy. A trial conducted by Marty, *et. al.*, (4247) involving a trastuzumab/docetaxel combination versus docetaxel alone for breast cancer therapy revealed that the combination therapy yielded a longer survival time, 31.2 months, and a negligible increase in side effects over standard docetaxel therapy alone (survival time of 22.7 months). Trastuzumab monotherapy yields similar results: Phase III clinical trials for HER2+ breast cancer patients indicated a 17% response rate to therapy with few side effects. Combination therapy with cytotoxic agents led to an increased response rate (44% with paclitaxel and 53% with anthracycline) over cytotoxic agents alone (Schaller, *et. al.*, 522). Trastuzumab is fast becoming a standard component of therapy for HER2+ breast cancer.

Bevacizumab

Because of the highly vascular nature of many solid tumors, developing therapies that cut off the tumor cells from their vital supply of oxygenated blood is a major goal. The role of VEGF in the process of angiogenesis has

been closely studied for many years, studies that have led to the development of a monoclonal antibody that blocks excessive VEGF-mediated angiogenesis: bevacizumab. Manufactured by Genentech with the trade name Avastin®, bevacizumab works by binding to the VEGF molecule, preventing its interaction with the VEGF receptor that triggers the angiogenic process (Midgley & Kerr, 999). For patients suffering from renal cancer and colorectal cancer, clinical trials studying the safety and efficacy of bevacizumab have been quite promising. Phase I trials indicate that the drug causes a negligible increase in side effects over the level of side effects resulting from standard chemotherapy. Phase II trials for renal cancer showed that 64% of patients on the high-dose bevacizumab regimen and 34% on the low-dose regimen experienced no further cancer progression versus 20% for placebo. Phase II trials for metastatic colorectal cancer in which bevacizumab/5-fluorouracil/leucovorin combination therapy was compared to placebo indicated similar results: 40% of patients with the combination regimen experienced an anti-angiogenic response versus only 17% for placebo (Midgley & Kerr, 1000). Further studies of the uses of bevacizumab in combination with standard cancer therapies and in other solid tumors such as non small-cell lung carcinoma are currently being conducted.

Conclusion

Receptor tyrosine kinase (RTK) pathways shave been shown to be powerful regulators of cellular growth and division processes. Over the past decade, major strides have been made toward elucidating how the ligands, receptors and intracellular protein factors specifically interact with each other to influence gene expression and how they malfunction to cause cells to become cancerous. Three major examples of how RTK signaling proteins can cause cancer include the overactivation of the Abl receptor, implicated in chronic myeloid leukemia and acute lymphoblastic leukemia, overactivation of the HER2 receptor, implicated in breast cancer, and overexpression of VEGF, implicated in solid tumor-related angiogenesis. These unique characteristics of these cancers provide excellent targets for pharmaceutical therapy that can eliminate cancer cells while leaving normal tissues relatively unaffected. Three new drugs have been developed to inhibit the activities of these aforementioned RTK signaling components, drugs that are effective in stopping the progression of cancer and cause fewer side effects than standard therapy: imatinib mesylate, trastuzumab and bevacizumab. Even with these successes, advances in cell signaling and cancer research are being made every day, filling the pharmaceutical pipeline with promising new drugs that are safer, more selective and more effective at treating cancer.

The motto of the National Cancer, one of the world's premier cancer research institutions, is "to eliminate the suffering and death due to cancer by 2015" (von Eschenbach, 820). Perhaps, with these innovations in RTK signal transduction research, such a goal can be met.

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The Origins of Alzheimer's Disease

Bornali Kundu

Alzheimer's disease (AD) is a form of dementia that affects thought processes, memory and language. It is the most common form of dementia in individuals over 65 years of age but can also be seen in genetically predisposed family members as young as 35 years of age. On average, AD patients will live 8-10 years past diagnosis[1]; however, the origins of the disease have yet to be clearly confirmed. Hundreds of organizations such as the Alzheimer's Association and the National Institute on Aging fund research focused on understanding AD etiology and pathogenesis. This is a topic of significant controversy in biomedical research. AD can be characterized by an array of symptoms which makes targeting its origins difficult; however, recent research has presented three competing models. This paper will propose a solution or at least a simple mechanism describing the origins of AD as can be pieced together from the current literature. The model is a rather new, but hopefully a promising path for directing future research in order to cure and even prevent the onset of AD.

The human brain can be thought of as a network of pathways carrying information coded in the form of electrical pulses. These pulses are known as action potentials (APs) and propagate information, both sensory and motor, throughout the brain and central nervous system. The neuron is the basic cell type of the brain and central nervous system.

The neuron's structure is designed to transport and process signals. It receives information through its dendrites (branched network of extensions from the head of the cell body) and sends out information via its axon to the synaptic terminal at the axon's end. These billions of single signals passing through the nervous system and eventually attenuate in the brain. There the higher cognitive centers interpret the signaling as sensory feedback, motor control, thoughts, decisions and memories. Neurodegeneration, as a result of AD, results in destruction of higher order brain functions.

AD pathophysiology has previously been characterized by the build up of amyloid-Beta (Aβ) plaques, composed of extracellular Aβ peptide deposits, and neurofibrillary tangles (NFT), composed of *tau* protein aggregates, in the hippocampus.[1] Oxidative stress (OS) has recently been brought into the limelight as the newest possible origin of AD. All three theories explaining the origin of AD have large amounts of supportive data. However, recent research has uncovered new anomalous data that the first two theories cannot account for. The evidence strongly points to the idea that OS perhaps precedes all other chemical and mechanical phenomena in the brain (i.e. amyloid beta (Aβ) plaque deposition and NFTs) and is the true origin of AD.

The hippocampus is the primary memory processing center of the brain. It harvests the input signals from the rest of the body and sorts them in specific synaptic pathways to form memories. The Aβ protein is a neuronal growth factor and is present in all cells, normal and AD alike. It is derived from the amyloid-beta precursor protein (APP) and cleaved by *presenillin-1 (*PS1) and *presenillin-2 (*PS2) enzymes. Aβ protein promotes cell survival and is observed to increase rapidly with repetitive head injury.[1] However, early-onset AD patients show mutations or genetic defects of the APP, PS1 and PS2 genes which result in mutant Aβ fragments that tangle to form highly cross-linked plaques.[1] Wang *et al*.[4] hypothesized that Aβ fibrillar clusters may interfere in synaptic transmission marking AD onset. However, based on recent

literature, this view point is becoming insufficient in explaining many observed phenomena. For example, in a review published by Varadajan *et al.*[5], it was shown that the sole presence of completely aggregated Aβ plaques or fibrils did not correlate with increased AD symptoms. In fact, it appeared that the cross-linking reaction of plaque formation actually had a protective effect on the neurons and shielded them from free radical attack in the brain. The question arises, is Aβ protein (not yet formed into plaques) necessary and/or sufficient to cause AD pathogenesis alone? The answer is no.

NFTs are the other visible, physiological trait of AD and are intracellular, as opposed to Aβ plaques which are extracellular. NFTs form when the protein *tau*, normally involved in maintaining the scaffolding network that houses other cellular organelles, begins to tangle with other *tau* threads. These tangles then proliferate and cause massive damage to neuronal connections and, eventually, whole brain atrophy.[6]

The first hint that *tau* protein may cause AD versus other candidates such as Aβ came from a landmark study published by Takashima *et al.*[7] in 1993. The study looked at the biological role of *tau* protein kinase (TPK I), an enzyme that modifies *tau* protein in the cell. The study found that Aβ plaques are present all over the AD afflicted brain and with it are varying amounts of *tau* protein. However, Aβ existing by itself in the brain does not cause programmed cell death (also known as apoptosis) as is seen in the presence of both proteins. It concluded that NFTs created from the *tau* protein, not Aβ plaques, were a good indicator of AD brain damage and that the mechanism for TPK I must be explored further.

In 2002, Stamer *et al.*[8] identified the mechanism with which *tau* protein works to cause increased production of toxic Aβ and OS. As mentioned above, *tau*-protein is involved in stabilization of the extracellular matrix and organelle transport along the axon. Overexpression of *tau* causes transport retardation and halts the growth of neurons, thereby reducing their ability to connect to each other, and creating a weaker signaling system in the brain. Without the necessary nutrition and fuel (all of which gets trapped in the cell body, the axon and dendrites begin to degenerate and free radicals are generated due to lack of peroxisomes. This leads to OS and neuronal degeneration.

The mechanism is sound, but one question remains: What mutates *tau* protein resulting in potential overexpression? It cannot be an innate mutation because AD is an aging related disease meaning that the patient is perfectly normal throughout the first half of life and develops the symptoms only later in life. In 2005, So-Young Park *et al.*[9] brought up an interesting observation in their study looking at *tau* and Aβ in the brain. They agreed with Takeuchi in that *tau* mediates Aβ toxicity. In addition, they observed *tau* degeneration via caspase-mediated cell death in presence of pre-aggregated Aβ (meaning pre-folded Aβ protein). This would connect the model presented by Valadarjan *et al*. with *tau.* However, no degeneration was observed with properly aggregated Aβ that forms the cross linked plaques. Degeneration was observed on neuronal and non-neuronal cells in presence of *tau* expression. Yet here the question remains is *tau* "necessary" and/or "sufficient" to produce AD pathogenesis? Again the answer is no.

In a unique study conducted by Riley *et al.*[10], in 2002, the amount of AD pathology present in postmortem brains was quantified and corresponding cognitive status before death was assessed. The participants were part of the Nun Study, conducted within the School of Sisters of Notre Dame, and lived in various part of the United States. The participants were all women between the ages of 76 and 102 years old (with the oldest member surviving 107 years). They lived together in a community environment and actively took part in vigorous exercise routines and daily intellectual stimulation. Additionally these women exhibited a range of cognitive function from intact function to mild dementia (as quantified using the Braak sys-

tem). In other words, they did not exhibit the characteristic signs of AD present in most elderly. After death, the donated brains of the sisters were examined and the results are truly astounding. The brains appeared to be completely afflicted with the traditional pathophysiology characterizing full onset AD including mass amount of plaques, NFTs and whole brain atrophy. A particularly impressionable example is Sister Martha's condition as presented by a follow-up study conducted in 2003 by the same group lead by David Snowdon. Sister Martha was active for the 105 years of her life and perhaps as a result remained dementia free. Her brain autopsy showed stage 4 (moderate to high) severity AD pathology. This evidence rules out the idea that either Aβ plaques, NFTs or a combination of both are sufficient to cause AD. This also raised the question, how did individuals with severe neuropathologic attributes avoid the clinical manifestations of the disease?

One answer lies in the distinctly different lifestyles of the sisters as compared to the normal geriatric populations. Up until the end of life, the sisters all enjoyed very active lifestyles both physically and intellectually. They participated in aerobic and cardiovascular exercise three times per week as well as regular literature discussions, debates and additional academic courses. It has been established through numerous health and fitness studies that intellectual activity along with vigorous exercise reduces oxidative stress in the body.[11] This crucial point shall be revisited later in the discussion. As previously mentioned, OS has recently been characterized as a strong potential candidate for initiating AD onset.

Oxidative stress refers to the level of oxidative damage in cells, tissues, or organs, caused by reactive oxygen species (ROS). ROS, such as free radicals and peroxides, are a class of highly reactive molecules derived from both endogenous sources, such as mitochodria producing energy and the liver's detoxification reactions, and exogenous sources, such as cigarette smoking, air pollutants and alcohol. ROS randomly pull electrons from different amino acid sequences in cellular DNA thus mutating it and destroying future protein structures (DNA is the code that the cell uses to make proteins). OS is reduced by antioxidants that degrade free radicals into harmless neutral states. Organisms receive a large amount of antioxidants from food sources. OS occurs all over the body but has been seen to have particular presence at synaptic junctions (the sites where two neurons form a communication connection) as presented in the study done by Stamer *et al.*[8] and also at the sites where neuronal blood vessels and neighboring neurons form connections as presented in a study done by Williams *et al.*[12] in 2005.

In 2000, Varadajan *et al.*[5] published an extensive re-

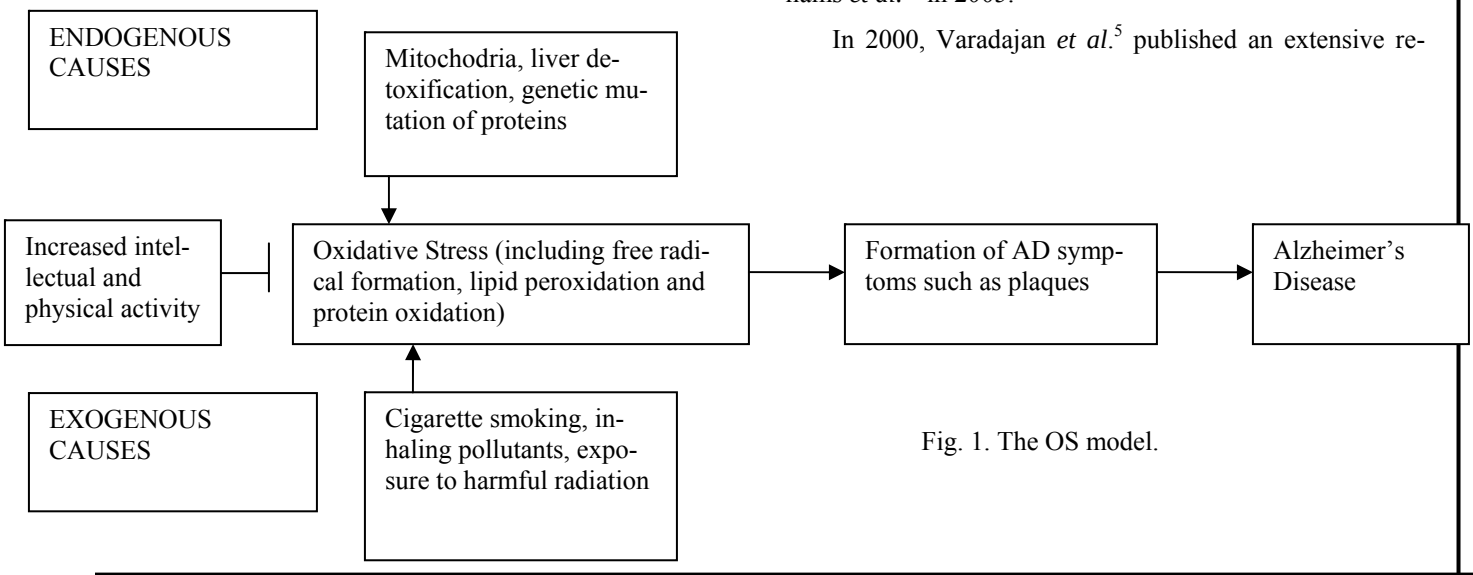

Fig. 1. The OS model.

view covering AD Aβ associated free radical OS. In the report, they proposed a mechanism for AD claiming that pre-aggregated Aβ in contact with metal ions would produce free radicals leading to OS, disturbance of the calcium homeostasis and ultimately cell death. But once aggregated, the Aβ proteins have formed plaques and therefore cannot produce and release additional toxins. As mentioned above, the plaques may even help protect neurons against OS. The source of Aβ toxicity came from the pre-aggregated Aβ and metal ion complex which produces free radicals. The free radical products plus pre-aggregated Aβ result in lipid peroxidation and oxidation in the brain. The mechanism is pictured in Fig. 2. The APP gene that expresses Aβ protein is present in the body naturally. The process of Aβ aggregation is also a natural pathway the protein would take. As mentioned, the presence of plaques is not sufficient to cause AD. However, the production of free radicals is a process that can be enhanced with unhealthy habits such as smoking and exposure to harmful radiation. In other words, the recent compilation of research would indicate that generation of free radicals is the main cause of OS, not Aβ. Aβ plays a vital role in producing the OS that would drive AD pathogenesis, but the initial presence of the free radicals is the real causation.

In 2001, Pratico *et al.*[14] confirmed that OS precedes the formation of aggregated Aβ deposition *in vivo* using highly sensitive biomarkers in a mouse model of AD. They reasoned that the central nervous system (CNS) is particularly vulnerable to OS because of its high energy/ oxygen requirement and low-efficiency antioxidant defense mechanism. Again in 2004, Ghanbari *et al.*[15] confirmed OS precedes any clinical and pathological manifestation of AD through human olfactory neurons in culture. They found lysosomal structures (the garbage disposals of cells that contain the free radicals that break down food particles) in an astounding 100% of AD affected cells. CNS OS manifests itself as lipid peroxidation (LPO) – fatty acids are more susceptible to becoming free radicals. Early and continued increase of LPO radicals in mouse hippocampal and cortical regions of the brain were found to consistently be followed by Aβ deposition in the same regions. In other words, Aβ deposition follows OS. OS can also be triggered by the incorrect folding of proteins within the endoplasmic reticulum (organelle that modifies protein formation).[16] Hayes *et al.*[16] showed that repeated incorrect folding of proteins "overworks" the body's natural mechanism to fix the mistakes, which results in accumulation of free radicals, which causes apoptosis resulting in neurodegeneration (a symptom of AD). In 2004, Li *et al.*[17] used manganese super oxide (MnSOD), a gene that knocks out a critical free radical reducing enzyme (MnSOD increases free radical concentrations), to show increased Aβ levels compared to MnSOD wild-type (with normal amount of MnSOD expression). This gives Aβ an additional role as a free radical-reducer.

Methods to reduce OS and free radical generation include changes is lifestyle and environment. Natural food sources of antioxidants (which break down free radicals in the body) include curcumin (a spice), vitamin-E, raw liver and ginko-baloba extract[1]. The effects of a healthy lifestyle can be seen in the Nun Study. A clinical study done by Myazaki *et al.*[11,] in 2001, shows that strenuous exercise lowers levels of free radicals and increases antioxidant activity in the blood. Vitamin E has been shown to inhibit free radical generation and toxicity of neurons in the hippocampus, the area of the brain involved in learning and memory, and is most closely associated with AD. Estrogen has also been shown to slow free radical reaction rates. As a result, women are advised to undergo estrogen replacement procedures after menopause. Additional sources of OS are also being explored.[1] Both astrocytes making up the blood brain barrier and brain endothelial cells making up the blood vasculature of the brain are also potential sources of OS.

Research is continuously uncovering pathways that

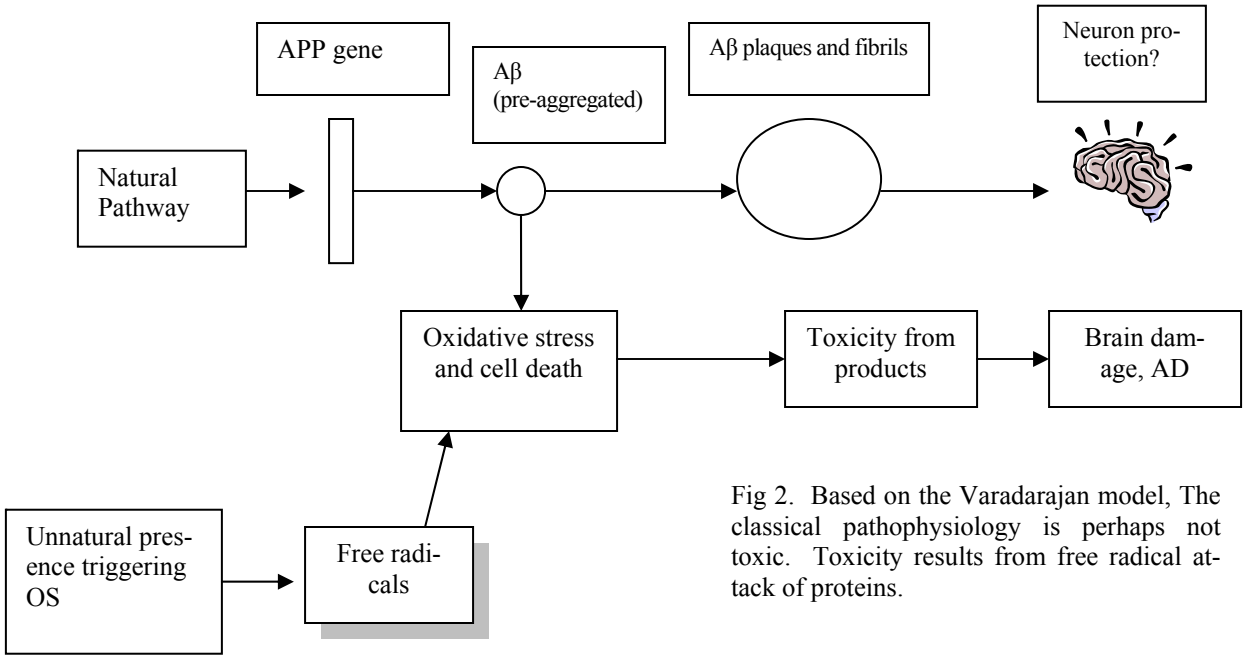

Fig 2. Based on the Varadarajan model, The classical pathophysiology is perhaps not toxic. Toxicity results from free radical attack of proteins.

may point to the main cause of AD. For now, recently developed theories about OS are most frequently and thoroughly investigated, as OS seems to precede gene mutation and general disruption of natural bodily processes. It is possible that, because they are effective in reducing OS, antioxidants may be equally effective in controlling the effects of AD. The hope is that by understanding the original mechanisms of OS, we may be able to prevent the onset of AD specific symptoms.

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Dimensional Accuracy and Strength of Rapid Prototype Casting Molds Made by the 3-Dimensional Printing Method

Aaron Johnston-Peck

Abstract

Rapid prototyping allows fabrication of complex components directly from a 3D computer model. The capabilities of various rapid prototyping methods to generate complex shapes have been well documented. However, the dimensional accuracy and functionality of the end product are often not reported. The goal of this investigation was to determine the dimensional accuracy and strength of sand molds made by the 3-D printing method. These molds can be used to cast aluminum, magnesium and other low temperature alloys therefore are an attractive method for rapid prototyping of castings.

The Z Corporation ZPrinter 310 with a zb56 binder and ZCast 501 powder (both proprietary) were used to make sand molds and test bars. The test bars were used to characterize the material's tensile and bending fracture strength. The maximum bending fracture strength of baked material was found to be 50.64 ± 7.75 *psi*. The maximum tensile strength of the baked material was found to be 41.60±9.93 *psi*. While the strength of the 3-D printed baked sand is less than typical no-bake mold sand, it is sufficient to withstand casting conditions of light metals. The maximum dimensional deviation of the cast parts from the CAD (computer aided drafting) model (the ideal dimensions) was found to be approximately ±2 percent. Printing features smaller than 0.15 inches (0.38 cm) resulted in larger dimensional deviations. The dimensional accuracy is anisotropic, showing dependency on printing direction. Nevertheless, the dimensional variations are within the normal tolerances encountered in sand casting. 3-D printing is therefore a viable method for rapid prototyping of dimensionally accurate aluminum castings.

A method of combining rapid prototyping with traditional sand molding was developed. The traditional mold incorporates the gating and riser system necessary to make a sound casting. The rapid prototype mold acts as a core, and includes only the complex casting.

Introduction

Rapid prototyping has made in recent years inroad in production of short-run parts. A number of systems to produce rapid prototypes are commercially available. The most common are described in this section. The flow chart in Fig. 1 displays the steps of the rapid prototyping process.

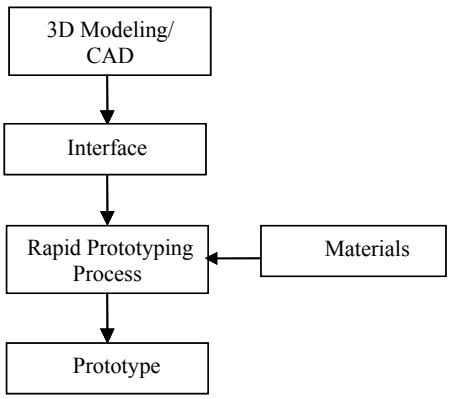


Figure 1. The Rapid Prototyping Process (Kochan, 17).

A computer model of the desired piece is generated in a three-dimensional modeling CAD program such as AutoCAD or Pro/Engineer. The CAD file is converted to a STL extension (STL stands for stereo-lithography; it is the common format used for all rapid prototyping interfaces (Grimm, 393)). The STL file is loaded into the specific rapid prototyping machines interface. The interface software performs the necessary operations to convert the STL file and run the machine.

Selective Laser Sintering (SLS)

In this method, a layer of powder is first deposited on a support platform by a blade or roller. This blade or roller moves fresh powder from the powder tank to the building area. A computer-controlled laser beam then traces out a two-dimensional cross-section of the part, selectively sintering (fusing) the layer together. The build platform then moves down by a one layer increment. A new layer is then sequentially deposited and sintered. After finishing the part, the un-sintered powder, which helps support the part during the process, is removed (Grimm, 166). To obtain non-porous surfaces, the part is infiltrated with an inflitrant, either an epoxy, wax, or resin (Grimm, 176). Capillary action drives the infiltrant into the open pores.

Three-Dimensional Printing (3DP)

3DP is an extension of 2-Dimensional ink-jet printing devices. The approach is to build the part layer-by-layer by jet printing a thin powder layer with a binder material. After the entire part has been printed, the unbound powder is removed and the part is cleaned (Grimm, 170). The part may be treated with an infiltrant (Grimm, 176). Though parts used for casting should not be infiltrated with anything because gas may result.

The aforementioned rapid prototyping techniques offer time saving over conventional machining process. However, they still have some limitations. Both SLS and 3DP involve many different steps as illustrated in Fig. 2. Consequently, dimensional control of the final part can be difficult. The geometrical accuracy and part stability are difficult to guarantee especially in complex components. Often, only simple shapes can be fabricated (Lewis, 3). A comparison of some of the properties of parts made by these methods is shown in Table 1.

In addition, the costs of equipment and materials in these rapid prototyping techniques are still high primarily because specialized equipment is required. Also some fabrication of large parts can take several hours in approaches which build the part layer-by-layer. The high costs and long fabrication time are some of the barriers that have limited a wider commercial use of these rapid prototyping techniques and must be resolved for mass-marketing.

Experimental Procedure

Three-point bending tests and tensile tests were employed to test the strength of the mold material. The three-point bending test used 3”x1”x.5” (7.62x2.54x1.27cm) test bars. The bars were printed on the ZPrinter 310 using ZCast 501 as the powder and Zb56 as the binder. All the defaults of the ZPrint 6.2 software were used. Ten bars were oriented in the Z direction; another ten were oriented in the Y direction. 5 bars printed in the Z direction and 5 of the bars printed in the Y direction were baked for 7 hours at 230 ºC. Twenty test bars were also made from no-bake sand process. These bars were made with a wood core pattern and had the same dimensions as the printed bars.

An Instron 1125 Low collecting data with MAC Workbench was used to run the three-point bending tests. The distance between the two bottom supports was 2 inches (5.08 cm). The cross-head or third point moved at a rate of 0.5 mm/min and data points were taken every 0.5 seconds. The tensile tests briquettes were designed according to the AFS Mold and Core Test Book sections 11-2 and 11-3. The briquettes were printed on the ZPrinter 310 using ZCast 501 as the powder and Zb56 as the binder. All the defaults of the ZPrint 6.2 software were used. Thirty briquettes were printed, 15 were oriented in the Z direction, 15 in the Y direction. Five of each orientation direction was left unbaked. Five of each direction was baked for 7 hours at 230 ºC. The remaining five of each direction were baked for 8 hours at 200 ºC.

The dimensional accuracy of aluminum 356 castings made from molds printed with the ZPrinter 310 was measured using a Romer CimCore Stinger II Coordinate Measuring Machine. The relatively small 8” x 10” x 8” build envelope of the Z310 precludes rapid prototyping of large

Table 1. Some properties of rapid metal tooling process (Karapatis *et al.*, 86)

	Density	Strength	Accuracy	Flexibility
Selective laser sintering	≈ 60% raw	100-200 MPa	≈ 100 μm	Medium
	≈ 80% infiltrated	For nickel-bronze powder		
Laser generating	> 90%	Near cast material	> 100 μm	Good
Three-dimensional printing	≈ 60% raw	Lower than cast material	Not available	Good
Machining	100%		25 μm – 50 μm	

molds with risers, sprues and gates. This study therefore utilized the ZPrinter prototype as a core. The rest of the mold (sprue, gating system, and riser) was made with a traditional no-bake. In other words, the Z310 is used to print a core, which would be inserted into a no-bake mold that provides the sprue, gates and riser necessary to obtain a sound casting. This concept is illustrated in Fig. 2(a) showing the drag (bottom side of the mold) with the core cavity. The fanned gate leading the metal to the cavity is also shown. Fig. 2(b) shows the printed core that fits into the cavity. The details of the part are incorporated in the printed core while the sprue, gating and riser system are provided by the traditional no-bake mold. The casting produced with this mold is depicted in Fig. 2(c).

Results and Discussion

Strength

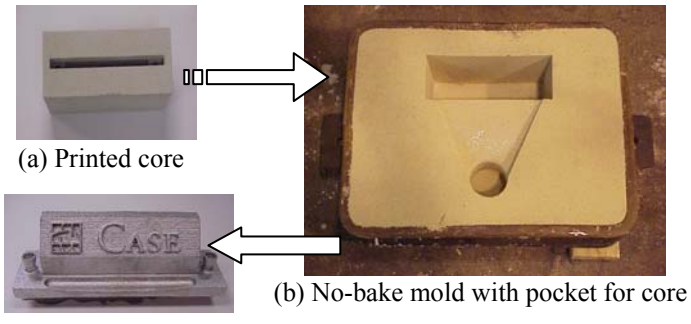
The data collected from the three-point bending tests was used to calculate the fracture strength. The maximum load applied to test bar before fracture was recorded during the test and used to calculate the fracture strength according to the following equation:

$$\sigma_{Fracture\text{-}Strength} = \frac{3FL}{2bd^2} \qquad (1)$$

where F is the maximum load, L is the distance between the supports, b is the width of the bar, and d is the height of the bar. The average bending fracture strength of the mold material derived from the data collected in the three-point bending tests is displayed in Figs. 3 and 4.

The no-bake sand was included as a baseline. No-bake is a common two-part binder (for our study we used Ashland Lino-cure) method used in making sand molds. The printed baked molds are weaker than the unbaked molds. Baking is necessary to remove the organics. The organics transform into gases when in contact with the molten metal, leading to detrimental porosity within the casting. The molds are stronger when printed horizontally. This indicates the intra-layer bonding is much stronger than the interlayer bonding. Printing horizontally reduces the number of layers and produces a stronger mold by decreasing the dependency on interlayer bonding which is weaker than intra-layer bonding.

The tensile strength of the mold material was calculated using data collected from the tensile tests. Dog bone test shapes were printed according to ASTM standards. The maximum load from the test was recorded. The maximum load applied to each dog bone shape is tabulated in Table 2. The maximum load data was used in the



(a) Printed core

(b) No-bake mold with pocket for core

c) Casting

Figure 2: Steps in casting of an aluminum rapid prototype with the 3-D printing method.

following equation:

$$\sigma = \frac{L}{A} \qquad (2)$$

where L is the maximum load applied and A is the area. The average tensile strengths of the mold material derived from the data collected from the tensile tests are displayed in Figures 5-7. As in the three-point bending tests, the no-bake molds have a higher tensile strength then the unbaked test specimens. The horizontally printed shapes are once again stronger, reinforcing the finding that the intra-layer bonding is stronger than interlayer bonding. Tensile strength increases up to a maximum and then starts to decrease. This may be a result of exposure to humidity in the air that weakens the material.

Another factor which comes into play in determining the strength is the temperature at which the material is baked at. Figure 7 displays the tensile strength dependence on temperature. A high temperature causes the binder to decompose and reduces the strength. A lower temperature removes the organics at a slower rate and increases baking time necessary. If the temperature is very low the organics will not be removed at all. A temperature approximately of 200 ºC prevents breakdown of the binder while still efficiently removing the organics.

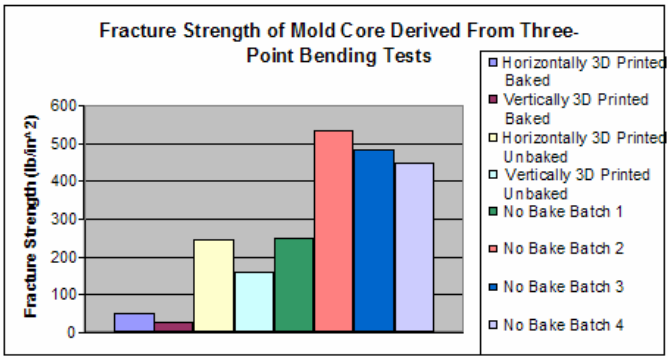


Figure 3: Comparative bending fracture strength of printed vs. no-bake sand.

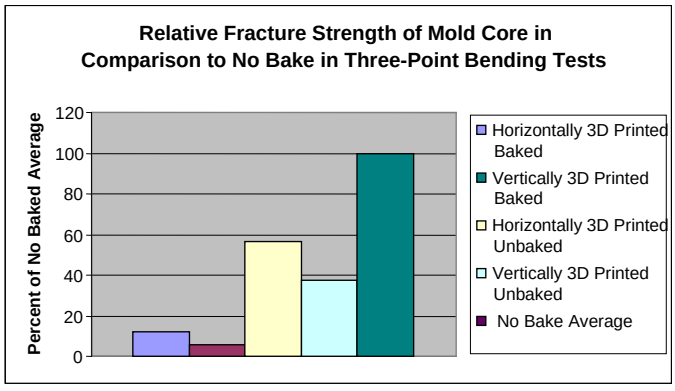


Figure 4: Normalized values of the bending fracture strength.

Dimensional Accuracy

The cast parts were measured and compared to the CAD file from which they were printed. The fourteen dimensions measured ranged from 0.07 to 7.75 inches (0.18-19.68cm). The percent deviation from the ideal dimension for each of the Case Plaque series of parts is shown in Figure 8. Measurements taken from the first two plaques indicated negative deviations from the CAD model dimensions. This is a most likely a result of shrinkage the metal underwent during cooling. Scaling factors were applied to the CAD model to offset this shrinkage. The scaling factors applied to each plaque are detailed in Table 4. Applying a scaling factor allows most measurements to be brought within a deviation of ±2 percent or better for most dimensions. Two measurements (9 and 10) displayed larger deviations from the CAD model even after the scaling factors were applied. Both these measurements were in small features, less than 0.15 inches (0.38 cm). Such deviations are typical of sand molds in general, not just limited to sand molds produced from rapid prototyping. The molten metal flows in the mold at relatively slow rates and low pressures because the flow rate and pressure is determined by sprue height and diameter. Since the pressure is low along with a slow flow rate the metal may solidify before the mold is completely filled, causing these large deviations.

Conclusions

A rapid prototyping method has been developed that combines the capability of 3-D printing to produce a com-

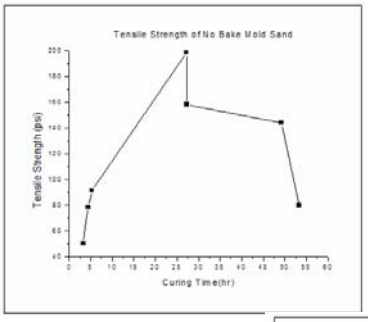


Figure 5. Tensile strength of no-bake sand for various curing times.

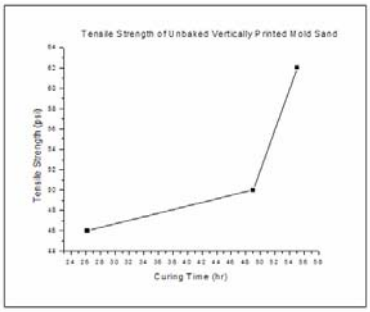


Figure 6. Tensile strength of printed sand for various curing times.

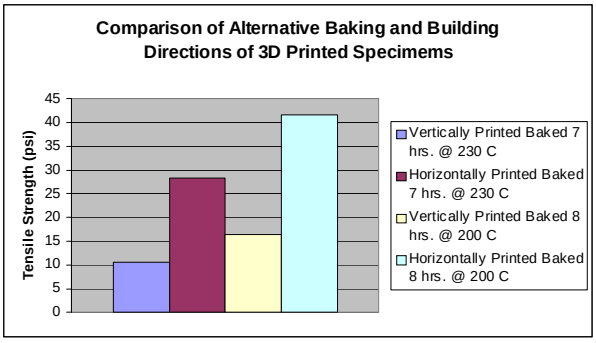


Figure 7. Comparative tensile strength in different directions of the printed specimens.

plex core with the ease and low cost of making no-bake molds. Jointly they can make low-cost, high integrity, complex castings.

Cores made with the 3-D printer are not as strong as no-bake cores. The direction of printing can make a significant difference in the strength in specific directions of the part. This is due to the way the binder is applied onto the sand layers during build-up of the part. The temperature at which the material is baked plays an important role in strength. However, by using the printed cores inside a no-bake mold that provides ample support, the lower strength of the printed cores becomes less important.

A correction factor has to be applied to the rapid prototype mold to offset the dimensional changes during curing of the mold, and shrinkage of the molten metal during solidification. These factors may be different in different directions of the mold and have to be customized for every casting. The dimensional accuracy can be expected to be within a range of approximately ±2 percent deviation from the CAD model. Features under approximately 0.15 inches (.38 cm) may experience larger deviations due to premature solidification of the metal.

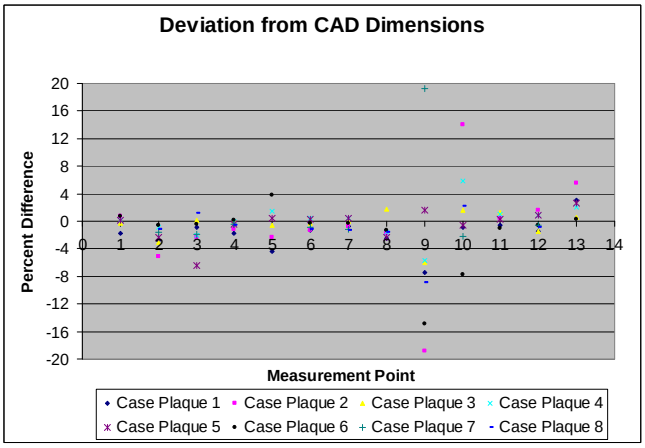


Figure 8. Dimensional deviation of the castings from the CAD model.

Appendix

Table 2. Maximum load applied to the sand test bars leading to fracture.

Bar Type	Max load (lb)	Bar Type	Max load (lb)	Bar Type	Max load (lb)	Bar Type	Max load (lb)
3D Baked Horz	5.1	3D Baked Vert	2.5	3D Unbaked Horz	22.4	3D Unbaked Vert	13.7
3D Baked Horz	4.2	3D Baked Vert	2.1	3D Unbaked Horz	18.4	3D Unbaked Vert	12.8
3D Baked Horz	4.4	3D Baked Vert	1.9	3D Unbaked Horz	21.7	3D Unbaked Vert	13.4
3D Baked Horz	4.1	3D Baked Vert	2.1	3D Unbaked Horz	19	3D Unbaked Vert	13.5
3D Baked Horz	3.3	3D Baked Vert	2.1	3D Unbaked Horz	19.8	3D Unbaked Vert	13.2
No Bake Batch 4	44.8	No Bake Batch 2	46.8	No Bake Batch 3	43.9	No Bake Batch 1	21.2
No Bake Batch 4	49.7	No Bake Batch 2	60.4	No Bake Batch 3	49.9	No Bake Batch 1	24.3
No Bake Batch 4	30	No Bake Batch 2	51.6	No Bake Batch 3	42	No Bake Batch 1	N/A
No Bake Batch 4	45.4	No Bake Batch 2	53.2	No Bake Batch 3	49.7	No Bake Batch 1	24.2
No Bake Batch 4	48.5			No Bake Batch 3	56.6		
				No Bake Batch 3	42		
				No Bake Batch 3	46.2		

Table 3. Curing time of the briquettes.

Briquette Type	**Number of Briquettes**	**Curing Time (hr)**
Unbaked Printed, Y direction	3	1.0
Unbaked Printed, Y direction	2	48.6
Unbaked Printed, Z direction	2	26.25
Unbaked Printed, Z direction	2	49.0
Unbaked Printed, Z direction	1	55.1
Baked (7 hr) Printed, Z direction	5	44.7 (before baking) 5.5 (after baking)
Baked (7 hr) Printed, Y direction	5	67.0 (before baking) 5.5 (after baking)
Baked (8 hr) Printed, Z direction	5	22.6 (before baking) .7 (after baking)
Baked (8 hr) Printed, Y direction	5	22.6 (before baking) .7 (after baking)
No-Bake Batch 1	4	5.3
No-Bake Batch 1	1	53.3
No-Bake Batch 2	3	27.3
No-Bake Batch 2	2	49.2
No-Bake Batch 3	3	3.3
No-Bake Batch 3	2	27.2
No-Bake Batch 4	5	4.4

Table 4. Scaling Factors applied to each printed mold

	X	Y	Z	Mold Wash
Case Plaque 1	1	1	1	no
Case Plaque 2	1	1	1	no
Case Plaque 3	1.01	1.01	1.01	no
Case Plaque 4	1.01699	1.01699	1.00722	no
Case Plaque 5	1.01699	1.01699	1.00722	yes
Case Plaque 6	1.015875	1.01159	1.015997	no
Case Plaque 7	1.016	1.013	1.0599	no
Case Plaque 8	1.016	1.013	1.016	no

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Risky Business: Playing Fast and Loose with a Suspicious Antiquity, the Ethics of Collecting, and Public Trust at the Cleveland Museum of Art

Katie Steiner

It was a brisk spring evening in Geneva, Switzerland, with the cool, white disk of the sun sinking slowly toward the horizon against an unseasonably portentous gray sky. As the work day drew to a close, an army of figures flooded into the once quiet, cobblestone streets, and a strong gale rising from the direction of the great churning lake nearby forcefully buffeted the individuals in the crowd along their journeys home. But one member of this swirling mass of bodies straining against the elements sought not the respite from long hours of toil—rather, for him, the day's work was just beginning.

Traversing the meandering, wind-whipped city streets with an unassuming air, the lone figure belied not only the special importance of his mission, but also the wealth, power and prestige of the institution he represented. As a curator of ancient art at one of America's most well-respected and richly endowed museums, the man was on a purchasing expedition. His charge was to scout the galleries dealing in classical art in Geneva, an important hub in the antiquities market, with the hopes of discovering a unique work of outstanding quality to augment the museum's already notable collection.

With potentially millions of museum dollars to be spent upon his recommendation, and the opportunity to cement his reputation within the scholarly community as a first-rate connoisseur, the curator had undertaken his assignment with great optimism and anticipation. However, his high aspirations had been met thus far with disappointment. To be sure, the dealers he visited in the past days had offered him a veritable hoard of superb objects, but he was looking for something more—a single work of transcendent beauty and force, of masterful skill, and of quality far surpassing the extraordinary.

Unwilling to accept failure in his mission, the curator determinedly navigated his way along the blustery Geneva streets toward one last after-hours appointment with a dealer. Upon reaching his destination, the curator paused briefly before the gallery's imposing stone façade, barred windows, and enormous vault-like door, and wondered whether he had encountered a fortress or a showroom for art. Taking a deep breath, he reached out his hand, rang the bell, and waited to be admitted. "This had better be good," he thought.

After a momentary interlude, the massive door heaved open to reveal the dark-featured, smartly dressed gallery proprietor. He greeted the curator with a smile and gestured for him to enter. As the curator stepped across the threshold, the dealer turned on his heal and swiftly lead his visitor down a narrow corridor, past the main showroom, and into the gallery's cluttered back storeroom. "We only do this for special clients," said the dealer with a sly grin.

Accustomed to being granted such privileged access, the curator calmly proceeded to survey the menagerie of artifacts that surrounded him. Almost immediately, however, his gaze fell on one peculiar object near the center of the room, which was enshrouded entirely in an opaque black veil.

"What's under there?" inquired the curator, motioning toward the mysteriously obscured object.

"Ah, that's a very special piece that I hesitate to part with just yet," replied the dealer. "Perhaps I can interest you in something else over here . . ."

"No, I must insist," continued the curator. "May I have a look?"

Nodding his consent, the dealer strode toward the object, and, seizing hold of the black shroud, whisked it free

in one sweeping motion of his arm.

The curator reeled in astonishment at the sight revealed before him. He could hardly believe his eyes, for resting quietly in the center of the room was a life-size bronze figure of a nude god by one of the greatest of all ancient Greek sculptors. This particular work had been known to scholars through ancient texts and surviving Roman marble copies, but an original version in bronze, perhaps even by the hand of the artist himself, had never before been encountered—at least until now.

The curator stood thunderstruck not only by the work's stunning visual appeal, due to its sinuous lines, elegant pose, and placid expression, but also by the great fortune of encountering such an unparalleled gem. Sinking into a nearby chair, he took a moment to catch his breath and regain his composure. As thoughts continued to swirl through his mind, the curator nevertheless forged his resolve on one key issue: he knew that he had to have the object.

It sounds perfect, doesn't it? An intrepid collector seeks to purchase an ancient work of art, stumbles upon a tremendous find, and then acquires it on behalf of his museum, where it will stand in perpetuity as a monument to a bygone culture for the enjoyment and education of all. Indeed, this simplified notion of antiquities as treasures to be sought after and placed on display is pervasive in society, thanks in large part to the depictions of archaeologists and art collectors in the popular media. After all, in the famous opening scene of Steven Spielberg's 1981 film *Raiders of the Lost Ark*, audiences are supposed to applaud Indiana Jones as he cunningly attempts to acquire a precious golden idol for a Western collection. While certainly no fault exists in admiring the achievements of past civilizations, even when it comes to the imaginary ones in Hollywood films, extended contemplation of the scene raises several questions. For instance, was the idol merely a treasure for the taking, and how should we feel, particularly from our more globally-sensitive, modern perspectives, about the manner in which it was acquired? Specifically, did our hero Indiana have permission to remove the idol from its country of origin? Did he consider the wishes and feelings of the local population? Did he document the find, its exact location, and its condition? Finally, did he take note of any other objects, paintings, or carvings in the vicinity to help interpret the meaning and significance of the work within the culture that produced it?

The scenario of the curator and the ancient Greek sculpture lends itself to a similar set of questions. On the surface, the desire of the curator to purchase a high-quality work for the museum's collection and the education of the public seems unproblematic, even laudatory. However, upon further reflection, a number of important issues arise. What is known about the origin of the sculpture? Who owned it in the past, and by what means did it arrive in Geneva? Who is the dealer, and can he be trusted? In the end, how big of a risk, from a legal, financial, and public relations standpoint, does the museum undertake in purchasing the work, should any claims from foreign governments arise to challenge its status as a legally exported item?

Along with the episode paraphrased from *Raiders of the Lost Ark*, the story of the curator and the classical sculpture is perhaps unproductive to investigate, given that it is only a fictional account. Nevertheless, the scenario is not wholly divorced from reality. On June 22, 2004, the Cleveland Museum of Art, self-proclaimed as ". . . one of America's leading comprehensive museums," made headlines when it acquired the *Apollo Sauroktonos ("Lizard Slayer")*. This exceedingly rare, life-size bronze statue is currently attributed to Praxiteles, a fourth century B.C. sculptor identified as one of the greatest artists of the Greek Classical period ("News Release"). The work was first shown at a gallery in Geneva, Switzerland in April

2003 to Michael Bennett, the museum's curator of Greek and Roman art. In the words of Bennett, who originally encountered the *Apollo* in the dealer's shop swathed in a black veil, the acquisition has been " '. . . by far the most exciting thing that has ever happened to me in my professional career' " (Litt, "Apollo" A1). The curator's enthusiastic response to the *Apollo* was echoed by then-museum director, Katharine Lee Reid, who noted that the work " '. . . is of great scholarly and educational significance . . .' " and that the purchase " '. . . is in keeping with our mission to further the research and understanding of art . . .' ". In addition, the sculpture was hailed by David G. Mitten, professor of Classical Art and Archaeology at Harvard University, as " '. . . the most important work of Classical sculpture to come to light and be acquired by a North American art museum since World War II' " ("News Release").

Despite the positive reactions of some to the purchase of the *Apollo*, other scholars have taken issue with the museum's decision to acquire the piece. The primary points of contention center on the work's incomplete, undocumented, and otherwise suspicious provenance, or ownership history. According to the museum, the sculpture was formerly located on the property of a retired German lawyer, who sold it to an unknown dealer in 1994. Exactly how the work made its way to the Geneva gallery from which it was purchased by the museum remains unanswered, as no paper trail exists (Litt, "A God of Myth"). Given the imperfect information accompanying the *Apollo*, Ricardo Elia, associate professor of archaeology at Boston University, has argued that " '[m]useums like the Cleveland Museum of Art are outrageous in their acquisition policies,' " since " '[t]he collecting of undocumented antiquities is what's driving the looting of archaeological sites everywhere' " ("Greek or Roman?"). Furthermore, Malcolm Bell, a professor of art history at the University of Virginia, has stated that the history attached to the work " '. . . sounds like the kind of fabrication that is made frequently in the market to provide a faked provenance' " (Litt, "A God of Myth").

So who are we to believe? Do we trust the museum's judgment regarding the truthfulness of the story accompanying the *Apollo*, and is the wish to acquire the work for the education of the public enough to overcome any suspicious conditions that may exist? On the other hand, how strongly do we weigh the concerns of scholars who fear that the work may have been recently and illicitly excavated, smuggled out of its country of origin and then given a false provenance to circumvent patrimony laws? Such questions are not simple to answer, but they are important to ask. The stakes for acquiring ancient objects with suspicious provenances are extremely high, since the collector faces the threat of legal entanglements and a public relations nightmare if the work is proven to have been illicitly removed. Furthermore, in buying an object that may have been stolen, the collector encourages other clandestine digs to take place, which is a practice that ultimately results in an enormous loss of information. Archaeologist Patricia C. Knoll comments that without scientifically conducted excavations, ". . . artifacts and other remains removed from their context lose most of what they can tell us about the past" (Knoll 193). In the end, the failure to collect such data limits the ability of archaeologists and ancient art historians to derive solid interpretations of cultures and their objects, and thereby threatens the very vitality of the fields.

Aside from the more philosophical reasons to question the museum's purchase of the *Apollo*, the potentially enormous investment required to bring the work to Cleveland also increases the need for careful scrutiny. Although the official price has not been disclosed, Cleveland Plain Dealer writer Steven Litt has reported that the museum ". . . discussed paying up to $5 million for the Apollo" (Litt, "A God of Myth"). Did the purchase of not only a controversial, but also highly expensive antiquity overstep the bounds of prudence? Could the museum have focused its efforts elsewhere to achieve similar, highly beneficial ends

with lower risks? Taking financial and other factors into consideration, such as the details of the work's history and the dealers who sold it, the nature of the art market, the policies regarding standards for acquisitions, and the role of art museums in society, we can attempt to arrive at a clearer answer to the main issue at hand: whether, in fact, the CMA should have purchased the *Apollo*.

Leading Us into Temptation

Before diving headlong into the rightness or wrongness of the CMA's actions, it is necessary first to gain a better understanding of the art historical significance of the *Apollo*, the sculptor who may have created it, and the subsequent allure the object posed to museum officials when it was offered for sale.

While a large degree of the work's attractiveness lies in its purely aesthetic qualities, the *Apollo* also carries an intense appeal because of the artist who may have been responsible for its execution. Praxiteles, to whom the sculpture is attributed, was an Athenian artist active from around 380 to 325 B.C., and is considered along with Pheidias, Polyclitus, and Lysippus as one of the greatest sculptors of the Greek Classical period. Although Praxiteles remains well-known to modern art historians, he also enjoyed a great deal of popularity and prosperity during his own lifetime. Producing accomplished works in both marble and bronze, the artist was esteemed for his versatility. In addition, Praxiteles introduced important sculptural innovations that helped to augment his fame and reputation ("Praxiteles"). While the fifth century architectural sculptures of the Parthenon possess a distinct "Pheidian grandeur," depicting deities as monumental and distant, Praxiteles instead humanized the gods by reducing their scale and presenting a more naturalistic treatment of their figures (Richter 177; "Praxiteles").

Praxiteles' most famous work is the *Aphrodite of Cnidus*, which dates from around 350 to 340 B.C. ('Praxiteles"). This marble figure, praised by Pliny as " '. . . the finest statue . . . in the whole world,' " depicts the goddess modestly covering herself with one hand and grasping a drapery in the other, which cascades onto a water jar at her side (Richter 200-201). Not only did the sculpture become one of the most well-known works in all of ancient Greece, but it also exerted a strong influence on the artist's contemporaries and led to the establishment of the nude Aphrodite as a popular subject ("Praxiteles", Richter 201). In addition to the high degree of fame garnered by the work, the *Aphrodite*'s importance stems from its demonstration of Praxiteles' characteristic style, which centers on languid, sensual figures posed in graceful, contrapposto stances ("Praxiteles"). Unfortunately, the original version of the sculpture no longer survives, but a number of Roman copies, including those in the Vatican, Brussels, and Munich, provide an accurate indication of how the artist's elegant yet naturalistic figure would have appeared (Richter 201).

As in the case of the *Aphrodite*, Praxiteles' *Apollo Sauroktonos* had been known only through Roman copies and textual sources. Writing in the first century A.D., Pliny comments in his *Natural History* that "[a]lthough Praxiteles was more successful, and therefore more famous for his marble sculptures, he nevertheless also created very beautiful works in bronze . . . He made a youthful Apollo called the *Sauroktonos* ("Lizard Slayer"), waiting in ambush for a creeping lizard, close at hand, with an arrow" ("Pliny"). From this description, scholars have identified several later reproductions, including the marble versions in the Louvre and the Vatican, and a smaller bronze copy in Rome's Villa Albani (Richter 201-202). Each work depicts the god as an adolescent, leaning with his left arm against a tree and poised with an arrow in his right hand, ready to strike an unsuspecting lizard climbing the trunk (Lawrence 188). This curious action of the figure may represent a mere genre scene of juvenile hunting. However, it also has been suggested that Apollo's activity may allude to his role as the god of medicine, since lizards

were believed to posses certain curative powers (Stewart 1: 179).

Unlike the extant Roman copies in Italy and France, the bronze *Apollo* encountered by Michael Bennett in Geneva is incomplete. The figure, standing at a height of 150 cm, lacks the accompanying tree, its left arm from the shoulder, and most of its right arm. However, the god's left hand and the body of the lizard have survived, albeit detached from the rest of the statue ("News Release"). The intact portions of the sculpture also sustained damage at some point in its history, since the figure exhibits an indentation on the right side of its ribcage, and since it stands slightly off vertical (Litt, "Apollo" A1). Despite its condition, the work was still highly attractive to the officials at the CMA because of its extreme rarity, the probability of its Greek origins, and its connection to Praxiteles. Although the museum acknowledges the chance that the *Apollo* is from the later Hellenistic or Roman periods, it argues that the casting techniques, the copper inlays for the lips and nipples, the remaining stone insert for the right eye, and the overall high quality of the figure's modeling point to fourth-century Greek workmanship ("Pliny"). If true, the value of the work increases enormously, given the scarcity of Greek bronzes and the fact that scholars regard Greek works as superior to later Roman copies (Litt, "Apollo" A1). In addition, with a fourth-century Greek origin, the assertion of the work's connection to Praxiteles becomes increasingly plausible.

Indeed, the greatest single factor heightening the attractiveness of the *Apollo* is the possibility that it represents the work of Praxiteles. According to the museum, "[t]he Cleveland Apollo [is] a unique masterpiece, as there exists no other large Greek bronze original sculpture anywhere in the world that can be securely attributed to any Greek master sculptor through literary sources" ("Pliny"). Furthermore, the fact that the work possesses qualities identical to one of the most famous sculptures from Greek antiquity also serves to increase its attractiveness as an addition to the museum collection. Like the *Aphrodite of Cnidus*, the *Apollo* exhibits the same contrapposto stance, grace of form, and naturalistic treatment that are the hallmarks of the artist to whom it is attributed ("Praxiteles").

Given the many enticing features of the *Apollo* on both an aesthetic and historical level, the CMA's decision to purchase the piece seems not only natural, but also entirely appropriate. After all, assuming cost was no object, what museum in the business of buying art would pass up an opportunity to augment its collection so easily and so significantly? Nevertheless, the alluring qualities of the *Apollo* represent only one facet of a larger story. Taking the work's reported ownership history into consideration, its apparently untainted appeal quickly begins to diminish.

A Problematic Provenance

Our discussion of the *Apollo*'s provenance begs an immediate question: why should record of the work's past make a difference to the CMA? The critical importance of ownership history has provoked leading archaeologists to declare that objects lacking complete documentation should be avoided altogether by collectors (Litt, "A God of Myth"). The call for such strict avoidance of works with incomplete or nonexistent records stems from the nature of the ancient art market. According to archaeologist Ricardo Elia, "[t]he antiquities market consists, in large part, of trade in unprovenanced cultural objects, most of which are illegally excavated and illegally exported from their countries of origin" (Elia 244). In other words, if a museum encounters an antiquity for sale that lacks complete documentation, a good chance exists that the work was clandestinely excavated and removed so as to skirt modern patrimony laws safe-guarding cultural property. Thus, purchasing an undocumented object not only deprives the collector of information about its cultural origin and significance, but also increases the potential for the collector to be rendered complicit in illegal, or at least highly questionable, dealings—something which museums, intending to serve

the public as best as possible, should avoid.

Despite the importance of complete documentation, the CMA nevertheless decided to purchase the *Apollo*, ignoring its suspicious provenance. For the museum, the path that led to the discovery of the existing information about the work began in April 2003, when Michael Bennett first encountered the sculpture in Geneva. According to Bennett, the gallery refused to offer details regarding the party from whom it had purchased the *Apollo*. Instead, the gallery provided him with the name of Ernst-Ulrich Walter, a retired German lawyer (Litt, "A God of Myth"). Walter, who is in his eighties, recalled seeing the work during the 1930s on his family's estate in Lausitz, a region east of Dresden (Litt "Apollo" A1; Litt "A God of Myth"). After World War II, the property was confiscated by the communist East German government, which retained it until reunification with West Germany in 1990. At this point, Walter successfully filed a claim to repossess the estate (Litt, "A God of Myth").

Then, in 1993 or 1994, Bennett reports that Walter rediscovered the *Apollo* lying broken on the floor of a manor house on his property (Litt, "A God of Myth"). As maintained by the CMA in a statement on its website, two other important events occurred in 1994. First, Walter's estate was visited by Dr. Lucia Marinescu, former director of the National History Museum of Romania, who viewed the statue in its shattered condition. Secondly, at some later point in 1994, Walter sold the *Apollo*, which was subsequently restored before it appeared again in Geneva in 2003 ("News Release"). Despite the opinions of Marinescu, who has posited in a published essay that the *Apollo* is of Roman origin, Walter sold the statue as an 18th or 19th century garden ornament for a mere 1,600 Deutschmarks, or about $1,250 (Litt, "A God of Myth"; Marinescu 303). In addition, Walter reports that the dealer to whom he sold the *Apollo* was Dutch, but that he does not recall the dealer's name and has no receipt from the transaction (Litt, "A God of Myth"). Finally, before it ultimately arrived in Switzerland, Bennett believes that the work was resold several times between 1994 and 2002, although no information is known about these other owners (Vogel).

Even upon a cursory glance, the story provided by the museum regarding the history of the *Apollo* is problematic for several reasons. One major difficulty with the CMA's information is its incompleteness, such as the eight-year span in which the work supposedly passed between several unknown hands. As a result of these information gaps, the story accompanying the *Apollo* becomes suspicious, since it begins to resemble the incomplete provenances that are so frequently fabricated and attached to illicitly recovered antiquities (Elia 244).

The reported provenance of the *Apollo* is also troublesome because of the difficulty, or perhaps impossibility, of proving that the sequence of events actually occurred. In all respects, the story hinges on the verbal account of Walter, as no receipts from the sales of the work or any other supporting documents have surfaced to reinforce his claims. Furthermore, it is important to point out that both Walter and Marinescu declined interviews with Steven Litt for an article that appeared on September 12, 2004 in the Cleveland Plain Dealer. While the CMA reportedly received signed statements from Walter and Marinescu, the museum refuses to make them or any other papers regarding the *Apollo* available to the public. Nevertheless, Bennett has stated that " '. . . I feel personally confident that the acquisition was proper . . .' ". Even so, both the silence of Walter and Marinescu and the museum's refusal to publicly support its position with concrete evidence suggest instead that there may be something to hide (Litt, "A God of Myth").

Aside from the museum's incomplete information and nondisclosures, the reported history accompanying the *Apollo* smacks of suspicion because of the very nature of the tale. According to Ricardo Elia, sellers with looted antiquities frequently try to ". . . cover up [a work's] true

source by creating fictional pedigrees like the 'old European collection' " (Elia 248). Similarly, as stated by Malcolm Bell, "[t]he attribution of previously undocumented works to private collectors, now deceased, or to distant places where it is difficult or impossible to seek confirmation of the claimed provenance, are strategies quite typical of the inventive minds of dealers" (Bell, "Re: Question"). Indeed, the provenance of the *Apollo* is composed of many of the same troublesome elements, including the placement of the work in Walter's "old European collection" and the inherent difficulties in verifying the story.

In addition to the *Apollo*, one famous example of a work with a false, unverifiable provenance is that of the Euphronios krater, depicting the death of Sarpedon, which is now considered one of the greatest masterpieces in the collection of the Metropolitan Museum of Art in New York (Bell, "Re: Question"). Robert Hecht, the dealer who sold the work to the museum in 1972, originally claimed to have acquired the krater from an Armenian coin dealer living in Beirut, whose father had purchased it in London in the 1920s (Meyer 98-100). However, in the months following the sale of the krater to the Met, the New York Times revealed evidence that the work had been looted from a tomb in Cerveteri, Italy (Nørskov 24). In 2001, additional support for the krater's illicit removal from Italy was discovered in a raid on Hecht's apartment. This search yielded an unpublished memoir in which Hecht allegedly admitted to purchasing the work from Giacomo Medici, an Italian dealer who has had other run-ins with the law (Falconi). While no proof of illegal activity surrounding the *Apollo* has been brought forth, the provenance does bear many similarities to that of the false history of the Euphronios krater. Like the krater, the *Apollo* raises suspicions because it supposedly came from an old private collection in a far away land, and because the stated history depends not on verifiable, documented evidence, but rather on verbal claims.

On top of the difficulties pertaining to the general traits of the *Apollo*'s provenance and the incompleteness of the information, other problems center on the specific details embedded in the story. For instance, Walter has stated that he remembers viewing the sculpture on his family's estate in the 1930s, and yet he cannot remember the name of the Dutch dealer to whom he sold the work in 1994. Is it likely that a clear 70-year old memory exists and a decade-old one does not, or is the relative power and vagueness of each recollection merely convenient to the story (Rijn, "The Mistake")? In this instance, however, the problematic aspects of Walter's tale may have a plausible explanation. According to Bennett and former CMA director Katharine Lee Reid, itinerant art dealers descended on Eastern Europe after the reunification of Germany and offered to pay cash for objects of all kinds (Kaufman and Ruiz). In the event that Walter did, in fact, sell the *Apollo* to a roving buyer, it may also explain why he lacks a receipt from the transaction.

Even if we accept Bennett's and Reid's claims, additional problems still remain with the given provenance. Specifically, important discrepancies exist between the timelines of events provided by the CMA and other sources. In a statement on its website, the museum reports that Marinescu first encountered the *Apollo* in 1994 ("News Release"). However, in a published essay from the 16th International Congress of Antique Bronzes held in May 2003, Marinescu writes that she first saw the *Apollo* on a visit to Germany in 1992 while it was in the process of being restored (Marinescu 303). As such, what is the cause for the contradictory information? Who is telling the truth? In addition, if the *Apollo* was still in pieces when it left Walter's hands in 1994, as the CMA claims, how could Marinescu assert that it had been restored prior to that point ("News Release")? While it remains uncertain which information, if any, is correct, the failure of the assertions made by the CMA, Walter, and Marinescu to corroborate one another casts serious doubt on the reliability

of the work's ownership history.

To further complicate the chronology of events, other reports state that Marinescu did not view the *Apollo* until after the 1994 date provided by the CMA. In an interview posted on the website of Michel van Rijn, a former art smuggler turned independent art crimes investigator, Marinescu maintains that she first saw the work in 1997 (Rijn, "Transcript"; Litt, "A God of Myth"). While Van Rijn's shady history forces us to question the reliability of his information, Marinescu's statement about her initial 1997 encounter with the *Apollo* is similar to another report in the New York Times, which appeared on June 22, 2004 (Rijn, "The Mistake"). In this article, Carol Vogel writes that "Ernst-Ulrich Walter . . . discovered the sculpture in 1994 after he had reclaimed his family's estate in the reunited Germany. The bronze was in pieces. Four years later, Dr. Lucia Marinescu . . . toured the estate and saw the work still in fragments." Adding still more complexity to the situation, Vogel goes on to state that Walter sold the *Apollo* shortly after Marinescu's visit, which, by the timeline in the article, would have occurred in 1998 (Vogel). Thus, the New York Times article contradicts the CMA's assertion that both Marinescu's visit and Walter's decision to sell took place in 1994, and thereby calls the accuracy of the given history of the *Apollo* into even greater suspicion.

Despite the serious inconsistencies and gaps in the *Apollo*'s claimed provenance, Bennett and Reid have expressed their confidence in the work's legitimate origins, given the extensive research conducted prior to the purchase (Litt, "A God of Myth"; Litt, "Apollo" A1). In fact, as a result of the information gleaned from their investigations, Reid has gone so far as to say that " '[t]here is every reason to believe [the Apollo]'s right' " (Litt, "Apollo" A1). For example, during the course of their research, the museum conferred with the Art Loss Register, a database of stolen objects, where a search on the *Apollo* came back negative. Such an absence of a competing claim of ownership would seem to uphold the notion that the work was acquired legally. However, in actuality, the findings of the Art Loss Register provide little support for the museum's assertions of the *Apollo*'s legitimacy, since no record of an object would exist if it was illicitly excavated and smuggled out of its country of origin (Litt, "A God of Myth").

In addition to the information supplied by the Art Loss Register, the CMA upholds scientific evidence as proof of the *Apollo*'s "clean" status. Shortly after Bennett discovered the work in Geneva, Reid requested that it be sent to Cleveland so that the museum could perform examinations and consult with other scholars. During this year-long process, tests conducted by Peter Northover of Oxford University illustrated that the metal alloy used for the figure was similar to that of other ancient Greek and Roman works—a find which helps to verify the *Apollo*'s authenticity. Furthermore, Northover tested a sample from the statue's metal base, which was found to date between 1400 and 1900. Still other tests by Henry Lie, a conservationist at the Harvard University Art Museums, showed that the figure was joined to its base only once, and that the corrosion on the surface of the solder was at least 100 years old (Litt, "A God of Myth"). Indeed, the information about the sculpture's base plate and the date of the solder are especially critical pieces of evidence for the museum. Since the figure and the base appear to have been attached a century ago at the earliest, the *Apollo* does not seem to represent a recently excavated find, and the "old European collection" story may yet hold water.

Nevertheless, important problems with the testing and the manner in which the information has been interpreted continue to cast doubts on the work's given provenance. For instance, the *Apollo*'s attachment to a 100- to 500-year-old metal plate implies to the museum that the statue must have been excavated and attached to its base at least a century ago—a time before patrimony laws governing the exports of antiquities came into existence. However,

what would have stopped a crooked modern conservator from joining a recently-discovered figure to a sheet of metal heisted from the roof of an old building? Such a scenario may have difficulties, since the century-old solder between the plate and the figure would seem to stand against the possibility of modern tampering. Even so, Lie's assessment of the age of the solder was based not on chemical testing of the surface corrosion, but rather on visual inspection (Litt, "A God of Myth"). Thus, without a scientific analysis of the solder, the date of the *Apollo*'s excavation and subsequent joining with its base remains questionable, and the possibility for a recent, illicit recovery remains.

Perhaps the most serious of all the *Apollo*'s problematic traits is the location and the gallery from which the CMA purchased the work. In 2003, Bennett discovered the statue at the Geneva branch of Phoenix Ancient Art, a gallery co-owned by brothers Ali and Hicham Aboutaam, who also maintain a showroom in New York (Litt, "A God of Myth"; Meier, "Antiquities Gallery"). The museum's dealings with a Geneva gallery are highly troubling, since Switzerland represents an important hub for the buying, selling, and transport of illicit artifacts. In her book The Return of Cultural Treasures, Jeanette Greenfield comments on the grim conditions of the Swiss art market:

> . . . Switzerland is the centre of stolen art from Italy and indeed from other foreign countries such as Greece, Turkey, Tunisia and Egypt. In Switzerland there is no restriction on the import or export of art treasures, which are often stored in bank vaults before being passed through various intermediaries on to foreign buyers, usually in the United States. This is said to represent an annual market of $2 billion. (Greenfield 215)

Because of the high volume of illicit antiquities passing through Swiss cities, the CMA's belief that the *Apollo* represents an exception to the rule may represent more of a fantasy than a fact.

As in the case of the gallery's location, the unsavory past behavior of the dealers who sold the *Apollo* to the CMA casts additional suspicion on the believability of the given provenance. In recent years, both Hicham and Ali Aboutaam, who have been described as some of the ". . . most secretive and aggressive buyers and sellers of antiquities" in the art market, have had run-ins with the law that stem from their questionable business practices ("Report: Museum Wants Refund"). For instance, in 2003, Ali Aboutaam was tried in a Cairo court for his alleged participation in a smuggling ring that had removed objects from Egypt and transported them to Switzerland, where they were dispersed to other Western dealers. Ultimately, Ali was convicted in absentia and sentenced to 15 years in prison (Meier and Gottlieb; Souccar). In addition, on June 23, 2004, just one day after the CMA announced its purchase of the *Apollo*, Hicham Aboutaam pleaded guilty in a Manhattan court to a misdemeanor federal charge that he falsified customs documents (Litt, "A God of Myth"). On these forms, which pertained to an ancient silver rhyton that his gallery later sold for $950,000, Hicham reported that the work came from Syria when it in fact originated in Iran, a country from which imports are highly restricted (Meier, "Art Dealer"). For his crime, Hicham was ordered to pay a $5,000 fine (Souccar).

Still other suspicions surrounding Phoenix Ancient Art pertain not just to the professional behavior of the Aboutaams, but also to the dubious nature of their merchandise. For example, in April 2003, the gallery agreed to return two ancient stelas in their possession which were found to have been smuggled out of Egypt in the 1990s (Meier, "Antiquities Gallery"). Furthermore, in 2001, the Kimbell Art Museum in Fort Worth, Texas made headlines when it sought a refund from the Aboutaam's New York gallery on a $2.7 million purchase of an ancient Sumerian statue. While it is highly unusual to seek refunds from dealers, museums have returned artifacts to their country of origin if the objects were proven to have been stolen ("Report:

Museum Wants Refund"). Thus, it has been suggested that the Kimbell likewise sought a refund from the Aboutaams as a result of doubts that arose over the statue's provenance (Rijn, "The Mistake").

Considering the track record of Phoenix Ancient Art and the fact that the Aboutaams have not shied away from dealing in suspicious antiquities in the past, the CMA's decision to purchase a work from their gallery with a price tag of perhaps several million dollars constitutes a highly questionable exercise in judgment, and an enormous roll of the dice. In fact, with so many problems accompanying the *Apollo*, from the dealers who sold it to the holes in its provenance, a few scholars have formulated alternative theories concerning the sculpture's true origins. (Here, it must be emphasized that these are quite simply theories, based only on speculation rather than solid evidence.) One hypothesis proposed by Malcolm Bell is that the *Apollo* represents a recent removal from a Roman site on the Balkan Peninsula (Bell, "Re: Question"). In the ancient cities of Nikopolis ad Istrum and Philippopolis, which are in modern-day Bulgaria, mints produced coins bearing the image of the *Apollo Sauroktonos*, indicating that inhabitants of the towns were familiar with Praxiteles' design (Richter 201-2; Poulter 8; "Plovdiv"). While Bulgaria is an archaeologically rich nation, few resources have been devoted to protecting its cultural heritage during the recent period of political upheaval and transition to democracy, causing looting to increase substantially (Bailey 112-113). Thus, Bell has conjectured that the CMA's *Apollo* may have been recently excavated and spirited away from one of the country's ancient Roman sites, perhaps even with the knowledge or help of the now suspiciously tight-lipped Lucia Marinescu from the neighboring land of Romania (Bell, "Re: Question").

An alternative theory concerning the *Apollo*'s true history has been proposed by Jenifer Neils, professor of art history at Case Western Reserve University, who, in light of other recent events in the art world, has postulated that the *Apollo* may be the recently recovered victim of a shipwreck. In 1998, fishermen trawling the area off the coast of Sicily snagged their nets on the *Dancing Satyr*, a fourth-century B.C. Greek sculpture, which some art historians have attributed to Praxiteles ("Greek Satyr"). This work, now located in the Sicilian village of Mazara del Vallo, depicts a nude male reveler in mid-leap, and may have been part of a larger group of figures accompanying the Greek god of wine, Dionysus ("Ancient Greek Bronze"). While it remains uncertain as to how the sculpture came to rest at the bottom of the sea, Italian officials believe that the *Satyr* may have been on board an ancient ship that sank as it was transporting other Greek works of art. Consequently, given the recent discoveries of both the *Satyr* and the *Apollo* and the possible connection of both works to Praxiteles, Neils has suggested that the two sculptures may have been plucked from the identical underwater hoard. Rather than being surrendered to authorities upon its discovery, the *Apollo* could have been sold to a foreign dealer, ultimately winding its way to the Aboutaams in Geneva.

While both Neils' and Bell's theories are compelling, no definitive proof exists to show that the CMA *Apollo* was, in fact, illegally excavated: no find spot has been located, no parties have come forward with new information, and no countries have sought its return. However, even in the absence of such proof, the given history of the work appears no more convincing. Despite the call from archaeologists for museums and collectors to acquire only fully documented works, the *Apollo*'s provenance carries gaping holes and is supported by inconclusive scientific evidence. In addition, the fact that the work was purchased in Geneva from a dealer of questionable integrity only heightens the suspicion surrounding its true origins. While the CMA may have been duped, even willingly, into buying a stolen work of art with a false "old European collection" provenance, could it be possible for the otherwise problematic acquisition to serve the greater good? In

other words, does the practice of acquiring ancient objects, even incompletely documented ones, and housing them in safe, environmentally sound galleries actually help to preserve the world's cultural property? Thus, in our investigation of the "rightness" or "wrongness" of the CMA's actions, it is necessary to probe the situation further before arriving at a final determination, and to investigate how the decision to purchase the *Apollo* and its implications fit into a larger framework.

Crime and No Punishment: Circumventing Cultural Patrimony Laws

Unfortunately, the *Apollo* does not represent the only problematic acquisition made by the CMA in its history. Rather, the purchase reflects a broader institutional culture that lacks a strong commitment to ethical collecting behavior. In fact, along with other major American museums, the CMA maintains a certain level of adherence to an outdated, "Indiana Jones-esque" approach to collecting. Under this philosophy, the glory of acquiring a great work of art reigns supreme over considerations for the manner in which that object appeared for sale on the market. As such, the ethics of transactions and the interests of the country from which an object originates have sometimes represented secondary concerns.

Indeed, instances of brash collecting behavior exist throughout the museum's past, such as the 1981 acquisition of Nicolas Poussin's *The Holy Family on the Steps*, which is now recognized as one of the museum's most notable highlights. The $2.2 million purchase was negotiated by then-museum director Sherman Lee, father of Katharine Lee Reid, whose tenure oversaw the acquisition of the *Apollo*. Lee, along with the French owner of the Poussin, consulted with officials at the Louvre on the procedures for obtaining an export license that would allow the work to legally exit the country. However, when the painting arrived in Cleveland, it did so unframed, rolled up in a suitcase, and sans export permit from the French government. In addition, the U.S. Customs documents accompanying the work falsely declared the painting to be of no value. In light of his actions, the French government banned Lee from future travel to the country, and the charges against him were only dropped in 1987 when, after years of pressure, the CMA agreed to loan the painting to the Louvre at some point over the next 25 years (Koczka 193).

Other indications of the CMA's weak institutional commitment to upholding ethical collecting practices stem from major objects in its ancient art holdings. For example, in 1967, the museum acquired the *Front Face of a Stela*, a Mayan relief carving depicting a royal woman, which dates to around 250-900 A.D. ("Front Face"). As suggested by its mutilated condition, the carving was hastily hacked away from its original stone slab by looters in Guatemala. While the site on which the relief was originally located had been studied and published by the early 20th century, CMA officials nevertheless agreed to purchase the carving in spite of its known illicit status. This problematic acquisition and the epidemic looting of Mayan carvings were later highlighted by archaeologist Clemency Coggins in a 1969 article in the Art Journal. In her essay, Coggins catalogued the CMA stela along with many other Pre-Colombian carvings that were plundered from their original sites and subsequently bought by respected American institutions. Although Coggins only listed the CMA stela and other works as belonging to unnamed American museums, members of the art community were still aware of the specific institutions implicated by the article for encouraging the pillaging of ancient sites (Coggins 94-96; Bator 3-4).

Another important ancient object with a dubious background that was acquired by the CMA is the over-life-size Roman bronze figure of *The Emperor as Philosopher, Probably Marcus Aurelius*, which dates to about 175-200 A.D. This work, which was purchased by the museum in 1986, is part of a group of monumental bronzes believed to

be from the site of Bubon in western Turkey (Kozloff, "Introduction" 131). However, some confusion exists regarding the exact find spot of the bronzes, since the works were excavated clandestinely by looters and smuggled out of the country. In fact, in an article from The Bulletin of the Cleveland Museum of Art in the year following the acquisition of the *Emperor*, then-CMA curator Arielle Kozloff tactfully admits that the Bubon site ". . . was disturbed sometime between 1952 and 1966" (Kozloff, "Appendix" 142). Thus, the acquisition of the *Emperor* once again illustrates a certain ongoing willingness of the museum to purchase even those works that appear on the market in a less-than-savory fashion.

As perhaps an acknowledgement of its history of aggressive buying behavior and an attempt to protect its own interests, the CMA in 2002 joined several of the world's most powerful museums, including the Louvre, the Hermitage, and the Metropolitan Museum of Art, in signing a defiant declaration against the return of cultural property. Although some countries have sought the restoration of objects removed unfairly from their soil, such as in Greece's high profile and long-running request for the British Museum to surrender the Elgin Marbles, the signers of the 2002 agreement insisted that the past purchases made by museums should not be held to today's more strict ethical standards (Eakin). Consequently, as in the belief that suspicious objects on the art market constitute "fair game," the CMA's decision to sign the multi-museum pact illustrates its continued pursuit of selfish interests over the concepts of equity and international co-operation. Even so, the act of requesting not to be judged on its past deeds might suggest that the museum has forged a new resolve in recent years to reform its buying behavior. However, from the circumstances surrounding the *Apollo*, we of course know this not to be true. While the possibility exists for the sculpture to have been illicitly excavated and smuggled out of its country of origin, CMA officials have justified the purchase by stating that the acquisition provides a greater benefit to society than had the object been overlooked. In this regard, former CMA director Katharine Lee Reid commented that " '. . . giving [the *Apollo*] a safe place . . . is preferable to leaving it in a [dealer's] store room' " ("Greek or Roman?"). Thus, as intimated by Reid, did the decision to purchase the *Apollo* and preserve it for future generations in a secure environment actually lead to the greater protection of the world's cultural property?

In contrast to the former CMA director, many archaeologists would argue that the acquisition of pillaged (or, at the very least, potentially pillaged and undocumented) objects actually stimulates more destruction than preservation. For instance, it is easy to see how the CMA, in the act of acquiring the Mayan *Front Face of a Stela*, indirectly supported the behavior of the looters causing irreversible harm to ancient objects and their sites. But aside from the frequent infliction of physical damage on plundered artifacts, what other losses might be incurred when museums purchase looted works? In order to answer this question, it is necessary to revisit the topic of scientific excavations and the value of gathering contextual information. According to anthropologists Arlen and Diane Chase and archaeologist Harriot Topsey, the discipline of archaeology was, in the past, ". . . primarily concerned with collecting artifacts." Today, however, they argue that ". . . an archaeologist 'collects data' and, more important, 'collects' context." The importance of "collecting" such contexts through scientific excavations is emphasized by the fact that scholars ". . . must know precisely where [an object] comes from to tell its story. Without any indication of its origins and context, it is deemed worthless by some, or at best unreliable" (Chase, Chase and Topsey 31).

Consequently, according to Topsey and the Chases, the true value of an artifact and our ability to understand it rests not in the object itself, but rather in its accompanying data. In fact, in an interesting anecdote by Karen D.

Vitelli, professor of anthropology at Indiana University, Bloomington, the power of contextual information becomes increasingly apparent. In the late 1960s and early 1970s, Vitelli and a team of archeologists excavated the prehistoric Franchthi cave, which is located on the southernmost tip of mainland Greece. During the excavation process, all of the soil removed from the site was passed through a screen in order to catch the small fragments of bone, shell, carbon, ceramic, and stone left behind by ancient inhabitants (Vitelli 24). After taking careful records of the specific stratigraphic layers in which the fragments were located, the team noticed that chips of obsidian occurred in older deposits than expected. Obsidian, a black volcanic glass found on the Aegean's Cycladic Islands, was known to have been fashioned into tools by Neolithic peoples on the mainland of Greece. As such, these populations must have possessed the seafaring technology required to obtain the material from its island source. In the Franchthi cave, however, the researchers found obsidian flakes in Mesolithic and Paleolithic deposits, suggesting that sea voyages in the Aegean took place thousands of years earlier than previously believed (Vitelli 25). Although the discovery carries important historical implications, Vitelli points out that it was facilitated by only ". . . a series of unremarkable tiny chips of stone whose significance came entirely from their context" (Vitelli 27). In this way, Vitelli's story demonstrates the powerful potential that scientifically gathered and recorded data holds, even for seemingly trivial objects.

While contextual information can provide invaluable clues about an artifact, the data needs to survive in order to offer any assistance. Sadly, in the case of the CMA *Apollo*, no such information regarding the work's original context appears to exist. As a result, scholars cannot definitively determine the work's age, artist, original location, or cultural significance. Indeed, the work's aesthetic beauty does serve as a testament to the achievements of ancient Greek, or perhaps Roman, sculptors, but the figure of the *Apollo* alone yields little else. Perhaps the absence of contextual data accompanying the work can be attributed to the detrimental behavior of treasure-seekers from a bygone age, before the invention of scientific excavation procedures. However, if the *Apollo*'s suspicious provenance is, in actuality, a false cover to hide its illicit status, then the lack of concrete data regarding the work's origin could stem from the destructive practices of modern looters. By stealthily removing works from the ground without the benefits of a scientific process, pillagers create irreparable gaps in knowledge. In addition, while the practice of looting causes more examples of ancient art to emerge, the uncovered objects offer little information to help further the understanding of the cultures that produced them. Thus, in acquiring a potentially multimillion dollar sculpture that may have been clandestinely excavated, the CMA encourages the behavior of looters and the continued destruction of archaeological sites. Furthermore, because of the losses of information resulting from pillaging, the museum's argument that the acquisition of the *Apollo* provides a noble, protective service rings somewhat hollow. Rather than fostering the preservation of the world's cultural property, the acquisition of undocumented artifacts would seem instead to encourage greater destruction—a practice which stands in direct conflict with the archival, educational role of museums.

In view of the negative repercussions that arise from collecting looted or undocumented works, why might a museum engage in this behavior nonetheless? One major cause for the continued practice of acquiring ancient, and even suspicious, objects could be the presence of economic motivations, since antiquities tend to represent "better buys" in comparison to other types of objects. According to Crain's New York Business reporter Miriam Kreinin Souccar, prices have risen in recent years for modern and contemporary works. As such, Souccar reports that ". . . more collectors looking for bargains have turned to less-expensive ancient art" (Souccar). In fact, because of the

undervaluation of the antiquities market, ancient objects were available in 2004 for as little as $1,000 (Russell). In addition to the relatively inexpensive prices for antiquities, museums might be motivated to purchase high-quality but risky objects in an attempt to gain an advantage over their competitor institutions. Since the 19th century, museums in major American cities have rivaled with one another to acquire greater levels of prestige (Rose and Acar 86). Thus, in terms of the *Apollo*, perhaps the CMA acquired the rare object not only to help better the reputation of its collection, but also with the mindset that had they not jumped at the chance, another "competitor" museum eventually would have.

One further explanation for why museums continue to purchase unprovenanced and clandestinely excavated objects is, quite simply, because they can. This is not to suggest, however, that laws and international agreements aimed at curbing the illicit antiquities trade do not exist. In fact, according to Vitelli, "[m]ost countries . . . have antiquities laws in which the government claims ownership of all archaeological materials, whether in state or private museums and collections, or as yet undiscovered in buried archaeological sites." As such, only objects accompanied by a government-issued export permit may legally leave a country's borders (Vitelli 18). In addition to the laws protecting cultural patrimony in individual countries, the United States has entered into agreements with nine nations, including Italy, to ban the import of entire categories of frequently pillaged objects (Bell, "The Getty's Italian Job"). Furthermore, the United Nations Educational, Scientific and Cultural Organization (UNESCO) adopted an important agreement in 1970, known as the Convention on the Means of Prohibiting and Preventing Illicit Import, Export and Transfer of Ownership of Cultural Property. This agreement, which encourages countries to both protect their own cultural property and cooperate with others to curtail the illicit art trade, was finally implemented by the U.S. Congress, with some provisions, in 1983 (Hingston 129-30).

Despite the fact that the United States and other archaeologically rich nations are cracking down harder on the illicit antiquities market, the existence of laws has been only marginally successful in curbing the buying and selling of looted works of art (Eakin). For instance, while the U.S. has agreed to ban the import of illicit artifacts from a handful of nations, objects that are exported illegally from their country of origin can, in most cases, still legally enter the U.S. (Bator 11). In addition, many laws protecting cultural patrimony have proven difficult to enforce. According to Neil Brodie, archaeologist and Coordinator of the Illicit Antiquities Research Center at Cambridge University, not even wealthy countries like the U.S. have the necessary resources to fully protect their own archaeological material (Brodie 17). Consequently, in developing countries, the fewer oversights and higher levels of poverty increase the temptation for individuals to augment their incomes through looting (Brodie 3). Furthermore, although all archaeological material is usually the lawful property of the country from which it originated, individuals in possession of ancient objects have little incentive to turn them over to the authorities. Instead, thanks to the illicit art market, the opportunity to sell a plundered object and earn a profit from it usually presents the more enticing option (Bator 42).

In light of the conditions surrounding the buying and selling of antiquities, former University of Chicago law professor Paul M. Bator has stated that ". . . so long as there is a world market for beautiful archaeological objects, a substantial amount of looting will persist no matter what regulatory system is installed, because total prevention would entail unacceptable costs" (Bator 49). In other words, providing that art buyers maintain a willingness to purchase plundered or unprovenanced works, laws will remain ineffective in stifling the activities of looters who strive to meet the market demand (Koczka 191). Due to the difficulties in eliminating the illicit art market through

laws and international agreements, Bator and others have suggested that museums themselves take measures to curb worldwide plunder by self-policing their activities and adopting official policies against the purchase of looted objects (Bator 81).

As the case may be, many museums today, including the CMA, claim to subscribe to independent or multi-institutional policies regarding the standards for collecting ancient objects. Therefore, in our investigation of the "rightness" or "wrongness" of the purchase of the *Apollo*, it is necessary to look beyond the existing laws and agreements that attempt to regulate the buying and selling of cultural property. Although the potential exists for the sculpture to have been illegally excavated and smuggled out of its country of origin, the *Apollo* might still have been legal to import into both Switzerland and the United States, which do not support the export laws of all nations. However, the fact that crimes committed in one country frequently go unpunished in another should not serve as a justification for the purchase of illicitly recovered works of art—after all, just because an action may be legal does not necessarily make it right. Thus, it is important to examine whether the purchase of the *Apollo* was in accordance with the standards established by the CMA's acquisition policy, and whether these guidelines are, in fact, sufficiently rigorous.

Acquisition Policies and Sub-standard Standards

Before investigating the specific set of guidelines for collecting antiquities to which the CMA subscribes, a brief study is in order of some of the toughest acquisition policies existing within the American art museum community. According to Malcolm Bell, one hallmark of the policies that best defend against the purchase of looted objects is the presence of a so-called exclusion date. With an exclusion date, the acquisition of an antiquity by means of either a gift or purchase is prohibited if the existence of the work has not been documented before a set point in time. Thus, Bell argues that because "[u]ndocumented antiquities are very likely to have been pillaged," the commitment to avoid acquiring works that were not known until after a specific date allows a museum to ". . . [distance] itself from the illicit art market" (Bell, "The Getty's Italian Job). In other words, by establishing a cut-off date, Bell comments that museums over time ". . . will exclude an ever-greater number of questionable antiquities," thereby removing themselves further from the realm of art looters and their plundered wares (Bell, "Better Late than Never").

Despite the importance of establishing a cut-off point for undocumented works, New York Times reporter Hugh Eakin acknowledges that "[m]ost of the large collecting museums have not formally specified a date." Among the few institutions that have settled on exclusion dates is the University of Pennsylvania Museum, which, in symbolic accordance with the UNESCO convention against the proliferation of the illicit art market, bars the acquisition of unprovenanced antiquities that have surfaced after 1970. Similarly, other institutions, such as the Michael C. Carlos Museum at Emory University, have adopted a 1983 exclusion date, reflecting the year in which the U.S. government officially joined the UNESCO convention (Eakin).

One additional museum that has instated a cut-off date for the acquisition of undocumented antiquities is the J. Paul Getty Museum in Los Angeles. Although somewhat later than the more ideal, symbolic date of 1970, the Getty's policy forbids the museum from acquiring unprovenanced works surfacing after 1995 (Bell, "The Getty's Italian Job"). Alongside the exclusion date, other aspects of the Getty's policy render it particularly strong, such as in its commitment to honoring the legitimate cultural patrimony claims of foreign nations. As the language of the policy clearly states, "[i]f the Museum becomes aware of a patrimony claim by a foreign government . . . the Museum normally will offer to return the object to the aggrieved county . . ." (J. Paul Getty Museum). In fact, it is important to point out that the museum has demonstrated

a notable willingness to follow through on this promise in its policy. For example, Getty officials have returned several works to Italy, such as a red-figure cup in 1997 and, most recently, three additional objects in October 2005 that were found to have been looted (Bell, "Better Late than Never"; Felch). Thus, despite the later exclusion date, the Getty policy's stance on returning stolen works of art and its demand for documentation have led Bell to declare this set of acquisition guidelines as being ". . . arguably the strongest of any major American museum . . ." (Bell, "The Getty's Italian Job").

Although the Getty and other institutions have drafted their own standards governing the acquisition of antiquities, many of America's major museums, including the Metropolitan Museum of Art, the Museum of Fine Arts in Boston, and the Cleveland Museum of Art, all claim to adhere to the policy adopted by the Association of Art Museum Directors (Bell, "The Getty's Italian Job"; Petridis). This organization, which represents institutions with operating budgets of at least $2 million, recently completed a revision of its guidelines for collecting antiquities in 2004 ("Mission Statement", Association; "Report of the AAMD"). Despite this review process, the policy remains much less rigorous than the standards set by the Getty and others. For instance, rather than setting a firm exclusion date for unprovenanced works of art, the AAMD's guidelines instead recommend that museums purchase only those works that have been out of their country of origin for a period of at least ten years (Eakin). Thus, by upholding a "rolling" exclusion date, the policy of the AAMD does little to encourage museums to distance themselves from the illegal antiquities market, since only the previous decade's worth of unprovenanced objects are barred from consideration.

In addition to the failure of the AAMD's policy to set a secure cut-off date for the acquisition of undocumented works, the guidelines are also less strict than those of the Getty in that museums are still permitted to use their discretion in buying unprovenanced and potentially looted objects (Eakin). On the one hand, the policy declares that the "AAMD deplores the illicit and unscientific excavation of archaeological materials and ancient art from archaeological sites . . .". On the other hand, the guidelines later state that ". . . some works of art for which provenance information is incomplete or unobtainable may deserve to be publicly displayed, preserved, studied, and published because of their rarity, importance, and aesthetic merit." Thus, when faced with an exceptional but unprovenanced object, the policy asserts that museums may ". . . use their professional judgment in determining whether to proceed with the acquisition" ("Report of the AAMD"). In light of this fact, Jenifer Neils of Case Western Reserve University has argued that the policy contains a " '. . . big loophole . . .' " in its guidelines. In other words, even though the policy purports to frown upon the looting of archaeological sties, Neils point out that if a museum deems a work to be " '. . . big enough and important enough . . .' ", openings in the AAMD policy would allow the institution to " '. . . acquire [the object] and put it on display, no matter where it came from, or how it reached the market' " (Eakin). As such, while acquisition policies should be designed to help curb the illicit antiquities market, the traffic in unprovenanced works, and the loss of archaeological information, the guidelines of the AAMD provide museums with the leeway to continue supporting these detrimental activities and are therefore unproductive.

Given the CMA's subscription to the AAMD's problematic policy for the acquisition of antiquities, how might we interpret this information to help us determine the soundness of the decision to purchase the *Apollo*? Outwardly, the museum appears to be on solid ground, since it can claim to have followed the guidelines of an organization that represents the country's largest and wealthiest institutions. After all, in spite of the incompleteness and suspicious nature of the sculpture's provenance, the mu-

seum could simply point to the loophole in the AAMD's policy and justify the purchase on the grounds of the *Apollo*'s special ". . . rarity, importance, and aesthetic merit" ("Report of the AAMD"). In addition, it should also be said that the adherence of a museum to an accepted set of standards governing the acquisition of antiquities is, in general, a sign of strength and ethical responsibility. However, because the AAMD's guidelines allow museums to continue purchasing recently found, undocumented works, and because this behavior subsequently drives the illicit art market, any claims for taking the moral high ground by adhering to this policy are, in fact, unfounded. Thus, although the acquisition of the *Apollo* may not represent a policy violation, the purchase of the sculpture appears to stand on no less shaky footing.

Despite the need for museums to adopt and adhere to acquisition policies with high ethical standards, it must be mentioned that such guidelines neither erase past deeds nor render a museum immune from the continued scrutiny of foreign nations. For instance, the Getty, which possesses perhaps the strongest acquisition policy of any major American museum, is currently embroiled in a battle with Italy over the return of a whopping 42 objects from the collection that may have been illicitly excavated and exported. In an even more shocking move, Italian authorities have charged the dealer Robert Hecht and the Getty's respected former curator Marion True with conspiring to traffic in looted antiquities. One of the objects that True may have knowingly accepted regardless of its alleged plundered status is the so-called *Getty Aphrodite*, which is considered to be one of the finest masterworks in the museum's collection (Felch and Frammolino; Bell, "Better Late than Never"). This over-life-sized, exceedingly rare, and undocumented temple cult statue was purchased by the museum in 1988, and, because of the absence of a provenance, some have suggested that the work could have been looted from a site in southern Italy or Sicily (Felch and Frammolino). While Italian authorities are currently attempting to hold the Getty and True accountable for the aggressive buying practices of the past, the fact that True is being singled out for bad behavior is also tragically ironic, since she was instrumental in persuading the museum to reform its ways and adopt the strict acquisition policy in place today (Bell, "Better Late than Never').

Consequently, the current woes of the Getty illustrate that the adoption of strong guidelines for the acquisition of antiquities, while certainly a step in the right direction, is insufficient to completely resolve the tensions between ancient art buyers and archaeologically rich nations, or even to protect the institution and its staff from litigation intending to redress past wrongs. Instead, the troubles facing the Getty suggest that deeper changes within the museum community regarding the collection of art may be required to build greater international cooperation, understanding, and exchange. Thus, in turning back our attention to the "rightness" or "wrongness" of the CMA's acquisition of the *Apollo*, it is necessary to undertake one final investigation before arriving at an ultimate evaluation of the museum's actions. Looking beyond the laws and policies that attempt to regulate the buying and selling of art, we must ask how the museum interprets its roles within society as a supplier of a community service and as an institution of public trust, and whether the purchase of the *Apollo* was in accordance with these broader institutional responsibilities.

A Matter of Trust

Disregarding the stipulations and allowances of the CMA's acquisition policy, what deeper considerations could have guided the museum's choice to acquire the *Apollo*? In other words, what basis for decision-making does the museum purport to use in its quest to fulfill its institutional mission? To answer this question, we must delve briefly into the realm of moral philosophy. According to Rushworth Kidder, founder and director of the Institute of Global Ethics in Camden, Maine, moral philosophy

incorporates three different traditions for ethical-decision making (Kidder 23). One approach, which Kidder terms "rule-based thinking," incorporates the Kantian notion of the "categorical imperative." Thus, with this mode of thought, greater good comes from acting in ways that can be established as universal standards for everyone to follow (Kidder 24). Another approach to ethical decision-making, which Kidder calls "care-based thinking," stems from Christian moral philosophy, in that greater good comes from treating others as you would wish to be treated (Kidder 25). The third and final approach to ethical decision-making is what Kidder terms "ends-based thinking," which stems from the principle of utilitarianism, or the idea that decisions should result in the greatest amount of good for the largest number of people (Kidder 24). As revealed by the CMA's mission statement, it is to this "ends-based," or community-based approach to moral decisions that seem, at least ideally, to drive the institution's behavior. Thus, the museum, founded in 1913 " 'for the benefit of all the people forever,' " strives ". . . to bring the pleasure and meaning of art to the broadest possible audience . . ." by adding to its collection, preserving it, and displaying it ("Mission Statement", The Cleveland Museum of Art).

The same community-based approach to decision-making that appears in the museum's mission statement is also manifested in the comments of Katharine Lee Reid regarding the acquisition of the *Apollo*. In defending the CMA's decision to purchase the controversial sculpture, Reid has argued that " '[t]he important thing is that a great work of art is available to the public . . . and is out of harm's way' " (Litt, "Apollo" A1). In taking just one part of Reid's statement, the purchase of the sculpture would seem to benefit the greater community by promoting the preservation of both art and knowledge, since removing the object from the more perilous location inside a dealer's shop or even from inside the ground fosters the survival of ancient cultural history. However, given the suspicious nature of the work's provenance, the argument that the acquisition constitutes an act of preservation, and therefore a benefit to society, falls short. As established previously, the acquisition of undocumented objects fuels the illicit art market. If looters know that museums and collectors are willing to purchase an object without documentation, plundering will continue, and the losses in archaeological data will increase (Chase, Chase and Topsey 37). Consequently, by acquiring the *Apollo* in spite of its suspicious and incomplete history, the museum does little to uphold its mission and its responsibility to the community to protect the art of the past. Rather, the purchase fosters greater destruction, in that it stimulates the illicit art market and furthers the obliteration of important historical information.

In addition to the notion of preserving the past, Reid's justification for the purchase of the *Apollo* includes the idea that the acquisition benefits the community by making it available for all to see. Thus, as reflected by both Reid's comments and the CMA's mission statement, one of the roles the museum purports to occupy in society is that of an educational institution. By acquiring the *Apollo*, therefore, the museum would seem to fulfill this service to the community, since the purchase would allow a wide audience to appreciate and learn about the cultures of the past. In reality, however, the acquisition of the sculpture is counterproductive once again to the museum's goal of supplying a greater benefit to society at large. Although the *Apollo* is aesthetically pleasing and speaks to the artistic achievements of ancient cultures, no one can identify for certain the specific culture from which the work hails. In other words, by maintaining a willingness to acquire unprovenanced or insufficiently documented works, the museum fails to provide the community with the full range of information that would allow it to better learn from and appreciate the collection. Furthermore, because the practice of acquiring imperfectly documented works encourages the continuance of looting and the loss of ar-

chaeological information, the purchase of the *Apollo* fails to conform to the educational mission of the CMA. Institutions that support education should likewise support the survival of information, but the CMA's act of buying suspicious works, which in turn promotes plundering and the loss of data, suggests otherwise.

Thus, while museum officials and the institution's mission statement purport to maintain a commitment to benefit the community at large, the acquisition of the *Apollo* stands apart from these ideals. Instead, the purchase is detrimental to society, since it fosters the loss of information that could have been used to better understand the past. In addition, the purchase of the *Apollo* constitutes a lack of regard for the community in the sense that it violates the trust that the public invests in it. In other words, society upholds an expectation that museums will perform a similar set of educational and preservation functions as manifested in the CMA's mission statement. Similarly, James Cuno, the director of the Art Institute of Chicago, has stated that ". . . the public has entrusted in [museums] the authority and responsibility to select, preserve, and provide . . . access to works of art . . ." (Cuno 73). One tangible sign of this public trust held by museums is the financial support that they receive from both municipal and philanthropic sources (Fox 25). This funding, on which museums depend to fulfill their missions, is granted to them because of the existence of the societal trust that an institution will, in fact, carry out its noble duties. In the case of the CMA's purchase of the *Apollo*, however, the museum fails to uphold the archival and educational roles that society expects of it. As such, if the public begins to feel that the museum is not maintaining its responsibilities to the community, the museums risks losing not only the support of donors, but the very loss of respectability, which may be difficult to regain (Lowry 146).

Conclusions and Solutions

In our exploration of the soundness of the CMA's decision to purchase the *Apollo*, we have entertained several different points of consideration, from the sculpture's historical significance, to its problematic provenance, to the dangers of stimulating the illicit art market by buying undocumented works, and finally to the clash of the purchase with the concept of public trust and the ideal role of the museum in society. Thus, in the end, how are we to evaluate the acquisition? Indeed, as the results of our many avenues of investigation have shown, the real and potential costs arising from this decision far outweigh the benefits. In spite of the work's stunning visual appeal and the international attention it has garnered for the museum, the CMA's choice to acquire the work has set the institution up for a great fall. Because of the sculpture's sketchy provenance and the history of the dealers who sold it, the possibility of foul play surrounding the work remains strong. In addition, the CMA's willingness to pay a price of perhaps several million dollars regardless of the object's suspicious history renders the institution's judgment even more questionable. Furthermore, the decision to acquire the *Apollo* reveals a lack of consideration for the broader implications that might occur in the illicit art market. By purchasing a major work with a suspicious history, the museum only encourages the continued behavior of looters, which is an outcome that educational and ethical institutions ought to avoid.

As such, given the problems surrounding the work and the negative repercussions of buying undocumented objects, the acquisition represents a highly irresponsible move. Although no information has surfaced to conclusively disprove the "old European collection" story accompanying the work, the museum's decision to add the sculpture to its collection still constitutes an unreasonable gamble with public trust. While society assigns museums the task of preserving and studying the art of past civilizations, the CMA violates the trust that the public invests in it by engaging in suspicious dealings with unreputable dealers and by behaving in such a way that leads to the greater

destruction of historical information. In addition, the purchase also illustrates the failure of the museum to perform due diligence in investigating the work prior to the official acquisition. Rather, blindsided by its own selfish concerns and the prospect of raising the prestige of its collections, the museum overlooked holes in the given provenance, the inconclusive test results, and the potential for detrimental outcomes to arise within the art market.

While the purchase of the *Apollo* represents an imprudent decision, to say the least, it does not follow that museums should always avoid taking risks. In fact, museums maintain a powerful capacity to challenge societal norms, such as in their ability to bring controversial or cutting-edge shows to otherwise reluctant communities. Sometimes, museums can even take risks in acquiring objects, such as in the case of contemporary works that may or may not hold their value over time. When it comes to acquiring antiquities, however, taking risks is an irresponsible roll of the dice, because what is at stake is the loss of information and the encouragement of the illicit art trade. In fact, the current legal entanglements at the Getty powerfully demonstrate the pitfalls of aggressive purchases of ancient art, and one can hope the CMA will learn from the Getty's mistakes. Nevertheless, many museum officials surely would argue that it is part of their job, and indeed part of the mission of their institutions, to bring the best possible objects to their respective collections. As institutions of public trust, however, museums should be held to higher-than-average ethical standards, and it is therefore insufficient for museums to acquire works without regard for the greater costs involved (Bator 83).

Thus, regardless of the culture of its competitors, the CMA ought to forge a greater institutional commitment against the purchase of undocumented works of art and adopt more culturally sensitive, globally minded methods for fulfilling the objectives of its mission. In order to begin this internal cultural shift, the CMA should adopt a stronger acquisition policy, perhaps modeled on that of the Getty, rather than simply hiding behind the weak guidelines of the AAMD. Furthermore, in the interest of fostering international goodwill and the rights of foreign countries to protect their cultural property, museums should reconsider the idea of ownership as the primary method for achieving their mission to educate the public about past cultures. Indeed, as stated by Paul M. Bator, "[a]rt is a good ambassador," in that "[i]t stimulates interest in, understanding of, and sympathy and admiration . . ." for the cultures which produced it (Bator 30). However, it does not follow that objects must be owned by a museum in order for their ambassadorial power to exist. Rather, in the interest of slowing the illicit art trade, museums such as the CMA should turn away from the entanglements of ancient art ownership, and instead foster international exchange through the organization of temporary exhibits of loaned objects.

Finally, in an effort to encourage additional goodwill and public trust, museums such as the CMA should adopt greater transparency in their procedures. Currently, the museum can more easily get away with purchasing a suspicious work of art, since it adopts a policy of nondisclosure (Litt, "A God of Myth"). Because the CMA has been able to envelop its dealings in secrecy, it becomes difficult for the public to examine its actions. Therefore, instead of stonewalling a public concerned over its internal procedures, the museum should take a more open stance in defending is actions by releasing supporting evidence for all to see.

Thus, while problems certainly remain at the CMA and other major American institutions, the topic of museum ethics is being pushed increasingly to the forefront in the press, the scholarly community, and the general public. In fact, one positive byproduct of the Getty's current entanglements with Italian authorities is that the past actions of the institution are becoming the frequent topic of conversation and debate. In the end, if more people are willing to enter the discussion over museum ethics, insti-

tutions will be more likely to adopt ethical policies and procedures. With this in mind, it is important that both scholars and members of the Cleveland community continue to ask questions regarding the CMA's acquisition of the *Apollo*. This process is especially vital, since the work will be hidden in storage for the next several years as the museum undergoes an extensive renovation and expansion. While perhaps museum officials are hopeful that the work will be removed from the radar screens of the public and foreign officials during the building period, the fact that the work is out of sight should not render it out of mind. Instead, the more people challenge the museum's decision to purchase the *Apollo*, the greater the possibility that the museum will reform its acquisition guidelines, and adopt tougher stances against looting and the purchase of undocumented antiquities. After all, in today's world, forging commitments any less strong would just be risky business.

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