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Cover art created by Vanessa Wyns.

FOREWORD

As part of our ongoing endeavor to provide Baylor University with a platform for the promotion and celebration of undergraduate research, the officers and staff of *The Pulse* are proud to present our spring edition. Every year, we seek to publish the top undergraduate papers across a variety of disciplines in order to extend scholarly conversations to a wider audience. This installment of *The Pulse* furthers that goal and exemplifies the dynamic research produced by Baylor undergraduates.

Publication in *The Pulse* is always competitive, a fact that speaks volumes about the quality of student research in departments across the university. This year we received 42 submissions, resulting in a 9.5% acceptance rate, one of our most selective to date. This affirms both the breadth and quality of undergraduate research happening at Baylor.

This edition, featuring an elegant cover design by our artistic specialist, Vanessa Wyns, contains four informative, engaging papers. Karen Caylor analyzes the virtue of temperance and its effect on the reader's education in Milton's *Paradise Regained*. Alyssa Leavell explores the connections between the female protagonists in Euripides's *Hippolytus* and Thomas Hardy's *Tess of the d'Urbervilles*. In his paper on the "Great War" between Barfield and Lewis, Stephen Margheim meticulously compares the two scholars' philosophical views on the imagination. Lastly, Colin Pardue's paper explores novel developments in the realm of metamaterials and details their potential applications in laboratories at Baylor. According to our usual practice when integrating different disciplines into one publication, each paper is published in the style appropriate for its discipline.

This journal is a direct product of the dedication of *The Pulse* staff, a group of students who devote their time to support the research undertaken by their peers. Our editorial board diligently examined each of our submissions, selected the top entries, and worked closely with our authors to prepare papers for publication. The public relations staff created posters, solicited submissions, advertised editions through a variety of media around campus, and composed several Faculty Features. Our adroit technical staff worked to typeset the final publication and provided continual maintenance to our website. The shared commitment of each staff member sustains *The Pulse* as it pursues its vision of promoting scholarly discourse across the university.

Our staff operates under the guidance of Dr. Susan Colón, who has led *The Pulse* since its beginning in the fall of 2004. Dr. Colón is currently on a semester-long sabbatical, and in her absence we have developed an even greater appreciation for the considerable amount of time and effort she invests in this organization. We would like to take this opportunity to express our gratitude for her leadership and dedication. Her efforts have introduced students to the world of academic publishing and inspired future editors and academics. Her guidance has established a solid foundation for *The Pulse*, and we look forward to welcoming her back in the fall.

We would like to extend our thanks to Baylor University's Honors College for supporting our publication. We would also like to thank Phi Beta Kappa, Zeta of Texas Chapter, for sponsoring the Wallace L. Daniel Award for Undergraduate Writing, which is given to the top *Pulse* paper of the year. The winner of this award also presents the annual *Pulse* Student Lecture, sponsored by the Honors Residential College. We congratulate this year's recipient, Stephen Margheim, for his award-winning paper entitled "Barfield contra Lewis on Truth and Imagination."

Please visit us at www.baylor.edu/pulse to learn more about *The Pulse* and to read issues from our archive. You might particularly want to take a look at our most recent issue, the fall special edition in History. While you are visiting, browse our new Faculty Features, which highlight the efforts of Dr. Dianna Vitanza and Dr. Randall Jean to support undergraduate research, and read about our upcoming fall 2011 edition on the art of Georges Roualt and Marc Chagall.

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John Milton's Paradise Regained*, though often overshadowed by its famous predecessor, is an important work for its descriptions of virtue, temptation, and the Son of God. This paper examines the nature of the Son's education, Milton's conception of temperance, and the roles they play in determining the kind of education Milton intends for the reader. These observations are followed by an analysis of the demonstrative and rhetorical devices that Milton uses to educate the reader in virtue.*

"Hung'ring More to Do My Father's Will": Temperance and the Reader's Education in *Paradise Regained*

Karen Caylor

In John Milton's brief epic poem *Paradise Regained*, the Son of God is led by the Holy Spirit into the desert after his baptism, where Satan tempts him, so that he may "lay down the rudiments / Of his great warfare" to "conquer Sin and Death" (1.158-159). These rudiments consist of his growth in self-knowledge and virtue, ultimately allowing him to redeem mankind by giving his life as an expression of his love for and obedience to the Father. Within the action of this brief epic, the Son grows in the four cardinal virtues: temperance, courage, prudence, and justice, which Josef Pieper calls "the four hinges on which swings the gate of life" (145). The first two temptations with which Satan tries the Son are the temptation to turn stone into bread and the temptation to partake of a sumptuous banquet. Both temptations deal with the virtue of temperance. As the Son faces the temptations, he must decide whether to succumb to intemperance or to practice temperance, which he knows his Father desires. In this paper, I examine several critics' approaches to understanding the education of both the Son and the reader in *Paradise Regained*, some ancient and medieval Christian conceptions of temperance and Milton's interaction with each, how the Son exhibits and practices temperance in his responses to the temptations, and how the Son's responses affect the reader's education. Ultimately, I argue that Milton uses the Son's actions and words to demonstrate his virtue and thereby attempts to persuade the reader to participate with the Son in his practice of temperance.

Though scholars disagree about the nature of the Son's education, they concur that Milton's demonstration of it is instrumental in his attempt to educate the reader. Their understandings of what the Son knows about himself in the poem and how he grows in virtue are crucial to these disagreements. Some scholars claim that the Son has complete self-knowledge from the beginning of the poem. Marc Ricciardi, in an attempt that ignores some of Milton's beliefs about the nature of the Son of God, aims to reconcile Milton's representation of the Son with his own view of the Incarnation and hypostatic union. Ricciardi claims that the Son is fully aware of his identity from the beginning of the poem and criticizes those who suggest that the Son comes to a gradual understanding of himself (Ricciardi 49). In a different interpretation, Angelica Duran describes the Son's education as a process of self-discovery in which Satan "unwittingly" helps him understand his vocation of pedagogy and gain confidence in his ability to fulfill it (162). However, many other authors find a deeper significance in the Son's growing self-knowledge than the mere individual self-discovery Duran describes. John Karl Franson claims not only that the Son learns about his divine nature through the temptations, but also that the temptations of the bread and the banquet specifically lay the groundwork for the final temptation, which culminates in "Christ's comprehension of the Incarnation" and his defeat of Satan (192). Barbara Lewalski, in *Milton's Brief Epic*, similarly contends that "only if Christ comes to understand himself and his work perfectly can he withstand the temptations of Satan," and further asserts that "[t]he temptation process itself serves as a stimulus to Christ's growth toward complete understanding" (133). As the Son comes to better understand his own divinity, he is more prepared to take on the role that his unique identity as the Son of God and Savior of mankind requires.

Like the Son's self-knowledge, the Son's virtue is an important aspect of understanding his education. In his book on the relationship between knowledge and heroic virtue in *Paradise Regained* and *Samson Agonistes*, Arnold Stein discusses the close relationship between self-knowledge and the virtue of temperance, claiming that "[t]he Christ of *Paradise Regained* is the great *exemplum*" of self-knowledge as "the condition of purification" (34). This recognition of the relationship between self-knowledge and virtue is crucial because it identifies the purpose for the Son's growing knowledge of himself. The process is not merely one of self-discovery, but one of growth in virtue for the

purpose of loving God and redeeming mankind. Anthony Bartl argues that Milton engages Aristotle's teaching on virtue throughout *Paradise Regained* by establishing "the Son as the truest model of the Aristotelian *great-souled man*" (3). Bartl acknowledges his debt to James S. Baumlin, who describes the Son as "committed to self-knowledge and rational self-government" and claims that the Son is "exercised in a distinctively Aristotelian ethic" (41, 51). The Son's education consists in a practice of the virtues which will allow him to fulfill his calling by the Father.

Based on disparate views of the Son's self-knowledge and virtue, and thus his education, authors develop different views of the reader's education—what and how Milton intended the reader to learn from reading his work. Lawrence Hyman, in his article "The Reader's Attitude in *Paradise Regained*," argues that readers often identify more readily with the cunning temptations of Satan than with the more austere replies of the Son, and that their realization of their difference from the Son will urge them to refrain from sin as he does. Although Hyman gives a fairly Gnostic account of the Son's resistance to temptations, claiming that its end is to separate the Son from the world, his assertion that Milton sets the Son up as an example to the reader is a fairly common interpretation. Duran makes similar assumptions in her account of the Son's education, implying that his education is Milton's model for the educational and personal development of any student. Others, however, see the construction of the poem itself as a mechanism for educating the reader. Elaine Safer, examining the dialogue between the Son and Satan as Socratic, calls the reader "the silent participant in the dialogue" and claims that "*Paradise Regained* establishes a mock set of values and a mock ruler (the Prince of Darkness), and by the process of mental combat enables the reader to choose to reject the values of the Sophist and adopt those of Christ" (224). Similarly, Ryan Netzley notes that despite the Son's apparent rejection of reading in *Paradise Regained*, the poem is written to be a practice in repetitive reading that enables a reader to practice and develop virtue. Like Safer and Netzley, I suggest that the Son's resistance to temptation constitutes much more than a mere moral example to the reader because of his unique identity and education. Because Milton establishes that one purpose of the Son's temptation is "lay[ing] down the rudiments / Of his great warfare" to "conquer Sin and Death," this interpretation of the Son's education coincides more closely with his nature as the Savior (*Paradise Regained* 1.158-159). The Son's actions and words are designed to draw the reader

into participation with his virtue, and the temptations of the bread and the banquet bring the virtue of temperance into focus.

Before we can examine exactly how Milton uses the Son's actions and words to educate the reader in temperance, we must first understand Milton's conception of temperance. Throughout his works, Milton draws on classical views of virtue. Despite the fact that the Son in *Paradise Regained* seems to disparage all classical learning (4.285-321), Milton's writings clearly treat classical learning as a valuable tool, though it ought to be subordinated to the study of Scripture. Aristotle's influence in particular is evident throughout much of Milton's writing. In his tract *Of Education*, for example, he uses Aristotle's term *proairesis* (moral choice) to describe the sort of reason he aims for students following his educational plan to develop (232). Bartl argues that "*Paradise Regained* is a deep engagement with Aristotle's *Nicomachean Ethics* that draws the philosopher's ethical teachings into the service of Christ" (3). Understanding Aristotle's definition of temperance and its Christian appropriations, then, is important for comprehending Milton's portrayal of the Son's temperance and his attempt to educate the reader in virtue.

The conception of temperance and its corresponding vices in *Paradise Regained* draws largely on Aristotle's treatment of them in the *Nicomachean Ethics*. Temperance, according to Aristotle, is a virtue concerned with the pleasures of the body, specifically the sense of touch. He also claims that taste is closely related to touch and that the pleasure gained by eating primarily comes from the sense of touch. To support this, he refers to a story of a "gourmet" who "prayed that his throat might become longer than a crane's," because what he enjoyed so much was the sensation of food sliding down his throat. (Aristotle 3.1118a.32-33). Consequently, if a disposition toward too much or too little physical pleasure constitutes intemperance, then the desires for food and sexual gratification are susceptible to intemperance. Gratifying these desires improperly is particularly disgraceful, Aristotle claims, because touch is the "sense that is most widely shared" with animals and that "gives scope to licentiousness" (3.1118b1-3). Intemperance in these desires, then, is "brutish," whereas temperance is properly human (Aristotle 3.1118b.5).

As he does with all of the moral virtues, Aristotle locates temperance as a mean between two vices. The desires themselves, he insists, are natural. "[T]he desire for food is natural" because everyone has need of food, and so seeks it "either in solid or liquid form"

(Aristotle 3.1118b.10-12). The desire for sexual intercourse is also natural for man, he says, especially "when, in Homer's phrase, he is young and lusty" (3.1118b.10). The vices associated with these desires, then, are dispositions toward either an excess or a deficiency of pleasure. Licentiousness refers to the former. However, although the simplest description of licentiousness is simply a desire for an excess, Aristotle notes that a person may be wrongly disposed toward bodily pleasures in several different ways. With respect to natural desires, one may simply want too much, as when a man might "eat or drink indiscriminately until one is full to bursting" and "exceed in quantity one's natural limit" of consumption (Aristotle 3.1118b.15). However, a man might also "go wrong" in his desires for particular things; some "go wrong in enjoying the wrong objects, others in enjoying things with abnormal intensity, or in the wrong way" (Aristotle 3.1118b.20-25). Thus, licentiousness is an excess of or aberration from reasonable, natural desire in degree, object, or quantity of object. Insensibility, the vice opposite licentiousness, is a deficiency of desire for either food or sexual gratification. This extreme seems highly improbable to Aristotle, for "if there is any creature to whom nothing is pleasant and everything indifferent, he must be very far from being human" (3.1119a.8-10). In fact, such a vice seems so unlikely that he is reluctant even to give this lack of desire a name, "because such a type hardly occurs" (3.1119a.10).

Aristotle claims that the deprivation of goods such as food and sex, whether voluntary, as in a fast, or involuntary, is an important way to gauge whether a man possesses the virtue of temperance or not. Licentiousness can be more evident in an intemperate person's behavior in the absence of a desired object than in his behavior when it is present. One who is licentious will be "unduly distressed at missing what is pleasant," while a temperate man will not. A temperate man might even abstain from pleasure intentionally, as in a fast (3.1118b.30). Conversely, if a man is too content when deprived of physical pleasures, he might be accused of insensibility.

Christian thinkers preceding Milton often engage with ancient conceptions of virtue, such as Aristotle's, and appropriate them to their own use. The general ideas which Aristotle sets forth concerning temperance continue to thrive in their works: that it is a virtue concerned primarily with the pleasures of the body, particularly eating and sexual intercourse; that it is a mean between the extremes of excessive desire for bodily pleasure and deficiency of desire; that straying from

temperance in either direction makes one less human; and that, as a virtue, temperance helps one to become more human. There are some major differences, however, between Christian and Aristotelian ideas of temperance. One interesting difference is that Aristotle found little reason to write of insensibility except as the opposite of licentiousness, but the Christian tradition has had more reason to discuss it as a vice. While Aristotle simply notes that desires for pleasures of the body are natural and claims that anyone who is disinclined toward them is strange and inhuman, Aquinas states in much stronger language that "to fly in the face of nature is wicked" (2a2ae.q142.a1). He emphasizes that "in the natural order of things pleasure goes with the operations necessary for human life," and that meeting human physical needs is so important that "to fail to meet these claims by refusing pleasure [one] would run counter to the order of nature and sin" (2a2ae.q142.a1). Because of early Christian battles with the heresy of Manichaeism, which regarded the body as evil, Aquinas explicitly affirms the goodness of nature, whereas Aristotle merely assumes it. The idea that a benevolent God created the material world as good is central to Christian understanding of temperance. While "foregoing these pleasures for a good purpose is sometimes praiseworthy or even obligatory," they should never be foregone out of the belief that the pleasures are themselves wrong (Aquinas 2a2ae.q142.a1). Even while speaking of practices which involve abstaining from pleasures, Aquinas emphasizes the fact that pleasure, as part of nature, is good.

The idea of a loving Creator is itself another difference between Christian and Aristotelian conceptions of temperance, and it is central to understanding Milton's portrayal of the Son's virtue in *Paradise Regained*. While in Aristotelian thought the purpose of virtue is the happiness of the one who is virtuous, in Christian thought a man is virtuous both for his own sake and to love God his Creator. Conversely, intemperance is not only an aberration from reason and nature, but also a transgression against the loving Creator of reason and nature. The practice of temperance, then, is not merely for the sake of being well ordered in oneself but for participation in divine love. Pieper states that "to love God more than himself is in accordance with the natural being of man" and that true temperance, in the Christian sense, is enacted in "selfless self-love, which seeks not itself blindly, but with open eyes endeavors to correspond to the true reality of God, the self, and the world" (149).

Milton directly engages with Aristotle's view of virtue rather than drawing on other Christian thinkers' interpretations of Aristotle's works, perhaps to counter some of the medieval applications of his ideas. He would have seen much of medieval thinkers' use of Aristotle's thought as "[justifying] perspectives and practices that would have been abhorrent to [him], due to their connection with Papal Rome" (Bartl 20). As a consequence, he chooses to work directly with Aristotle's text and to learn from the ideas outside a tradition that he believes has used the *Ethics* to ill ends. However, as a Christian, he must incorporate Aristotle's thought into his Christian teaching in a way that bears many similarities to Aquinas's thought. As Bartl puts it, Milton aims to "infuse [Aristotle's teaching on ethics] with faith and charity and thereby redeem it, insisting that even the great Philosopher needs to be brought to the foot of the cross" (21).

In *Paradise Regained*, the Son demonstrates his temperance by his actions and words in resistance to Satan's temptations to make bread from stone and to partake of the banquet offered to him in the desert. Interestingly, Satan never tempts the Son with sexual pleasure. The demon Belial suggests this in the second council of demons, but Satan rejects this method of temptation in favor of "manlier objects," using "that which only seems to satisfy / Lawful desires of nature" (Milton, *Paradise Regained* 2.225, 229-230). In his first assay, Satan suggests in the guise of an old shepherd that the Son turn one of the stones around him to bread in order to alleviate his hunger. Following the biblical account, the Son's response comes from Deuteronomy 8:3: "Man lives not by bread only, but each word / Proceeding from the mouth of God" (Milton, *Paradise Regained* 1.349-50). In his second attempt to cause the Son to break his fast, Satan presents the Son with a sumptuous banquet. In this instance, he does not merely suggest that the Son break his fast by his own power, but provides food with which to do it. As before, the Son declines his offer. The Son's acceptance or rejection of food may not seem to be a question of temperance. By the time Satan arrives to tempt him, the Son has been wandering in the desert without food "full forty days" (Milton, *Paradise Regained* 1.303). By all appearances, the Son's breaking of his fast would not be intemperate. Forty days without food tests the limits of both hunger and the endurance of the human body. The Son seemingly refuses a pleasure that would only meet his natural need thus exceeding the idea of foregoing pleasure "for a good reason"

(Aquinas 2a2ae.q142.a1). In looking only at this apparent asceticism, Hyman's reading of the Son as aloof, bent on detaching himself from the world of the flesh and setting an austere example for the reader, seems plausible. Such a fast, contrary to nature, certainly appears to be an extreme case of the insensibility of which Aristotle could hardly conceive.

The Son's identity as both fully human and the Son of God, however, explains the extremity of his fast while still allowing his active resistance to function as a model for temperance and an opportunity for the reader to learn temperance. The Son's case of fasting seems to be exceptional, his body sustained supernaturally by the Father. Because of his divine sustenance and particular calling, the idea that eating the food would be intemperate, and not merely satisfaction of need, is conceivable. The narrator informs the reader before the temptation to turn stone into bread that the Son "[no] hunger felt, / Till those days ended, hungered then at last / Among wild beasts" (Milton, *Paradise Regained* 1.309-310). Before the temptation with the banquet, the Son claims that he has no "appetite" and that he has not needed to endure this fast by means of his own virtue thus far, asking, "if nature need not, / Or God support nature without repast, / Though needing, what praise is it to endure?" (Milton, *Paradise Regained* 2.249-251). As Franson states, "he recognizes that his human appetite is an unreliable indicator of his actual bodily needs, that the Father can work … a miracle upon him … satisfying his temporal requirements, yet leaving the pains of hunger with the apparent motive of creating trying circumstances under which faithfulness can be tested" (182-183). Satan's words of temptation to partake of the banquet primarily appeal to pleasure rather than need as the purpose of the food in front of him: "Their taste no knowledge works, at least of evil," he says alluringly, "[b]ut life preserves, destroys life's enemy, / Hunger, with sweet restorative delight," (Milton, *Paradise Regained* 2.371-373). In identifying "life's enemy" as hunger, rather than the sin and death that the Son has been sent to defeat, Satan attempts to persuade the Son that satisfying his hunger is a good in itself.

The Son's demonstration of his temperance in these two temptations is ultimately Milton's attempt to draw the reader into participation with him in this virtue. These instances of obedience are opportunities for the Son to grow in virtue by practicing it and to gain self-knowledge. However, he does not learn any new external information in these encounters. Both before and after Satan tempts him to turn

stones into bread, as well as before and after the banquet temptation, he expresses trust in God to provide what he needs despite his hunger. Rather, he is presented with an opportunity to practice his virtue and, as Aristotle says, become "temperate by performing temperate [acts]" (2.1103b.1). He undergoes an experiential education, and in it he has an opportunity to cause his actions to coincide perfectly with his words before the temptation, demonstrating that he actually possesses the virtue of temperance rather than merely speaking as though he does.

First, he continues in the unperturbed attitude that he exhibits before the temptations in the face of his long fast, recognizing its unique purpose. He is not, to use Aristotle's words, "unduly distressed" at the lack of fulfillment of his desire for food; he remains calm and able to see through each of Satan's arguments (3.1118b.30). Furthermore, he reveals his trust in the Father as the real source of provision for his needs and claims that he has been given the ability to fulfill his need should he so desire: "I can at will, doubt not, as soon as thou, / Command a table in this wilderness, / And call swift flights of angels ministrant / Arrayed in glory on my cup to attend" (Milton, *Paradise Regained* 2.383-386). He is cognizant of a greater purpose for his fast and decides to continue to fill himself rather "with better thoughts that feed / [Him] hung'ring more to do [his] father's will" (Milton, *Paradise Regained* 2.258-259). He recognizes that his true good, even above his immediate physical health or satisfaction, lies in his loving obedience of the Father and in fulfilling his call to redeem mankind. Because he trusts and loves the Father, he is able to practice temperance in the face of this temptation.

As many critics have noted, one component of this practice of virtue is the Son's self-knowledge; the Son demonstrates his virtue partly to himself. Just as Job, an important type of Christ throughout the poem, was stripped of all of the external benefits of righteousness but was commended for remaining faithful to God, so also the Son is led into the desert away from all other men to be tested in his virtue and love for God. In the midst of a later temptation, the Son states that perhaps the reason behind his travel in the desert is that he "be tried in humble state . . . suffering, abstaining, quietly expecting / Without distrust or doubt, that [his Father] may know / What [he] can suffer, how obey" (Milton, *Paradise Regained* 3.189, 192-193). However, in his speech to Gabriel before the Son is led into the desert, the Father seems perfectly confident in the Son's ability to obey and suffer, calling him "far abler to resist" Satan's "solicitations" even than Job (Milton, *Paradise Regained*

1.151-152). The purpose of the Son's temptation is not to prove his worth to the Father, then, but for his own sake; he gains an experiential self-knowledge. He claims that virtue on his own part did not help him withstand his fast before the temptations, but aid from God. However, his response to Satan's temptations is an active resistance, and his words are forceful and confident: "Thy pompous delicacies I contemn / And count the specious gifts no gifts but guiles" (Milton, *Paradise Regained* 2.390-391). The Son practices virtue in these temptations, conforming his will to the disposition for which he has already shown a propensity. He also gains knowledge of his own temperance. In gaining knowledge of his virtue, he is gaining knowledge of who he is as the Son of God and his own calling. His temperance, as we have noted before, is not merely for his own sake, but for the sake of trusting and loving the Father and mankind, whom he has been sent to save. As the Son grows in temperance, then, he grows in his ability to love.

In addition to the active demonstration of the Son's growth in the virtue of temperance to himself and the reader, the Son's words also draw the reader into participation in this virtue. One way in which the Son draws the reader toward virtues is by using epideictic or demonstrative rhetoric, in which a speaker attempts to persuade his audience to praise or blame the object of his speech. Throughout *Paradise Regained*, the Son blames Satan for his deceit and malice, particularly in his attempts to lead the Son toward intemperance. In the temptation to turn stone into bread, the Son blames Satan after he has identified him as the "arch-fiend," saying severely: "Deservedly thou griev'st, composed of lies from the beginning, and in lies wilt end" (Milton, *Paradise Regained* 1.407-408). In the banquet temptation, he calls Satan's display "specious" and the goods he offers "guiles," asking almost contemptuously: "And with my hunger what hast thou to do?" (Milton, *Paradise Regained* 2.389-391). In blaming Satan as a liar, he exposes Satan's intentions, revealing that he knows Satan's words cannot be trusted. By having the Son accuse Satan so unequivocally, Milton attempts to sway the reader's attitude as well. The reader is called to blame Satan's malice and guile along with the Son. Even in a later temptation that is more directly related to justice, Milton maintains his concern for educating the reader in temperance. As the Son looks on the city of Rome, he reproaches the Romans for their "sumptuous gluttonies and gorgeous feasts," saying that they are "by themselves enslaved" to their intemperate behavior (*Paradise Regained* 4.114, 144). This censure of intemperance continues to call the reader to

despise such vices. By blaming the tempter and the vices to which he is tempted, the Son's words endeavor to sway the reader to have the same distrust for Satan and same contempt for intemperance as the Son has.

Within these temptations, the Son does not directly use praise as much as blame. In one instance, however, he expresses confidence in his Father, identifying himself with others who have similarly depended on God for their sustenance:

> [God] fed
> Our fathers here with manna; in the mount
> Moses was forty days, nor ate nor drank,
> And forty days Elijah without food
> Wandered this barren waste, the same I now (1.351-354).

By calling attention to his Father's provision in the past, he praises his Father's generosity and love. Milton, by having the Son praise his Father, hopes to persuade his readers to similarly praise the Father for his sustaining love.

Another device that Milton uses to draw the reader into participation with the Son's temperance is the rhetorical question. In the temptation to turn stone into bread, the Son begins with the question "Think'st thou such force in bread?" (Milton, *Paradise Regained* 1.347). This calls into question Satan's assumptions about the nature of what the Son is enduring, that he needs to "save [him]self" from his hunger (Milton, *Paradise Regained* 1.344). He continues with the question, "is it not written … Man lives not by bread only, but each word / Proceeding from the mouth of God[?]" and subsequently begins to name examples of God's provision for others (Milton, *Paradise Regained* 1.348-350). By placing these claims in the form of a question, he causes the reader to participate in his reasoning. In this case, his words prompt the reader to doubt Satan's thinking and to remember the stories of God's provision.

The Son's response to the banquet temptation is also characterized by the use of rhetorical questions. He asks Satan, "Said'st thou not that to all things I had right? / And who withholds my power that right to use? Shall I receive by gift what of my own, / When and where likes me best, I can command?" (Milton, *Paradise Regained* 2.379-380). In asking these questions, the Son prompts the reader to recognize Satan's mischaracterization of the Son's need and the deceptive allure in the sumptuous descriptions of the "table richly spread" with delicacies

(Milton, *Paradise Regained* 2.340). The first question draws the reader's attention to the words Satan uses in his temptation: "Hast thou not right to all created things, / Owe not all creatures by just right to thee / Duty and service, nor to stay till bid, / But tender all their power?" (Milton, *Paradise Regained* 2.324-327). In the second, the Son both questions Satan's assumptions about the matter and implies that he is undertaking this fast freely for some purpose, though "to what intent" he still may not grasp fully (Milton, *Paradise Regained* 1.291). Satan's own rhetorical question implies that because the Son has the right to control created things, he ought to assert that right against whatever may be keeping him from the satisfaction of his desires. However, the Son's second question informs the reader that he is practicing virtue by obeying his Father out of love, rather than out of submission to a coercive call. The third rhetorical question implies that he has no need of Satan's luxurious gift, for everything Satan offers has already been given to him. His needs have already been supplied. The reader understands, then, that the Son's acceptance of Satan's "gift" would be unreasonable because it would entail disregarding the Father's provision. In this way, Milton draws the reader to believe with the Son that the Father has provided for all real needs, and that reaching beyond the fulfillment of need would be intemperance.

In conclusion, I have described how Milton's views of the Son's education and temperance are key to understanding the reader's education in *Paradise Regained*. Because scholars understand the Son's self-knowledge and virtue differently, they also differ in their understandings of the purpose of the Son's education, and thus the nature of the reader's education. Milton's view of virtue as a disposition to be developed is deeply influenced by Aristotelian ideas, though he appropriates these ideas to his ends as a Christian author. As I have shown, understanding that the Son's education consists in his growth in self-knowledge and practice of virtue and recognizing its purpose of "lay[ing] down the rudiments / Of his great warfare … [t]o conquer Sin and Death" suggests a reading that takes account of the Son's nature as the Redeemer of mankind (Milton, *Paradise Regained* 1.157-159). Milton's clear use of demonstrative and rhetorical tools further supports the interpretation of the poem as an attempt to bring the reader into the Son's virtue, instead of simply establishing the Son as moral example.

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Although many Victorian authors looked to classical Greece for their subject matter and themes, Thomas Hardy is unique in his adoption of the overarching Hellenic worldview. His tragic heroine in Tess of the d'Urbervilles *demonstrates Hardy's particular reliance on* Hippolytus *of Euripides. The plight of Tess mirrors that of Phaedra; both women are caught between battling forces of love and purity, and both are eventually overpowered by the strength of their passions. In a particularly Greek manner, Hardy does not hold his heroine morally responsible for her actions. Tess is a victim, like Phaedra, of a higher power. However, Hardy diverges from the idea of the Greek hero in the conclusion of his novel, in which Tess is neither absolved nor avenged, but dies in obscurity with no voice to clear her name.*

The Suffering Woman: Hardy's Tess and Euripides's Phaedra

Alyssa Leavell

The Victorians harbored a keen awareness that they lived in the shadow of the ancient Greeks. They imagined the classical world as a "Golden Age," as termed by Thomas Love Peacock, a time "without rivals in any other department of literature."[1] Lacking any apparent hope of eclipsing their predecessors, writers of the nineteenth century resigned themselves to mere imitation of classical themes. The problem, of course, with imitation is its inauthenticity; the tragic grandeur of Greek myth does not translate well into Christian humility and faith. For the most part, Victorian writers did not capture the weight of Hellenism because they lacked its heavy heart. Notoriously skeptical of Christian grace, Thomas Hardy stands out among his contemporaries as a rare example of authentic Hellenism in an age of mimicry. His most popular and perhaps most poignant novel, *Tess of the d'Urbervilles*, embraces a worldview that draws heavily on Greek concepts of human futility and suffering. Hardy models the proud yet ill-fated Tess after Phaedra, the suffering woman of Euripides's *Hippolytus*, who, like countless women before and after, is torn between the goddesses of passion and chastity.

The similarities between Tess and Phaedra partially developed from the time periods in which Hardy and Euripides wrote. Both authors witnessed a rapidly changing society that questioned, among other conventions, the feminine role. This identity struggle gave rise to the suffering women who are both torn between the force of passion and the desire for purity. Within contemporary literature Tess is uniquely Greek, as she and Phaedra are not morally responsible for their tragic descents but fall victim to forces outside of their control. Eventually, the unrelenting pain in their lives drives both women to self-sacrifice in order to appease their respective gods. However, here Hardy's representation of the suffering woman differs from the Greek model. As Phaedra's tragedy finally comes to an end, Artemis appears onstage to defend her innocence. By contrast, Tess is neither absolved nor avenged, but dies in obscurity with no voice to clear her name.

The Suffering Woman: A Reflection of Changing Times

Hardy fully understood that the critics of his day considered Aeschylus and Sophocles the great Greek tragedians and viewed Euripides as something of a tagalong little brother—he came too late, the critics said, after all the good ideas had been taken, and he was a little odd to begin with. Scrawled onto the title page of Hardy's copy of *The Tragedies of Euripides* is a quotation by Swinburne: "It is far easier to overtop Euripides by the head and shoulders than to come up to the waist of Sophocles or the knee of Aeschylus." Hardy has written underneath, "An old opinion, but not true." [2] Clearly, Hardy identified with Euripides in a way that other critics could not understand.

Hardy perceived a kindred spirit between Euripides and himself partly because of their similar portrayals of women. Although all the Greek tragedians created strong female characters, most of their powerful women possess some character traits of men. The tragic cycle of Aeschylus's *Agamemnon* begins with Clytemnestra, who abandons her role as a wife and mother to take on the duties of a man. Sophocles's Antigone also takes charge due to inadequate male leadership. Euripides, on the other hand, presents beautifully crafted heroines who fully maintain their femininity, yet are capable of great emotional depths. Hardy's heroines are likewise celebrated for their "intimate and profound interpretation of the woman's heart," as termed by an unsigned reviewer of *Tess of the d'Urbervilles* (Hardy 467-468). Therefore, it should come

as no surprise that Hardy did not turn to the female characters of Sophocles or Aeschylus, but to Euripides's Phaedra as a model for his own tragic heroine.

Hardy and Euripides shared an interest in female characters in part because of their historical contexts. Both were poised on the cusp of a transitional time period between a passing era of moral faith and one of skepticism looming in the future. This societal change challenged, among other conventions, traditional psychological and social attitudes toward women. Hardy and Euripides were both deeply aware of this undercurrent in their respective ages, and they used strong female characters to comment upon the changing role of women within the larger context of their changing worlds.

In his vibrant overview of nineteenth-century Britain, *The Victorian Frame of Mind*, Walter E. Houghton analyzes the hypocritical nineteenth-century attitude towards women, which he traces back to two contradictory circumstances: women were expected to be innocent and they were increasingly expected to be educated. On the one hand, the Victorian age emphasized respect for morality, which women supposedly epitomized. The home was seen "as a source of virtues and emotions which were nowhere else to be found, least of all in business and society … It was a place apart, a walled garden."[3] Men spent time at home because they expected their wives to be vessels of purity and innocence. At the same time, women began to benefit from the rising establishment of public education. On this matter Houghton quotes John Stuart Mill, who credited the increasing dialogue between husband and wife to the "kind and degree of improvement which has been made in women's education, [making] them in some degree capable of being his companions in ideas and mental tastes."[4] These improvements in education, despite bringing women closer to intellectual equality with their husbands, clashed with the Victorian standard that women must be innocent paradigms of virtue. With education inevitably comes a loss of naiveté, a thirst for identity, and a questioning mind that conflicts with the ideal of a pure and submissive Victorian wife.

Hardy perceived the double standard that his society imposed upon women, and he expresses his concern through the misunderstandings between Tess and her mother, Joan. Joan Durbeyfield views Tess's misfortunes with a matter-of-fact mentality that seems rather cold compared to Tess's sensitivity. Hardy makes clear that Joan is not cruel, just from a different time; her relationship to Tess represents "the

Jacobean and the Victorian ages… juxtaposed" (Hardy 50). The Victorian era, with its rigid ideals and increased public education, expected women to rigidly uphold the moral canon while giving them the intellectual tools to refute it. It is only natural that Joan, from her practical upbringing, is shocked that Tess has "not got [Alec] to marry 'ee! … Any woman would have done it but you, after that!" And it is equally natural, from a Victorian perspective, that Tess recognizes her mother's conventional prudence and admits "perhaps any woman would except me," yet she remains firm (111). Tess, the Victorian, has a strong and personal sense of morality, yet she finds that her convictions contradict those of her society, and therein lies the problem.

Euripides also lived in an evolving world. Richard Jenkyns, the author of *The Victorians and Ancient Greece,* believes that Euripides's plays, chiefly of all the Greeks, "were surely produced in a time of intense spiritual discomfort, a time when the old moral certitudes were being undermined by the speculations of rationalistic philosophers."[5] The Peloponnesian War inspired in Athens the strange mixture of patriotism and suffering that only war can bring. Meanwhile the Sophistic Movement, much like the scientific advances that fascinated Hardy, emphasized rational thought and questioned traditional mythology and social values. Among these changes, women began developing a sense of autonomy, and new legislation emphasized their importance. Aspasia, the female philosopher and partner of Pericles, went from house to house throughout Athens, teaching other women to question their traditional roles in Athenian society. W. L. Courtney, a rough contemporary of Hardy's, describes the revolutionary effect of Aspasia on her companions:

> Thucydides makes Pericles say, speaking of the proper place of women in a social state, that that woman leads the best life whose name is least commented upon by the public, either for praise or blame. That, no doubt, was the Athenian ideal; but it was exactly the opposite of the ideal which Pericles aimed at in his own house. No one was more talked about than Aspasia.[6]

Certainly Pericles's personal views regarding women are impossible to divine, but, regardless of his intentions, he passed a law in 451 BCE that strengthened the importance of female citizenship. Athenian women were considered full citizens of their state even before the passage of

this law, but the title carried little or no political power for women before 451. They were unable to contribute to public affairs, and citizenship had been strictly patrilineal, passing from father to son regardless of the mother's status. Pericles increased the standards of citizenship to include only children born of both Athenian parents.[7] As a result, the citizenship of women carried weight in addition to a title. This legislation, along with the philosophy and public image of Aspasia, began stirring up questions regarding the traditional feminine role.

Like Hardy, Euripides focused much of his attention on the changing position of women in society and in the home. His personal view of women has been highly contested. According to H. D. F. Kitto in his book *Greek Tragedy: A Literary Study,* Euripides has been attributed with both "the misogyny which ancient critics regretted in him, [and] the feminism of which some moderns accuse him."[8] Paul Decharme acknowledges in *Euripides: The Spirit of his Dramas* that he has "said little of [women] that is good, and a great deal that is bad."[9] Yet at the same time, Euripides's most complex characters are often the very women he condemns. Decharme does say that although Euripides is generally negative toward the virtue and value of women, he provides his female characters with ample reasons that include "the faithlessness of the husband … the allurement of evil counsels … heredity … her education … [and] the conditions in which she was placed in virtue of the law."[10] In fact, Edith Hamilton points out in *The Greek Way* that feminists of the early twentieth century used Euripides's passage from *Medea* as a battle-cry:[11] "They say of us that we live a life of ease at home, but they are fighting with the spear; judging ill, since I would rather thrice stand in arms, than once suffer the pangs of child-birth" (Euripides 143). Euripides recognizes the changing position of women in his age, and, although he is certainly critical, he also points out the compromising positions in which his society placed the feminine sex.

If the female characters of Euripides reflect fifth-century legislation and the philosophy of Aspasia, the skeptic might point out that, as they were contemporaries, any similarity should apply just as well to Sophocles. Although Sophocles and Euripides were contemporaries by date, the plays of Sophocles do not generally express the changes that unsettled Athens during their lifetimes.[12] Edith Hamilton also acknowledges that "Sophocles was aloof from the spirit of his age" in both his style, which conforms so closely to Aristotle's declared norm, and in his themes.[13] Both Sophocles and Euripides lived during a time of change; only Euripides, like Hardy, embraced it.

Although Euripides was critically regarded as the most flawed of the tragedians, Thomas Hardy recognized in his female characters the sufferings of a more modern age. Greek wives in the late fifth century BCE strove to reconcile their sexuality with their identities, as did the women in Hardy's lifetime. Naturally, when Hardy created his most complex female character to date—Tess Durbeyfield—he looked first to the example of Euripides to find a woman in great pain due to the injustices of her age. This woman is Phaedra of *Hippolytus*.

The Suffering Woman: Caught between Love and Purity

Suffering female characters are central to many of the works of Euripides, but Phaedra most closely resembles Tess as both are pawns caught between the battling forces of love and chastity. In Phaedra's case, the goddesses Aphrodite and Artemis appear physically onstage as well as through the emotional turmoil of the characters to represent love and chastity. With Tess, the forces of desire act upon her through external sources, specifically Alec and Angel, while her own purity comes from within. Both women struggle to exist in harmony between these opposing ideals, but the strength of passion eventually overcomes them.

The interplay between Aphrodite and Artemis in *Hippolytus* can be interpreted either as a battle between incarnate deities or as the mere personification of natural forces. Hardy seemed to favor the former interpretation. In his *Literary Notebooks*, Hardy records that, "The common theory … is that in Homeric days men believed faithfully in the acts & adventures of the Gods."[14] According to Hardy's source, the early Greeks took the gods of Homer literally. Later interpretations have identified the gods as mere symbols of the natural elements that they represent; however, since the passages indicating Hardy's literal understanding of Greek deities form the full extent of his notes on the subject, the Greek gods will hereafter be treated literally, as they are presented in *Hippolytus*.

When seen as tangible beings, the goddesses Aphrodite and Artemis frame every action in *Hippolytus*, leaving very little to human control. Actual statues of the two goddesses would have stood at either side of the stage. Characters allude to the statues from time to time—for example, Hippolytus offers a garland to the image of Artemis at the opening of the play, and his attendant then accuses him of ignoring "[Aphrodite], who hath her station at thy gates" (Euripides 176-177)[15].

These marble images suggest the omnipresence of the gods, who preside over every action of man. This framing device is reinforced chronologically by the embodied presence of the goddesses themselves at the play's beginning and end. *Hippolytus* opens with a lengthy soliloquy from Aphrodite and closes with a series of monologues from Artemis. In these speeches, Aphrodite swears to "avenge me on Hippolytus this very day" for his loyalty to Artemis, and Artemis later responds that she will "revenge me on another, whoever to her be the dearest of mortals" (Euripides 175, 210). These appearances echo the statues' message that the gods are always present, but they take the implications further; when the gods are warring, mortals suffer for it.

Phaedra falls prey both to Aphrodite's jealously, which enflames her love in the first place, and Hippolytus's exclusive devotion to Artemis, which renders compromise or even sympathy from him impossible. Thus throughout the play, the contrast between sex and virginity sets up the context within which tragedy unfolds. When Phaedra first appears onstage she declares three wishes, first to "draw from the dewy fountain the drink of pure waters," then to "cheer on the hounds and … hurl the Thessalian javelin," and finally to join "[Artemis], mistress of Limna near the sea … breaking the Henetian colts" (Euripides 180). These seemingly contradictory desires are all traditional activities of Artemis. Phaedra longs to run through the wilderness worshiping the goddess of virginity, but instead she has "fallen by the evil influence of some God," namely Aphrodite (Euripides 180). The passion that infects her soul has driven her to the verge of suicide, and Hippolytus's tirade against women sends her over the edge. His zeal for Artemis makes Hippolytus hate sexual love, and he illogically extends this hatred to all women, for in his eyes "in some way or other they surely are always bad" (Euripides 191). This irrational obsession with Artemis on the part of Hippolytus, combined with the sexual desire aroused in Phaedra by Aphrodite, creates an insurmountable conflict for Phaedra, who finds herself unable to maintain her respectability and therefore chooses death as a final recourse against dishonor.

Although the goddesses do not appear incarnate in Hardy's works, the forces that they represent set up an important dichotomy in *Tess of the d'Urbervilles*. Tess struggles throughout her short life to reconcile the perceived disjunction between her body, the object of sexual passions, and her soul—the soul, Hardy takes great pains to tell us, of a pure woman. The perception of physical sexuality and spiritual purity as

irreconcilable forces is endemic to Victorianism, but nevertheless harks back to the conflict established between Aphrodite and Artemis in Euripides's *Hippolytus*.

Even the most insensitive of readers ought to divine the suggestions of Aphrodite in the character of Alec d'Urberville. Tess first meets Alec in a garden lush with strawberries and roses, both powerful symbols of seduction. Alec knowingly takes full advantage of these implications. Although Tess would rather accept his gifts of her own accord, Alec insists upon personally feeding her the aphrodisiacal strawberry until "in a slight distress, she parted her lips and took it in" (Hardy 69). This clear foreshadowing imprints Alec's character with that of seduction, so that the following rape scene conforms to his sexually charged nature. Late in the novel, Alec essentially swears by the goddess Aphrodite, perhaps not by name but by nature. Immediately after denouncing Christianity as "religious mania," Alec pleads with Tess, calling upon "all that's tender and strong between man and woman" to bind his oath (Hardy 365). The back-to-back renunciation of the Christian God and the invocation of another power strongly suggest Alec's metaphorical loyalty to the classical goddess of sexuality, Aphrodite.

Angel Clare's relation to the Cyprian goddess is less pervasive, though still present. Admittedly, he is compared more often to Apollo, due largely to a direct reference in the text (Hardy 412). Nevertheless, a distinct sexual attraction draws him toward Tess at Talbothays Dairy. This attraction becomes most apparent on the morning that Angel returns from Emminster and finds Tess descending the stairs of the diary house:

> She had not heard him enter, and hardly realized his presence there. She was yawning, and he saw the red interior of her mouth as if it had been a snake's. She had stretched one arm so high above her coiled-up cable of hair that he could see its satin delicacy above the sunburn; her face was flushed with sleep, and her eyelids hung heavy over their pupils. The brimfulness of her nature breathed from her. It was a moment when a woman's soul is more incarnate than at any other time, when the most spiritual beauty bespeaks itself flesh; and sex takes the outside place in the presentation. (Hardy 198)

Angel's love is not purely carnal, like the love of Alec. Because of the influence of sexual passion, however, he cannot separate Tess from her

body, which he proves on the night after their wedding in his extreme reaction to her sexual past. Tess's confession transforms her in Angel's mind as he explains, "You were one person; now you are another," and in his horror he abandons her (Hardy 256). He falls victim to the prevailing idea of his time that divided women between the virgin and the whore, which Houghton describes as "an image wonderfully calculated not only to dissociate love from sex, but to turn love into … worship of purity."[16] This extreme perspective renders Angel unable to moderate his opinion of Tess into something between the polar opposites.

Tess herself is also unable to break free from this dichotomy, despite being as pure in spirit as Artemis herself. Although Alec defiles her, according to society's standards, and Angel condemns her, Tess remains almost painfully innocent. She states her lack of desire for Alec outright, claiming, "My eyes were dazed by you for a little, and that was all," and even with Angel, "there was hardly a touch of earth in her love" (Hardy 106, 221). She is a child of nature, an innocent spirit, a disciple of Artemis, so much so that Angel even calls her such (Hardy 161). Tess's consciousness of this rift in her personality constantly plagues her. She cannot place herself in a world that reveres the pure and castigates the flesh, and so she comes to the verdict "that in inhabiting the fleshly tabernacle in which Nature had endowed her she was somehow doing wrong" (Hardy 336). The war between Aphrodite and Artemis, incarnate in *Hippolytus* and implied in *Tess of the d'Urbervilles*, forces Tess to deem herself unfit for the world.

The Suffering Woman: The Victim of a Higher Power

The characters of Tess and Phaedra are alike in their struggles to resolve purity and passion, but perhaps more importantly, they are also both portrayed as victims of overpowering external forces. The suffering women of *Hippolytus* and *Tess of the d'Urbervilles* cannot escape their suffering, and they cannot act against the forces of passion. Among the Victorians, Hardy is unusual in his portrayal of Tess as a helpless innocent, "more sinned against than sinning" (260). In this way, his view resembles that of Euripides, whose female characters are described by Paul Decharme as "more unfortunate than guilty. They are the true victims of Aphrodite."[17] The parallel language is unmistakable. In the character of Tess, Hardy pursues the mentality of the Greeks, who often ascribed human misfortune to fate or the acts of the gods rather than a lapse of morality.

Hippolytus presents Phaedra as powerless, an innocent bystander to the wrath of Aphrodite. As the play opens, Aphrodite laments that "Phaedra dies, an illustrious woman indeed, yet still [she must die]" in order to fulfill the goddess's plot for revenge (Euripides 176). The desire awakened by Aphrodite is taboo, but Phaedra maintains social propriety as she copes with her passion. Although despair eventually overpowers her, the text clearly absolves Phaedra of blame; nearly every character attests to her helplessness. Her nurse acknowledges that "[Aphrodite] is a thing not to be borne, if she rush on vehement" (Euripides 186). Artemis explains how "she endeavored by right feeling to conquer [Aphrodite, but] she was destroyed" (Euripides 207). The chorus sums up Phaedra's plight most completely in a sort of premature eulogy:

> Wherefore she was heartbroken with the terrible disease of unhallowed love by the influence of [Aphrodite]; and now that she can no longer hold out against the heavy calamity, she will fit around her the noose suspended from the ceiling of her bridal chamber, adjusting it to her white neck, having revered the hateful goddess, and embracing an honorable name, and ridding from her breast the painful love. (Euripides 194)

Throughout the play, blame is pointed away from the central characters and toward the gods, especially Aphrodite. Phaedra attempts to control the passion inflicted upon her by Aphrodite but, in Greek fashion, she is powerless against the will of the gods.

Hardy echoes this Greek concept in the character of Tess. Human futility is a common theme in Hardy's novels, in which some overpowering force often drives the plot regardless of the intentions of the characters. *Tess of the d'Urbervilles* is no different, as Tess herself is carried through life by circumstances outside her control. In *The Hardy Companion,* F. B. Pinion refers to this force as the "'unsympathetic First Cause', the universal harshness," but it is more commonly known as the Immanent Will, which drives many of Hardy's characters to their doom.[18] The most accurate description of the Immanent Will comes early in the novel, in the image of the reaping-machine. As the machine cuts down row after row of wheat, Hardy describes the field mice that continually retreat into the shelter of the uncut stalks. As they flee, the mice are unaware "of the doom that awaited them later in the day

when … the last few yards of upright wheat fell also under the teeth of the unerring reaper," forcing the mice out to be killed (117). Tess sees the resemblance between those doomed mice and the lives of men, all eventually cut down by an impersonal and unstoppable fate. She describes to Angel her own future as "very fierce and cruel and as if [it] said, 'I'm coming! Beware of me!'" (154). In a world where human lives are controlled by an external power, Tess is not to blame for her misfortunes. Like the mice before the reaping machine, she is only a victim in the path of her unsympathetic fate.

Just as Aphrodite drove the helpless Phaedra to her death, so Hardy includes in his novel the force of passion, which works in service to the Immanent Will to seal Tess's doom. At Talbothays Dairy, the milkmaids are oppressed by unbidden love, "an emotion thrust on them by cruel Nature's law—an emotion which they had neither expected nor desired" (176). The attraction between Angel and Tess is so strong that "flesh and blood could not resist it," and so try as she might, Tess cannot detach herself from the situation (184). Like Phaedra, Tess struggles to act virtuously in spite of her circumstances until she is overpowered by her passion. When she can endure no more emotional torment, she resorts to murder because she "could not bear the loss of [Angel] any longer" (411). Even here, Hardy does not ascribe any blame to her. Tess's sufferings, including the murder of Alec, are the result of forces outside of her control, especially the overwhelming power of love.

Hardy's treatment of Tess as an innocent victim is jarringly Hellenic within the context of nineteenth-century Britain. Walter Houghton identifies the Victorian age as a time when sexual aberration, "no matter what the extenuating circumstances, was spoken of with horror."[19] In an 1892 review included in the appendix of the Broadview edition of *Tess of the d'Urbervilles*, Clementina Black acknowledges Hardy's unusual position towards Tess's culpability. Hardy understands that a woman's entire life cannot be deemed immoral based on a single sexual incident; however, according to Black, "the writers who have had eyes to see and courage to declare the same truth about women are few indeed," placing Thomas Hardy in a "brave and clear-sighted minority" (Hardy 469). Although the Victorians were quick to assign moral blame to any sexually deviant woman regardless of her circumstances, Hardy, like the Greeks, accepted the role of fate in the lives of men and women.

Thus the fates of Tess and Phaedra coincide. In presenting the suffering woman, Hardy imitated a conflict originally constructed by

Euripides. Both Tess and Phaedra fall under the irresistible influence of desire in the face of an unrealistic standard of purity. Neither woman is reproachable for succumbing to this force, as Victorian standards would insist, but rather they are portrayed in the Greek tradition as victims of a higher power. In this way, Hardy demonstrates a strong Hellenic trend in his own thinking. His suffering woman, Tess, is innocent and pure in spite of her misfortunes.

The Suffering Woman: A Sacrifice

Given the unrelenting suffering that Tess and Phaedra endure, coupled with their own powerlessness, death emerges as their only escape from misery. Tess and Phaedra are both driven to self-sacrifice in order to relieve the burden of their grief. A higher power, whether it be love, fate, or ill circumstance, pursues these sorrowful women until the tragic cycle concludes with their deaths. In the case of Phaedra, Artemis hints at retribution and an attempt to restore justice. Hardy, however, comes to a different conclusion in his novel. For Tess, he skeptically remarks, "justice was done," and retribution is neither anticipated nor even possible (Hardy 422). Both women are sacrifices; only Phaedra attains absolution.

In *Hippolytus*, Euripides makes the death of Phaedra a clear metaphor for sacrifice. Phaedra has been oppressed by Aphrodite's power since the play's introduction. When her misfortunes reach their peak, when suicide seems to be the only option, Phaedra asserts that her death will be cathartic, simultaneously purging dishonor from the goddess's reputation, cleansing the world of the taboo she has breached, and resolving her own conflicted heart. Before entering her chamber to hang herself, Phaedra announces, "Having quitted life this day, I shall gratify [Aphrodite], who destroys me" (Euripides 193). She offers her own life to bring peace to the goddess, to her family, and to her suffering soul. Although Tess does not directly commit suicide, the sacrificial imagery is made equally obvious in her conversation with Angel beneath the Pagan structure of Stonehenge. "I think you are lying on an altar," Angel remarks to her as she reclines on a slab of rock, to which she replies, "I like very much to be here" (420). Tess's gods, like the gods of Phaedra, are part of the pantheon of fate and love, which Hardy emphasizes in dialogue:

> "Did they sacrifice to God here?" asked she.
> "No," said he.
> "Who to?"
> "I believe the sun." (Hardy 421)

Just after this conversation, Tess knowingly gives herself over to her pursuers, saying "I am ready" before they take her to her death (Hardy 422). The Christian principles of mercy and peace are alien concepts beneath the shadow of Stonehenge. Tess lives in a world more akin to that of Phaedra, where she must sacrifice herself to appease the god pursuing her.

In the end however, a final variation distinguishes the sufferings of Phaedra from those of Tess. Simply put, Phaedra is absolved. Artemis appears, too late to save her, but she attests Phaedra's "nobleness" and vows to wreak vengeance on Aphrodite's favorite mortal (Euripides 207). Phaedra is dead, but her honor has been restored. *Tess of the d'Urbervilles*, on the other hand, concludes with a sentence that has caused much consternation among critics. The heroine is hanged, and, according to the text, "'Justice' was done, and the President of the Immortals, in Aeschylean phrase,—had ended his sport with Tess" (Hardy 424). This line is frequently dismissed as an incongruous detail or "afterthought."[20] Admittedly its unfortunate allusion to Zeus in *Prometheus Bound* introduces a malevolent deity who seems to contradict the impersonal, blind fate that Hardy alludes to early on through the image of the threshing machine. A comparison of this line with the conclusion of *Hippolytus*, however, reveals a very different meaning. Hardy is not commenting on the nature of the Immanent Will. Rather, he is contrasting the fate of Tess to the Greek tradition of the *deus ex machina*, in which a god arrives at the last minute to preserve the hero's glory. Unlike *Hippolytus,* there is no retribution in Tess's story, no divine spokesman to testify for her honor, and no absolution of her spirit. Whatever justice exists has run its course only by purging the world of Tess's seemingly endless sufferings.

Conclusion

In his personal notebooks, Hardy compares the themes of Euripides and Aeschylus. Although Aeschylus held a special fascination for Hardy, "As elements in a romance or in a study of char[acte]r

the inventions of [Euripides would] be as much superior as they are more obvious."[21] The philosophy of the Greeks inspired Hardy, and his admiration is reflected in *Tess of the d'Urbervilles*. Tess, the suffering woman, draws heavily from the tragic foundations laid by Euripides in *Hippolytus*. Tess and Phaedra are reflections of their unstable times, and they suffer the same essential conflict throughout the course of their respective narratives. Both are trapped between overpowering forces of love and unreasonable standards for chastity. Neither character suffers as a result of a lapse in morality, but rather both are relentlessly pursued by fate, which ultimately ends in sacrifice.

Although Phaedra achieves divine absolution in some sense, this form of resolution is not possible for Tess. Here, Hardy splits from the Greek view. Heroes such as Achilles and Heracles, whose exploits were celebrated even by the gods, do not exist in the world of Hardy. Phaedra achieves honor, eventually, as a tragic heroine, but Tess leaves the world in obscurity. Hardy himself is the only figure who can proclaim Tess's purity in the way that Artemis supports Phaedra, and he does so in the subtitle of the novel: "A pure woman, faithfully presented."

NOTES

[1] Peacock, "Four Ages," 7.
[2] Found at the Dorset County Museum in Dorchester, England.
[3] Houghton, *Frame of Mind*, 343.
[4] Ibid., 342.
[5] Jenkyns, *The Victorians*, 31.
[6] Courtney, *Old Saws*, 100.
[7] Gagarin and Cohen, *Cambridge Companion*, 16.
[8] Kitto, *Greek Tragedy*, 189.
[9] Decharme, *Euripides*, 93.
[10] Ibid., 104-107.
[11] Hamilton, *The Greek Way*, 279.
[12] Kitto, *Greek Tragedy*, 187.
[13] Hamilton, *The Greek Way*, 280.
[14] Bjork, *Literary Notebooks,* vol. 1, 59.
[15] I quote the Theodore Buckley translation because Hardy himself was most familiar with Buckley. Unfortunately the Buckley translation uses the Roman names for the gods, which is anachronistic for Euripides's

work. For the sake of consistency, I am converting all Roman names back to their original Greek.

[16] Houghton, *Frame of Mind*, 355.
[17] Decharme, *Euripides*, 104.
[18] Pinion, *A Hardy Companion*, 177.
[19] Houghton, *Frame of Mind*, 356.
[20] Pinion, *A Hardy Companion*, 177.
[21] Bjork, *Literary Notebooks,* vol. 1, 152.

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In his "Great War" with C. S. Lewis, Owen Barfield maintains that the imagination can both perceive and create truth via poetry. Lewis, however, contends that the imagination is incapable of creating truth. Examination of Barfield's Poetic Diction *and his correspondence with Lewis elucidates the differences in their theories of the imagination and explains Lewis's argumentative errors.*

Barfield contra Lewis on Truth and Imagination

Stephen Margheim

Owen Barfield's position in his "Great War"[1] with C. S. Lewis, as primarily articulated in his book *Poetic Diction* and secondarily in his letters with Lewis,[2] holds that the imagination can both perceive and create truth via poetry. Lewis contrarily contends that the imagination is incapable of creating truth. This paper explicates Barfield's position and Lewis's objections in order to demonstrate that Barfield is victorious in the war, or, more specifically, that Lewis's objections do not hold. I begin by examining Barfield's theory of imagination as found in *Poetic Diction,* which undergirds his arguments for imagination's both passive and active relationship toward truth. I then consider Lewis's objections to these two arguments. Finally, I return to Barfield's theory of imagination to illumine how and why Lewis's objections miss the mark.

A Theory of Imagination and Its Arguments

In a talk entitled "Lewis, Truth, and Imagination," Inkling philosopher Owen Barfield remarks that a theory of imagination must, at its heart, concern itself with the relationship between imagination and truth.[3] From *Poetic Diction*[4] one can enumerate the basics of Barfield's theory of imagination:[5]

- The poet sees Meaning through inspiration;
- The poet creates meaning[6] through metaphor;
- The meaning of the metaphor arouses the aesthetic imagination of a reader, allowing him or her to perceive hitherto unapprehended Meaning;

- Meaning represents the true nature of reality;
- Thus, the reader perceives truth via the arousal of imagination, and the poet creates truth via metaphor.

In order to understand Barfield's conclusion, one must first understand his definitions and then more fully reconstruct his arguments. The key terms to be defined are imagination, truth, and reality.

Barfield defines imagination as a felt change of consciousness.[7] Though this is an opaque definition, we benefit by limiting ourselves to the primary type of "felt change of consciousness" that Barfield concerns himself with in *PD*: perception. When one perceives an object, a discernable change occurs in one's consciousness. Consider, for example, someone approaching a tree from afar. From a distance one sees only a green speck, but as one walks forward this speck becomes more definite. The moment the mind realizes that the green speck is a tree there is a "felt change of consciousness." The form of imagination that Barfield connects with perception is aesthetic imagination.[8]

Aesthetic imagination is the faculty that apprehends the outward form of an object as a shadow of inner meaning.[9] Returning to the tree example, the eyes perceive the form of a green speck, and the mind apprehends that this form represents "treeness." Within *PD*'s opening paragraph, Barfield states explicitly the foundational role aesthetic imagination plays in his consideration of poetic diction: poetic diction is involved fundamentally in arousing aesthetic imagination.[10] The arousal of aesthetic imagination is therefore the bright line for determining whether or not a given text is poetic, though this determination is somewhat subjective. Barfield quickly notes that although personal experience provides the starting point for aesthetic imagination, such subjectivity is not final.[11] Poetic diction has an objective aspect. It can give rise to knowledge, as one is able to establish objective similarities among phenomena.[12] Moreover, this active ability to recognize resemblances ultimately leads to wisdom. As Lionel Adey summarizes, insofar as poetry arouses aesthetic imagination, the reader grows in knowledge, wisdom and perception.[13]

Barfield makes the connection between truth and imagination explicit when, in his letters to Lewis, he defines truth as reality taking the form of consciousness.[14] As regards both imagination and truth, the consciousness of an individual is the primary object affected. Yet this definition of truth is as opaque as that of imagination above. In order to understand Barfield's definition of truth, we must first assess

his conception of reality. Once we comprehend what form reality takes, we may more easily understand how this is truth.

For Barfield, reality can be either revealed or seen. As a result, reality takes the form of consciousness as either concepts or percepts. Concepts are the knowledge gained via aesthetic imagination, which, to recall, apprehends the form of an object as an image of inner meaning. Percepts, however, arise from pure sense-data. This distinction is directly analogous to the distinction between how the poet and the reader each perceives truth. As the outline of Barfield's theory of imagination states, the poet *sees* truth through inspiration, but the reader *conceives* of truth via the arousal of aesthetic imagination. The sight of the poet is distinguished from the conception of the reader just as percepts differ from concepts. Poetic inspiration, in its purest form, occurs when reality enters the consciousness of the poet as a result of sense-data; poetic inspiration derives from percepts. Poetic diction permits reality to enter the consciousness of the reader as a result of aesthetic imagination; poetic diction derives from concepts. This bifurcation of reality with respect to truth is, however, only one aspect of Barfield's definition of reality; the other concerns reality with respect to meaning.

Throughout *PD*, Barfield asserts that reality affects an individual's consciousness when the concrete, unified meaning of various phenomena is revealed. While today such phenomenal unity must be *revealed* to most people via concepts, Barfield contends that all ancient peoples (as opposed to a handful of poets) were able simply to *see* such unity via percepts.[15] This insight stems from Barfield's philology. He contends that words in ancient languages have a concrete, unified meaning that only subsequently produces abstract, differentiated ideas. To support this argument he provides the examples of the Latin term *spiritus* and the Greek term *pneuma*, since both words have the tri-partite meaning of wind, breath, and spirit. For the ancients, each word had its own peculiar, unified meaning of 'wind-breath-spiritness.' This unified meaning, which the ancients simply *saw*, best represents true reality for Barfield. Reality, therefore, can take the form of consciousness as either percept or concept, and a true concept or percept will represent such concrete, unified meaning.

This intricate system of definitions forms the premises upon which Barfield argues that the imagination can perceive truth. The poet can see truth via inspiration in a way similar to the ancients. The reader, by contrast, must have truth revealed by means of poetic diction. The

most efficacious form of poetic diction in this regard is the metaphor. A poetic metaphor allows the reader to perceive truth because it restores the primal unity between abstract and concrete. For example, a metaphor that blurs the distinctions between spirit, breath, and wind would allow their meanings to permeate one another in the reader's consciousness.[16] To the extent that a poetic metaphor permits the imagination to perceive this interpenetration, true reality enters into conscious experience as a concept, and the imagination perceives truth.

Yet one may ask how a poetic metaphor allows the reader to perceive this primal unity. Here Barfield's argument becomes slightly more nuanced. The perception available for moderns via metaphor is distinct from the perception available to the ancients. While ancient people *saw* the unified relationships between things, they did not *apprehend* them, strictly speaking.[17] Apprehension necessitates concepts, yet the ancients comprehended reality simply as percepts. The perception available through poetic metaphor is superior to that of ancient peoples because it connects percepts with concepts. Perception via metaphor allows the reader to experience the permeation of meaning by reconnecting a term's modern, narrow range of meaning with its older, more extensive range of meaning. While the ancients easily saw the unified nature of reality, and we must have it revealed, we are nonetheless in a superior position. Whenever reality is revealed (or perhaps unveiled), our apprehension allows us to establish objective similarities among phenomena; such is Barfield's understanding of knowledge. The recognition of similarities is dependent upon one's ability to maintain distinctions between previously viewed phenomena. The unified understanding of reality for the ancients precludes Barfield's form of knowledge. As shall be shown below, the distinction in perception via metaphor and that of the ancients draws on Barfield's second argument—that the imagination can create truth.

While C. S. Lewis concedes Barfield's argument for the truth-perceiving abilities of the imagination, he doubts the argument for the truth-creating ability of the imagination.[18] In order to appreciate why Lewis is skeptical, we must both reconstruct Barfield's second argument and assess Lewis's definitions of the key terms of the debate. I turn first to Barfield's second argument, and then examine Lewis's objections.

Barfield's argument for the imagination's ability to create truth is, in its basic form, quite simple. The argument may be reconstructed as follows:

- Meaning is truth;
- Insofar as a poet creates true meaning, he re-creates Meaning;
- Thus, insofar as a poet creates true meaning, he re-creates truth.

Its complexity derives from Barfield's definition of creation and his distinction between meaning and Meaning. In order to investigate the validity of this argument, we must examine these particular points of interest.

Barfield distinguishes between creation as an aesthetic term and creation *ex nihilo*. The former is bringing further into consciousness something essentially unconscious; the latter is a power belonging to God alone. Thus, while the poet is involved in re-creation, strictly speaking, he can be a true creator from an aesthetic point of view. As demonstrated above, by creating a poetic metaphor, the poet arouses cognition of concepts. He does so by means of suggestion from percepts, which he perceived as a result of inspiration. The ability to arouse concepts in a reader classifies the poet as an aesthetic creator of meaning. In order for the poet to create truth, however, Barfield must demonstrate how the meaning that the poet is bringing further into consciousness is representative of the true nature of reality. Barfield's argument on this point relies on his distinction between meaning and Meaning.

For Barfield, "meaning" is particular, while "Meaning" is universal. By this he means that meaning is the created associations of a word, while Meaning is the indivisible relationship between mind and nature.[19] The poet aesthetically creates new meaning via metaphor by recovering the lost, unified meanings of particular words or ideas. The (re)creation of meaning is the recovery of forgotten meaning. For example, when William Wordsworth uses the verb "ruining" with reference to a waterfall in the lines "Ruining from the cliffs their deafening load / Tumbles" he reconnects the particular ideas of rushing, falling, and destroying, and thus recovers the term's original, unified meaning. Yet Barfield argues that beyond static recovery, this process yields positive gain through the creation of new meaning.[20]

Barfield's example of the word "ruin" exemplifies this thesis. Its etymological root, the Latin verb *ruo*, is today either translated as *rush* or *fall*, with both terms denoting a sense of swift, disastrous movement.[21] However, over the course of history, the verb began to entail not only the act of falling, but also the consequent state of having fallen. The

process of loss and recovery created new meaning for the verb "to ruin"—not just to fall, but to destroy. This new meaning, however, is not arbitrary. It allows for a clearer perception of the Meaning of *ruo* as a swift but also disastrous movement. The waterfall both falls from and, through erosion, destroys the cliff. By reconnecting these ideas of swift movement and disastrous effects, Wordsworth's metaphor truly does create new meaning. Because this created meaning allows for clearer perception of Meaning, Wordsworth here also creates truth.

Lewis's Objections

Lewis's disagreement with Barfield centers on his belief that no one can create truth, whether by imagination or any other means. This position is informed by Lewis's own views on the natures of imagination and truth. Thus, in order to appreciate fully Lewis's objection, one must analyze his views on imagination and truth. I turn first to Lewis's conception of imagination.

Lewis's contention that the imagination cannot create truth rests on his view of the imagination as static and non-assertive. In a letter to Barfield, Lewis adumbrates this understanding of imagination.[22] Lewis states that the exercise of the imagination is necessary only for the *connaissance*[23] of meaning. Implicit in this statement is Lewis's belief that the imagination is a state.[24] Lewis also implies that the imagination is non-assertive, that is, its products are neither true nor false as such.[25] Given this view of imagination, Lewis contends that the imagination can at best create meaning, but never truth.[26] This led to Lewis's famous declaration that mind is the vehicle of truth, imagination of meaning.[27]

Lewis's objection to imagination's active relation to truth also rests on his understanding of truth. Lewis denies[28] Barfield's belief in truth beyond true assertions because, for Lewis, truth is only manifest in the internal consistency and experimental verifiability of an assertion.[29] Moreover, Peter Schakel argues that Lewis held objective truth only to be found in concrete facts, which are received by reason rather than the imagination.[30] Lewis maintains that truth is a static, consistent body of facts and judgments. Therefore, only facts (percepts or concepts) are "true," while the process of imagining is at best "meaningful." This view of truth supports Lewis's conception of knowledge as merely one's sensory experiences in systematized form.[31] For Lewis, knowledge is a state, while, for Barfield, it is the activity of recognizing unity. These conceptions of truth and knowledge reveal Lewis's pre-conversion

materialistic rationalism.[32] This rationalism, as Stephen Thorson has shown, barred Lewis from believing that imaginative experiences, poetic or otherwise, could create new knowledge of truth.[33] Schakel argues that this tension between reason and imagination in Lewis's epistemology continues well after his conversion precisely because of his static, logocentric[34] conception of truth.[35]

Lewis's differing views of truth and imagination inform his objections to Barfield's position. Schakel succinctly sums up Lewis's differences with Barfield as the belief that "reality" is superior to "meaning" because reality objectively exists, and meaning is only a subjective reflection of the "real." Reason ranks above imagination because the former deals with concrete facts and the latter only with imaginative meaning.[36] This position contrasts with Barfield's view that the subjective individual determines the nature of his experienced phenomena. In Lewis's mind, if Barfield argues that truth can be created, then Barfield must conceive of reality as subjective; Lewis adamantly rejects the subjectivity of reality; therefore, truth can in no way be created.[37]

This practical syllogism is complicated, however, because Lewis's stance with respect to subjectivity evolved over time. For example, Peter Schakel considers Lewis's different approaches to the act of reading in two of his critical works—"The Personal Heresy" and the later *An Experiment in Criticism*. In the earlier work, Lewis held an objective, depersonalized approach to reading.[38] In the later work, however, he perceives the act of reading as intellectual interaction between an author's words and a reader's response to them.[39] This positive view of the interchange between the objective meaning of the author and the subjective response of the reader displays the influence of Barfield's thought.

The clearest example of Lewis's evolution is found in *The Abolition of Man*. While Lewis does not directly address the relation between imagination and truth, he does address the relationship between subjectivity and objectivity, the question at the heart of Lewis and Barfield's debate.[40] In this 1943 work,[41] Lewis critiques the rationality of the modern world, which bases truth or falsity on subjective emotions. This criticism betrays Lewis's tension between subjectivity and objectivity, which Schakel observes throughout Lewis's corpus.[42] Lewis's conception of the *Tao*, however, suggests a partial engagement with Barfield's view of the synthesis of subjectivity and objectivity. For Barfield, truth is the synthesis of subjective mind and objective nature

from the point of view of reason, and likewise Meaning from the point of view of imagination. Lewis's conception of the *Tao* is similarly the synthesis of subjective sentiments and objective value from the point of view of ethics. Schakel's discernment of tension can be seen when Lewis reminds the reader that emotions are necessarily a-logical.[43] Barfield's influence is also seen, however, as Lewis immediately adds that emotions can be reasonable, if they respond in accordance with Reason.[44] Insofar as Lewis allows subjective sentiments to rank equal with objective facts, Barfield's position is in play. These indications that Lewis may have recognized the strength of Barfield's position do not, however, override the fact that Lewis remained fundamentally an objectivist to the end.

To this point, let us return to *The Abolition of Man* and examine Lewis's attack on what he calls the "Green Book." Lewis ardently critiques the Green Book's claim that anyone who says "this waterfall is sublime" is actually saying "I have sublime feelings about the waterfall." Lewis insists that the waterfall is sublime regardless of anyone's perception of it as such. The view of "Gaius" and "Titius,"[45] which says that each sentence containing a predicate of value is actually a statement about the emotional state of the speaker, represents precisely the modern trend toward subjectivism that Lewis traces in Barfield's position. His staunch critique of such a position, in a book published in 1943 no less, reveals that Lewis remained an objectivist even post-conversion. The final question thus arises: who is right? I argue that Lewis has misinterpreted Barfield's position as it appears in *Poetic Diction*.[46] Barfield's position properly lies in a synthesis of Lewis's objectivist views and the subjectivist views that Lewis opposes.

Barfield's Synthesis

In the outline of Barfield's theory of imagination articulated above, the lynchpin is the claim that Meaning represents the true nature of reality. In order to illumine Barfield's theory of imagination fully, we must further examine this thesis. According to Barfield, Meaning reveals reality because it is objective reality interacting with both subjective reason and imagination. Contrary to Lewis, reason and imagination are here equal, as both are necessary for the *connaissance* and creation of meaning. For the *connaissance* of meaning, imagination is needed to see meaning, while reason is needed to *apprehend* meaning.[47] For the creation

of meaning, both are needed to transmit meaning via poetic metaphor.[48] Thus, while Lewis supposed reason to be superior to imagination and Barfield to hold imagination superior to reason, Barfield's theory of imagination places imagination *equal* to reason.

To understand why Barfield sees imagination and reason as equal, one must analyze his conception of polarity. Shirley Sugarman, a student of Barfield's, conceives of his theory of polarity as the interdependence and permeation of opposite forces that have one source.[49] Imagination and reason are two opposite forces, but they are opposite forces on a unitary process, and are thus also, to some extent, one and the same thing. To explicate this enigmatic concept, I turn to an external example.

Barfield's theory conceptually echoes Socrates's understanding of opposites as presented in the *Phaedo*. On his deathbed, Socrates describes opposites as having one source or head.[50] Later in the discussion, Socrates distinguishes between "concrete opposites" and "essential opposites." The former is a class of opposites in which opposites are generated out of their opposites.[51] Socrates gives the example of smallness and largeness. Socrates observes, "when anything becomes greater it must inevitably have been smaller and then have become greater."[52] The opposites of the latter class, however, are never generated into or out of one another.[53] These opposites are "the abstract concept[s] of an opposite" and "those very opposites the immanence of which gives the [concrete opposites] their names."[54] Under this hermeneutic, the opposites of Barfield's theory of polarity are best understood as concrete opposites, that is, they are opposites generated out of their opposites.

This view of the relation between imagination and reason is seen most clearly in *PD*'s chapter on "The Poet." Here Barfield argues that the poet cannot simultaneously be creator and judge of his own work. Each requires the respective mood of creation and mood of appreciation, which are opposite poles in the unitary process of creating meaning—the one giving rise to the other and vice-versa.[55] Thus, in order to create meaning, and consequently to create truth, the poet must possess and use both imagination and reason, his consciousness oscillating between the two as he deliberates over each phrase.[56]

Barfield's theories of imagination and polarity reveal that claiming the poet creates truth is *not* the same as claiming reality is purely subjective. Barfield's position is a much more nuanced account of the relationship between mind and nature that constitutes reality. Reality is neither mere objective nature nor is it mere subjective mind. It is,

however, the interpenetration of these concrete opposites. The mind itself bars human consciousness from ever purely understanding this interpenetration, so that one can see it more clearly, but never perfectly. One can only understand reality through a particular lens. Thus, from the point of view of imagination, reality is understood as Meaning, while from the point of view of reason, it is understood as truth. This is how and why Barfield constantly, but implicitly, equates Meaning with truth. This mirror image of truth is how poetry can both perceive and create truth: the meaning it creates is a true reflection of Meaning, and the truth it perceives is a true reflection of Truth.

While Lewis does positively engage with Barfield's position, he does so only implicitly and slightly. The ethical truth of the *Tao* arises from the synthesis of subjective sentiments and objective value, but the aesthetic truth of the waterfall is found purely in objective nature, regardless of subjective emotions. This view of truth is precisely the static, logocentric view he held in the "Great War." The extent to which Lewis adopted views similar to Barfield's is therefore beyond our grasp. In order to weigh their positions in the "war," therefore, we are left to consider whether or not Lewis's objections hold. Though Lewis thought that Barfield held imagination as superior to reason, Barfield's theory of imagination places imagination *equal* to reason. Barfield's claim that the poet creates truth is *not* a claim that reality is purely subjective. Given a proper understanding of his position in *Poetic Diction*, we see that Lewis's objections miss the mark. As a result, Barfield's arguments and position should be held as superior.

NOTES

[1] Lewis uses this term to describe their dispute in *Surprised by Joy*. The main group of letters comprising the Great War was written between 1925 and 1927, before Lewis's conversion to Christianity (Adey, *C. S. Lewis's "Great War,"* 13).

[2] I intentionally consider Barfield's thought without reference to his anthroposophy.

[3] Barfield, "Lewis, Truth, and Imagination," 97.

[4] Hereafter simply referred to as "*PD*."

[5] This overview comes primarily from Barfield, *PD*, 141.

[6] Note the difference between "Meaning" with a capital "M" and

"meaning" with a lowercase "m." The difference between these forms will be elucidated in the reconstruction of Barfield's argument for imagination's ability to create truth

[7] Barfield, *PD*, 48.

[8] Note the etymology of "aesthetic" from the Greek *aisthetikos* (sensitive, perceptive), which derives from *aisthanesthai* (to perceive, whether by the senses or by the mind). Indeed, Barfield plays with this distinction between perception by the mind and perception by the senses in his differentiation of apprehension and sight.

[9] Barfield, *Rediscovery of Meaning*, 19.

[10] Barfield, *PD*, 41.

[11] Ibid., 42.

[12] Ibid., 55.

[13] Adey, *C. S. Lewis's "Great War,"* 20.

[14] Ibid., 42.

[15] This latter thesis is an attack on the "logomorphism" that Barfield found nearly ubiquitous in his contemporaries' thought. Logomorphism is "projecting post-logical thoughts back into a pre-logical age" (*PD*, 90). For the views of some of these contemporaries, see Barfield, *PD*, 14-38.

[16] I offer the first stanza of William Wordsworth's poem, *We Are Seven*, as an example: "A Simple Child, / That lightly draws its breath, / And feels its life in every limb, / What should it know of death?" Wordsworth elegantly plays on the relation between breath and life, allowing the permeated meaning of the two terms to be revealed to a reader.

[17] Barfield, *PD*, 87.

[18] Adey, *C. S. Lewis's "Great War,"* 42.

[19] Barfield, *PD*, 179.

[20] Ibid., 116.

[21] Ibid., 113.

[22] Adey, *C. S. Lewis's "Great War,"* 42-43.

[23] The French term literally means "knowing," but Lewis here uses it in its more specifically epistemological sense that is roughly equivalent to "coming to true understanding."

[24] Adey cites examples of Lewis's use of prepositions when describing imagination: He is "in" a state, "during" a time, "after" which he "emerges" (76). These quoted prepositions are taken from various other letters to Barfield over the course of the Great War.

[25] Adey, *C. S. Lewis's "Great War,"* 42.

[26] Ibid., 31.

[27] The direct quote, "reason is the natural organ of truth; but imagination is the organ of meaning," can be found in Lewis, "Bluspels and Flalansferes," 265.
[28] This verb is precisely used. In their personal correspondences, which I was able to examine thanks to the generous people at the C. S. Lewis and Friends Collection at Taylor University, Barfield and Lewis would write either *"Credo"* or *"Nego"* next to one another's claims.
[29] Adey, *C. S. Lewis's "Great War,"* 25.
[30] Schakel, *Reason and Imagination*, 111.
[31] Ibid., 90-91.
[32] Ibid., 93.
[33] Thorson, "'Knowledge,'" 91.
[34] Logocentric here refers to Lewis's strict definition of truth as ordered reason and thus is a definition focused purely on the relationship between *kosmos* and *logos*.
[35] Schakel, *Reason and Imagination*, 108.
[36] Ibid., 124-125.
[37] Thorson, "'Knowledge,'" 109.
[38] Schakel, *Reason and Imagination*, 164.
[39] Ibid., 165.
[40] Adey, *C. S. Lewis's "Great War,"* 76.
[41] Nearly 20 years after the "Great War."
[42] Schakel, *Reason and Imagination*, 108.
[43] The term "a-logical" is deliberate. The standard, philosophical division between logical and illogical includes the class of a-logical things, which are utterly opposed to the logical class. Illogical things are therefore lacking logical ordering, but this lack depends on them essentially being such that they could be logical. A-logical things, by contrast, can never be logical.
[44] Schakel, *Reason and Imagination*, 19.
[45] These are the authors of the "Green Book," whom Lewis never names explicitly and to whom he consistently refers by these pseudonyms. Scholars have since confirmed that the "Green Book" is in fact *The Control of Language: A critical approach to reading and writing*, by Alex King and Martin Ketley.
[46] Which is not to say that Lewis's interpretation of Barfield's position was not correct at that specific point in the Great Debate, given that *Poetic Diction* was not published until 1928. Indeed, Lewis's arguments may have helped form Barfield's position in *Poetic Diction*.

[47] See page 34 above on Barfield's distinction between seeing and apprehension.
[48] Barfield, *PD*, 178.
[49] Sugarman, "BARSPECS," 75.
[50] Plato, *Plato in Twelve Volumes*, 60b.
[51] Ibid., 70e.
[52] Ibid., 70e. All translations of Plato are by Fowler.
[53] Ibid., 103c.
[54] Ibid., 103b.
[55] Barfield, *PD*, 107-108.
[56] Ibid., 110.

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Metamaterials are substances that possess unnatural electromagnetic properties. Engineers have harnessed these properties in various electronic devices. This paper discusses the production of one such device, a composite right/left-handed transmission line. A composite right/left-handed transmission line utilizes either split ring resonators or complementary split ring resonators to generate negative permeability and permittivity in a circuit. Consequently, this device can improve conventional circuit components, including lowpass filters and electrical couplers.

Examining the Potential of Metamaterials for the Design of Composite Right/Left-Handed Transmission Lines

Colin Pardue

Introduction

The etymology of metamaterial comes from the Greek preposition "meta" meaning "beyond" [1]. When combined with "material," the word metamaterial describes a substance with properties that extend beyond the ordinary. More accurately, a metamaterial is an artificial substance whose geometry and material have been manipulated to create electromagnetic properties not found in nature. Formerly, metamaterials were only found in the cloaking devices of science fiction, but recent discoveries in engineering made metamaterials a tangible reality [2]. In fact, metamaterials have been touted by *Science Magazine* as one of the top ten breakthroughs of science in both 2003 and 2006 [3]. Metamaterials represent a revolution in the way researchers understand and engineer materials. Nevertheless, as physicist Martin Wegener says, while "Conceptually, there has already been a revolution … whether it will lead to revolutionary products remains to be seen" [4].

This paper will provide a general overview of the field of metamaterials and highlight one potential application—constructing a left-handed transmission line. A conventional transmission line transmits energy between two points. While a left-handed transmission

line accomplishes the same goal, it transmits the energy between the points using left-handed propagation. These left-handed transmission lines have very small dimensions, a characteristic of particular interest to researchers. This paper demonstrates that a composite right/left-handed transmission line can be designed and fabricated at Baylor University using complementary split ring resonators and tuned using electromagnetic simulation software, a characteristic that would be very beneficial to researchers involved with planar microwave circuit design. These designed transmission lines have a narrow, low frequency passband that provides a similar level of functionality as conventional transmission lines, but at a smaller size.

History of Metamaterials

The study of metamaterials began in 1898 when Jagadis Chunder Bose began the study of artificial materials with chiral properties. His work started the trend of engineering new materials to produce desired properties [5]. Victor G. Veselago first described left-handed media in 1968 with his now well-cited paper, "The electrodynamics of substances with simultaneously negative values of ε and μ." In it, he explored the electrical and magnetic properties of a hypothetical left-handed medium, formulating his hypothesis from the laws of wave propagation though a left-handed substance. Even though Veselago knew of no such substance with left-handed properties, he devised conditions and parameters that rendered the creation of metamaterials feasible [6].

In 2000, David R. Smith et al. further explored the concept of combining materials with negative ε and negative μ into a single substance [7]. Their paper, "Composite medium with simultaneously negative permeability and permittivity," proposed a segmented implementation of metamaterial components, consisting of negative ε and negative μ substances combined in series. In 2001, they synthesized a novel material by intertwining thin copper wires and split ring resonators in a 2-D array using a shadow mask etching technique on a fiberglass circuit board [8]. After constructing this material, they fashioned a prism from it and measured the scattering angle of light passing through it. The result experimentally indicated negative refraction, a property unique to left-handed media; Smith's group had created the first confirmed metamaterial. Their results were published in a *Science* article entitled "Experimental verification of a negative index of refraction." In the ten

years since Smith's group produced the first metamaterial, metamaterial research has grown exponentially.

Developing a Left-Handed Medium

Left-handed media are the most significant type of metamaterial, and the two terms are often used interchangeably. Left-handed media describes any medium with simultaneously negative values of electrical permittivity ($\varepsilon < 0$) and magnetic permeability ($\mu < 0$). In contrast, ordinary materials have positive values for both ε and μ ($\varepsilon, \mu > 0$). While plasma can attain a negative value for ε, and gyrotropic magnetic materials can have a negative value for μ, no natural substance has both negative properties at once [5]. The key characteristic that arises from a medium with a simultaneously negative ε and μ value is wave propagation that follows the left-hand rule for electromagnetics. The electric field (**E**), magnetic field (**H**), and wave propagation (**k**) vectors compose a left-handed triplet that enables metamaterials' novel and revolutionary applications [1].

Although the existence of metamaterials defies traditional electromagnetism, their electrical characteristics can easily be described with fundamental electromagnetic theory. Nearly all of the unique electromagnetic properties of metamaterials come from their left-handedness, which results from the left-handed triplet of the **E**, **H**, and **k** vectors, where **k** is defined as:

$$\boldsymbol{k} = \omega\sqrt{\varepsilon\mu}$$

and ω is the angular frequency. A negative ε or μ forces the operand inside the radical to be imaginary, making propogation impossible. However, according to Maxwell's equations, if both ε and μ are negative, the wave propagation becomes left-handed, due to a left-handed triplet among **E, H,** and **k.**

Several interesting electromagnetic properties arise from the left-handed nature of metamaterials. The Poynting vector is defined as

$$\mathbf{S} = \mathrm{Re}\{.5(\mathbf{E} \times \mathbf{H}^*)\}.$$

Since a concurrent change of ε and μ does not affect the Poynting vector, **S**, **E**, and **H** still form a right-handed triplet [9]. Thus, the **S** and **k** vectors point in opposite directions, meaning that the energy of a wave travels in the forward direction, while wave propagation travels in

the backward direction. In other words, a wave traveling in a left-handed medium propagates in the opposite direction of its energy! Left-handed media are the only known substances that support backwards wave propagation in "unbounded homogeneous isotropic media" [9].

Another major property of metamaterials following from these special electromagnetic characteristics is negative refraction. With negative refraction, rays are refracted on the same side of the normal boundary as the incident vector, instead of the opposite side of the normal boundary, as observed in conventional refraction. Figure 1 illustrates such a phenomenon. Negative refraction can only occur in substances where the phase velocity is negative. Consequently, the boundary conditions and backwards wave property of left-handed media imposes a unique restriction on the boundary between a right-hand and a left-hand medium that forces the angles of incidence and refraction to have opposite signs [9].

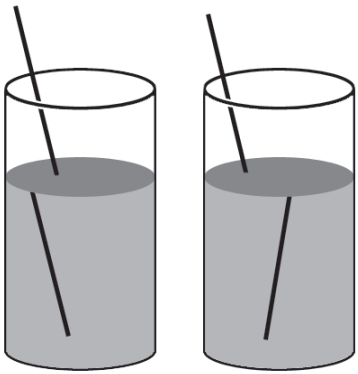


Figure 1 – Comparison of Regular Refraction (left) and Negative Refraction (right). Note: this is just illustrative, since a liquid metamaterial has not yet been realized.

The unique properties of metamaterials have many applications. Since metamaterials rely on their constituents being small, they can create smaller electrical components with the same characteristics as ordinary materials [10]. For example, in the field of microwave engineering, researchers have created narrow passband components with sharper transitions at sizes smaller than previously imagined. Several other researchers have succeeded in redesigning passive microwave components using metamaterials, integrating both a reduction in size

and increase in electrical performance. A few of these components include branch line couplers, wideband filters, and stopband microstrip lines [11], [12], [13].

However, metamaterials are receiving much more attention in the science community for areas outside of microwave design. Undoubtedly, the most notable one of these applications is the creation of a cloaking device. Fermat's principle states that light always takes the quickest optical path. However, because of metamaterials' negative index of refraction, this path is not necessarily a straight line [9]. Researchers hope to develop a metamaterial whose left-handedness is used to bend light around an object, effectively cloaking it. In fact, this effect has already been accomplished at some infrared frequencies, rendering very small objects undetectable by infrared radiation. If researchers can adapt this process to a wide band of visible light frequencies, cloaking devices are possible.

Visible light can also be focused more sharply by using left-hand slabs in conjunction with more conventional focusing tools, in a manner similar to the use of phase compensation in electronics. From this application comes the idea of a "perfect lens," with focusing properties theoretically beyond the diffraction limit [9]. Essentially, metamaterials could lead to imaging with unlimited resolution. While immediate tangible results are unlikely, the unique properties of left-handed propagation have challenged traditional understanding in the fields of optics and electromagnetism.

In general, the components used in metamaterial synthesis must have dimensions that are orders of magnitude smaller than the signal wavelengths at the specified frequencies where left-handed behavior is desired [9]. Since left-handed materials are not found naturally, materials must be combined to synthesize a metamaterial. In most cases, engineering tailors one constituent to provide negative permeability and another to provide negative permittivity. This combination forms a left-handed medium.

The electrical characteristics of the individual constituent materials are not important; the macroscopic analysis of the final synthesized product signifies a metamaterial. Thus, an acceptable term for a general left-handed medium is a bulk metamaterial, which can be described as a material that consists of many combined unit cells with electrically small dimensions and whose electrical properties come from the complete product and not an individual unit cell [9].

A variety of sources provide metamaterials' negative permittivity. As noted earlier, a periodic mesh of wire media was utilized in the first confirmed metamaterial. A wire mesh can be in a straight line, plane, or cube to enable left-handed behavior in 1, 2, and 3 dimensions respectively. Additionally, when transmission line analysis on a wire mesh is used, the wire medium can be approximated as a shunt inductance. Thus, inductors placed in parallel on a transmission line can also provide the negative permittivity [9].

The first metamaterial utilized split ring resonators to create negative permeability. Like the wires, these resonators can be arranged in various dimensions to enable left-handed propagation in multiple dimensions. Split ring resonators can be approximated as a series capacitance using transmission line analysis, meaning that series capacitors can provide the negative permeability for left-handed transmission lines.

Thus, most metamatrials require a periodic array of wires and split ring resonators. However, for transmission lines, the metamaterial can be comprised of shunt inductors and series capacitors instead. Interestingly, this circuit is the opposite of a regular transmission line model, where the circuit model contains series inductors and shunt capacitors.

Metamaterial Transmission Lines

When David R. Smith's research group created the first documented metamaterial, they used a split ring resonator, as proposed by Sir Pendry. A split ring resonator is an arrangement of two concentric rings with gaps or splits that have a negative permeability when excited by an axially applied magnetic field [14]. A visual representation of a split ring resonator can be found in Figure 2. In microwave engineering, the rings are printed on a dielectric substrate using a conductive metal. The rings provide a distributed capacitance between them, causing current to flow from one ring to the other when an axial magnetic field is applied.

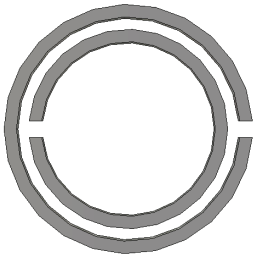


Figure 2 – Diagram of a split ring resonator

The resonant frequency for a split ring resonator is given by

$$\omega_0^2 = \frac{2}{\pi r C L}$$

where C is the per unit length capacitance in the slot between rings [9]. At this resonant frequency, the split ring resonator responds to the axial magnetic field as a strong magnetic dipole. The capacitance of the rings matches the inductance of the split ring resonator, resulting in a resonant LC circuit where μ diverges at the resonant frequency. While the permeability theoretically increases when right below the resonant frequency, the permeability shrinks dramatically just above the resonant frequency and is negative for a narrow band [14]. In essence, the split ring resonator behaves as an LC circuit with a resonant frequency that can be specified by altering dimensions such as the outer radius and slot width [15]. Because of the negative permeability, a sharp transmission null is observed at the resonant frequency for a split ring resonator. For this reason, split ring resonators are commonly used in transmission line design to provide the negative permeability needed to synthesize a left-handed medium.

Complementary split ring resonators behave as the electrical dual, or opposite, of split ring resonators, but they are also an effective component for transmission line design. Figure 3 shows how the split rings of the complementary split ring resonator are formed with an absence of metal, while the area around the rings is all metal—the inverse of the split ring resonator design. The most common way of creating complementary split ring resonators is to etch the design in the ground plane, right under the conductor strip. In contrast to a split ring resonator, an array of complementary split ring resonators is excited when an

axial electrical field is applied [15]. Complementary split ring resonators have a strong electric dipole at the resonant frequency, which is the dual behavior of the split ring resonator. Also unlike split ring resonators, complementary split ring resonators cause the permittivity of the substrate to become negative above the resonant frequency. The resonant frequency of a complementary split ring resonator is defined by

$$f_o = \frac{1}{2\pi\sqrt{L_c C_c}}$$

where L_c and C_c are inductance and capacitance of the resonator, respectively. The resonance results in a transmission null at the resonant frequency, like the split ring resonator. However, in this case, the transmission null is because of a negative ε value rather than a negative μ value [15]. The negative ε characteristic of the complementary split ring resonator makes the complementary split ring resonator effective in the synthesis of left-handed mediums by providing the negative permittivity required.

Typically, the design of planar metamaterial transmission lines occurs in one of two ways: either with the dual transmission line approach or the resonant type approach. The resonant type approach involves the use of either split ring resonators or complementary split ring resonators. The main conceptual difference between the resonant and dual transmission line approaches is that the resonant approach uses distributed capacitance and inductance rather than a lumped one. As mentioned before, split ring resonators can provide the negative permeability necessary for a left-handed transmission line, mimicking the series capacitance of a composite right/left-handed transmission line. Thus, a composite right/left-handed transmission line can also be fabricated by milling a layer of split ring resonators on top of a host line, and adding a shunt inductance either by via holes or inductors connected to the circuit in series [9]. Combining complementary split ring resonators etched in the ground plane of a substrate with series gaps etched in the microstrip line synthesizes another resonant type composite right/left-handed transmission line [9]. Figure 3 contains a depiction of an implementation of the resonant type technique.

The resonant type approach has several advantages. Split ring resonators' and complementary split ring resonators' unusual characteristics are partly due to the fact that they are sub-lambda structures [13]. This designation means that they have much smaller dimensions at

the resonant frequency than at the signal wavelength, usually by more than a factor of 10. Accordingly, the use of split ring resonators and complementary split ring resonators can result in drastic miniaturization of many planar microwave components.

Of the two, complementary split ring resonators have some design advantages over split ring resonators. Complementary split ring resonators are paired with gaps in the microstrip line, which provide the de facto negative permeability needed to create a metamaterial. These gaps are much easier to implement in microstrip technology than vias, which provide a de facto negative permittivity when combined with split ring resonators to create left-handed behavior. However, either split ring resonators or complementary split ring resonators can be used successfully in the design of composite right/left-handed transmission lines, as part of the resonant construction method.

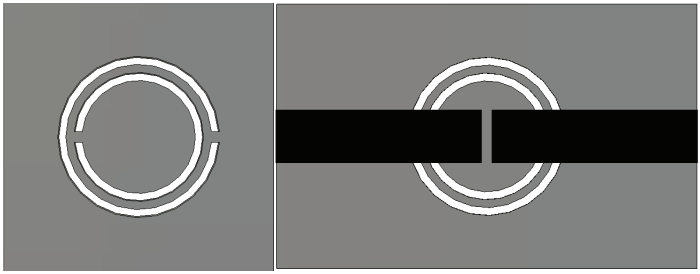


Figure 3 – Complementary split ring resonator (left) and a resonant type transmission line using a complementary split ring resonator (right). The grey is the ground plane, the white is the absence of metal in the ground plane, and the black is the microstrip line with a gap in it.

Composite right/left-handed transmission lines are perhaps the most significant achievement concerning metamaterials in microwave engineering. While traditional transmission lines support ordinary, forward wave propagation, as described earlier, a planar substance with a simultaneously negative value for ε and μ facilitates wave propagation in the backwards direction. Consequently, a left-handed transmission line can be thought of as having an alternating pattern of series capacitances and shunt inductors, which is the dual to conventional transmission line designs [9]. The conceptual model shown in Figure 4 is a left-handed transmission line with backwards wave propagation. The left-handed transmission line acts as a low pass filter, letting lower frequencies through while stopping higher frequencies.

However, a pure left-handed transmission line is impossible to synthesize [16]. Parasitic effects, or any undesirable effect in a circuit, start to appear at higher frequencies. Either the series capacitance will change to inductance, or the shunt inductance will change to capacitance, and this change will result in the termination of the left-handed passband. But as the frequency continues to rise, parasitics will also cause the other parameter to change, resulting in a series inductance and a shunt capacitance. Of course, this creates a right-handed transmission line, so another passband appears that supports forward wave propagation [16]. Such transmission lines are designated composite right/left-handed transmission lines because of the presence of a left-handed passband at lower frequencies and a right-handed passband at higher frequencies. Several engineers have discovered that composite right/left-handed transmission lines can be designed in such a way that the series capacitances and the shunt inductances of the left-handed portion of the transmission line change simultaneously, resulting in a continuous transition between the left-handed and right-handed passbands. This design is called the balanced case for a composite right/left-handed transmission line.

The equivalent T-circuit model for a lossless unit cell of a composite right/left-handed transmission line based on complementary split ring resonators is shown in Figure 5 [9]. C_g and L_c are designated as the loading elements of the transmission line and are often times called C_L and L_L, with the L subscript meaning "left" instead of "inductance". These variables can be the equivalent capacitance and inductance of split ring resonators, of complementary split ring resonators, or of reactive elements used to directly provide the parameters needed for left-handed propagation. These are the elements that give the transmission line its left-handed behavior—the metamaterial elements. At the frequencies at which left-handed propagation occurs, both the parallel inductance and series capacitance behave negatively [17]. At lower frequencies, the loading elements have a stronger influence over the transmission line behavior, and the transmission line acts as a left-handed line. However, at higher frequencies, parasitics start to dominate, and the parallel inductance and the series capacitance are both positive. In this case, L and C_c are circuit elements that come from the host line itself and are often denoted as L_R and C_R, and at higher frequencies these elements have a larger influence on the transmission line because of parasitics, resulting in a pure right-handed transmission line that acts as a high pass filter [9].

Each composite right/left-handed transmission line has these parameters: inductance and capacitance values that come from the metamaterial reactive elements as well as from the host line. The remaining capacitance found in this equivalent circuit model is unique to composite right/left-handed transmission lines due to the complementary split ring resonators. This capacitance comes from the coupling between the host line and the complementary split ring resonators, and it is not necessarily found in all composite right/left-handed transmission line designs.

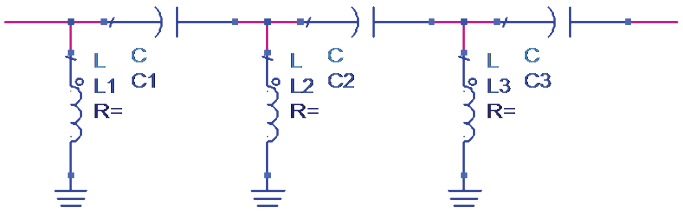


Figure 4 – Basic, conceptual model for a left-handed transmission line

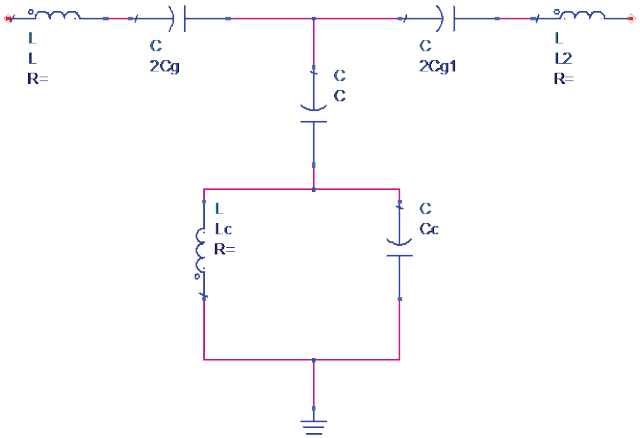


Figure 5 – Circuit model for a left-handed transmission line based on complementary split ring resonators (bottom)

Composite right/left-handed transmission lines have special properties that make them especially useful for designing planar microwave components. Because they have both backward and forward wave propagation, the characteristic impedance and phase of a composite right/left-handed transmission line can be designed at any two arbitrary

frequencies [11]. This technique emphasizes the design flexibility, as opposed to traditional transmission lines that can only have a specific phase at the resonant frequency and its odd harmonics. For instance, at a given characteristic impedance, a composite right/left-handed transmission line can have an electrical length of 90° at two arbitrary frequencies whereas a traditional transmission line may only be designed at one arbitrary frequency. Composite right/left-handed transmission lines enable engineers to design a transmission line with a second operating frequency that does not have to be an odd harmonic, resulting in an extra design parameter [11]. Because a composite right/left-handed transmission line has both a right and left-handed pass band, it has both positive (left-handed band) and negative phase shift (right-handed band). Thus, a desired phase shift can be attained by using a one stage composite right/left-handed transmission line [17]. Since metamaterial transmission lines can achieve in one step what often takes multiple stages in conventional design processes, many planar microwave components can be fabricated at much smaller sizes using metamaterial design over conventional design.

However, designing a composite right/left-handed transmission line differs from conventional transmission line design; many of the formulas must be altered to account for left-handed propagation and the existence of a dual-band. The unique aspect of composite right/left-handed transmission lines is that they can have explicitly designed characteristic impedance and phase at two arbitrary frequencies, found in the equations

$$Z_0 = \sqrt{Z_s(\omega)\left[Z_s(\omega) + 2Z_p\omega\right]} \quad (1)$$

$$\cos\ \beta \mathrm{l} = 1 + \frac{Z_s(\omega)}{Z_p(\omega)} \quad (2)$$

where $Z_s(\omega)$ is the impedance branch of the series and $Z_p(\omega)$ is the impedance of the parallel branch [11]. βl is the electrical length/phase of the line in degrees.

In the case of a balanced composite right/left-handed transmission line, the transition between the left and right-handed bands is continuous. The cutoff frequencies of the right and left-handed bands are given by:

$$\omega_{cR} = \frac{2}{\sqrt{L_R C_R}} \quad (3)$$

$$\omega_{cL} = \frac{1}{2\sqrt{L_R C_R}} \quad (4)$$

Equations 3 and 4 can be used to determine the lower frequency boundary of the left-handed passband, and the higher frequency boundary of the right-handed passband. The propagation constant for a composite right/left-handed transmission line is

$$\gamma = \pm\frac{j}{\Delta z}\sqrt{\left(\omega L_R - \frac{1}{\omega C_L}\right)\left(\omega C_R - \frac{1}{\omega L_L}\right)} \quad (5) \text{ [18]}$$

Solving for the zeroes of Equation 5 yields

$$f_1 = \frac{1}{2\pi\sqrt{L_R C_L}} \quad (6)$$

$$f_2 = \frac{1}{2\pi\sqrt{L_L C_R}} \quad (7)$$

These two frequencies are the resonant frequencies of the series branch (Equation 6) and parallel branch (Equation 7). Equation 3 can also be written as

$$Z_0 = \sqrt{\frac{\omega L_R - \frac{1}{\omega C_L}}{\omega C_R - \frac{1}{\omega L_L}}} \quad (8)$$

The solution in Equation 6 is a zero for Equation 8, and Equation 7 is a pole for 8, meaning that f_1 is the upper limit for the left-handed passband and f_2 is the lower limit for the right-handed passband [18]. In the case of a balanced composite right/left-handed transmission line, f_1 and f_2 must be the same for a continuous transition between the right and left-handed passbands to exist. More specifically, using equations 6 and 7, the following condition must be met:

$$\omega_o = \frac{1}{\sqrt{L_R C_L}} = \frac{1}{\sqrt{C_L L_R}} \quad (9)$$

Thus, the transition frequency can be tuned and the composite right/left-handed transmission line can be balanced simply by choosing appropriate values for the capacitances and inductances. Equations 1 and 8 also show a dependence of Z_0 on frequency, meaning at the transition frequency of a balanced composite right/left-handed transmission line,

the characteristic impedance of the left and right-handed portions must be the same. Using Equations 8 and 9, this means that

$$Z_0 = \sqrt{\frac{L_R}{C_R}} = \sqrt{\frac{L_L}{C_L}} \quad (10)$$

Now that the relevant frequencies for the composite right/left-handed transmission line can be chosen using appropriate values of C and L for the right and left-handed elements, all that remains is to derive the values for C_L, C_R, L_L, and L_R. In most cases, this derivation requires manipulating the geometry of the circuits until the desired element values are reached. For circuits involving complementary split ring resonators and split ring resonators, this means altering the radii of the rings and the width of the rings to achieve the appropriate values for C_L and L_L [9].

The ability to tune the transition and cutoff frequencies of a composite right/left-handed transmission line simply by altering the geometry of the complementary split ring resonators and split ring resonators is a major benefit of the resonant design. The remaining parameters, mainly resulting from the microstrip line, can be derived from fundamental microwave engineering techniques and conventional transmission line analysis. The number of stages of a composite right/left-handed transmission lines can also be varied. For the resonant approach, this means adding more complementary split ring resonators or split ring resonators. Adding more resonators improves the performance of the composite right/left-handed transmission line with the tradeoff being an increase in size [9].

Experimental Negative μ Line Designs and Results

Based on the aforementioned theories and design processes, a negative μ line was designed. By designing a negative μ line, the effectiveness of a particular split ring resonator design could be quickly checked using software called Advanced Design System (ADS). Thus, first testing a negative μ allows only the resonators to be tested, isolating the most complex and crucial part of a composite right/left-handed transmission line. ADS was used for the first part of this project to perform electrical simulations of the equivalent circuit models as well as create the layout from which the circuits were fabricated. Square split ring resonators were modeled since they are more easily implemented in

ADS. The consequence of using square split ring resonators is increased coupling between adjacent split ring resonators that can affect the behavior of the transmission line. However, since this research attempts to design the smallest possible transmission line, only one split ring resonator was used in the design. Because the coupling problem cannot occur with only one split ring resonator, square split ring resonators can be safely used without altering the performance of the transmission line.

Preliminary electrical simulations were run in ADS to verify a left-handed passband behavior for parameter values based off formulas and the work of Martin et al. [19]. The component values and schematic are shown in Figure 6. A clear left-handed passband was shown in the simulation results.

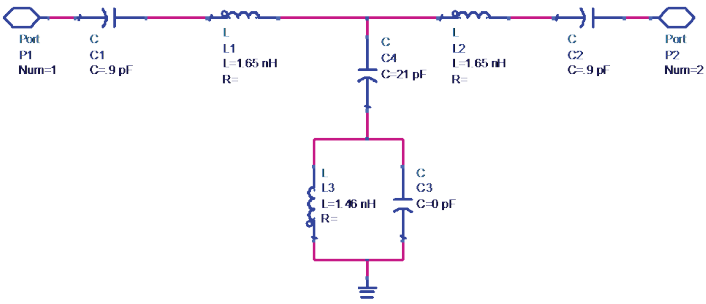


Figure 6

Next, the split ring resonators were designed. Normally, an electromagnetic simulation is run from the layout design, and the simulation is used to fine tune the geometry of the split ring resonators until the desired transmission is achieved. For the first part of this research project, verifying the successful design of a resonator was more important than designing an entire composite right/left-handed transmission line, so no simulations were run at this point. Using the work of Lu and Hui-Yong as a guide, five different designs were created as seen in Figure 7 [20], [21]. Three basic split ring resonator shapes were used, and two variations with varying microstrip line width and length were also created. Thus, a trial and error process was used to determine which resonator would yield the best transmission line.

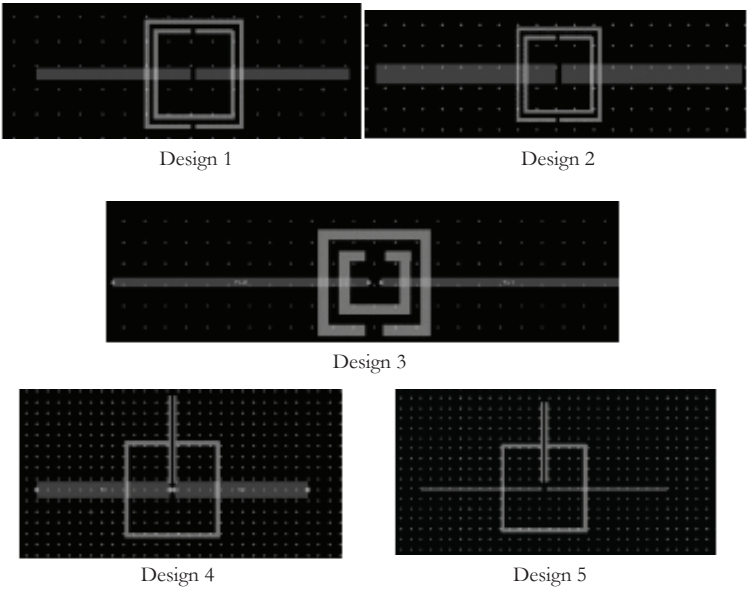
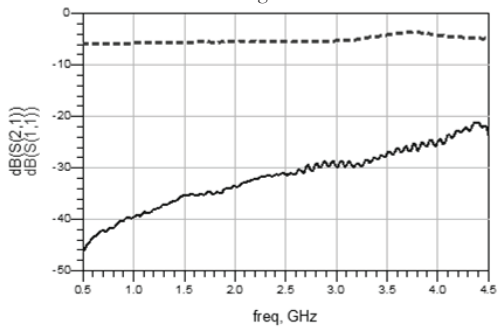


Figure 7 – These are the layouts created in ADS for the 5 different designs. The white dots are the grid and not a part of the design. The black is the substrate (the layer between the resonators and the microstrip line). The darker grey is the microstrip line on the top of the board, and the lighter grey is the split ring resonator on the bottom side of the board.

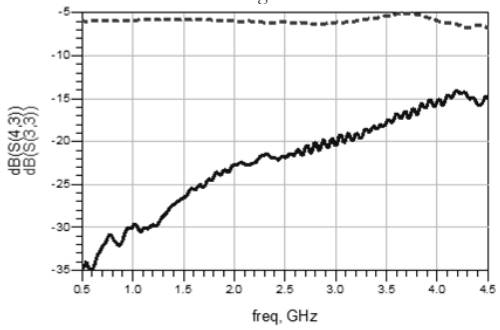
Negative permeability lines were then fabricated by utilizing the various split ring resonator designs. A line with negative μ but positive ε acts as a stop band, resulting in a transmission null (a sharp decrease in the transmission characteristic). Figure 8 shows the measurements of each of the negative μ lines; the location of each graph corresponds with the order of the design layouts in Figure 7. Each fabricated negative μ line was measured using an Agilent Network Analyzer and calibrated using a 3 dB attenuator. The first three designs showed no unusual behavior by the split ring resonator. However, Designs 4 and 5 showed a clear spike and then drop in permeability at approximately 1.7 GHz for the S_{21} parameter. S_{21} is commonly called the transmission, indicating the part of the signal that is passed through. The sharp null that appears in the transmission value indicates that the permeability of the line became negative at this frequency. Thus, the resonators of this design had a resonant frequency of 1.7 GHz, and at this frequency the

resonators cause the permeability of the host line to become negative. This encouraging result demonstrated that the last two designs created effective split ring resonators. These resonator designs, Designs 4 and 5, were then used to design composite right/left-handed transmission lines, using a complementary split ring resonator instead of a split ring resonator.

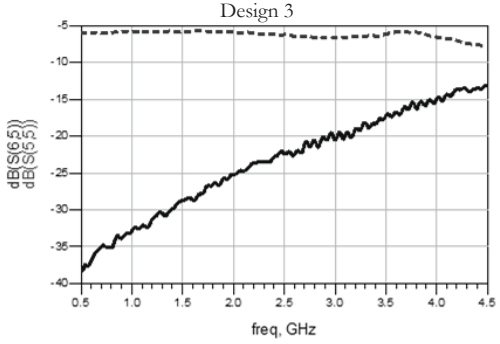
Design 1



Design 2



Design 3



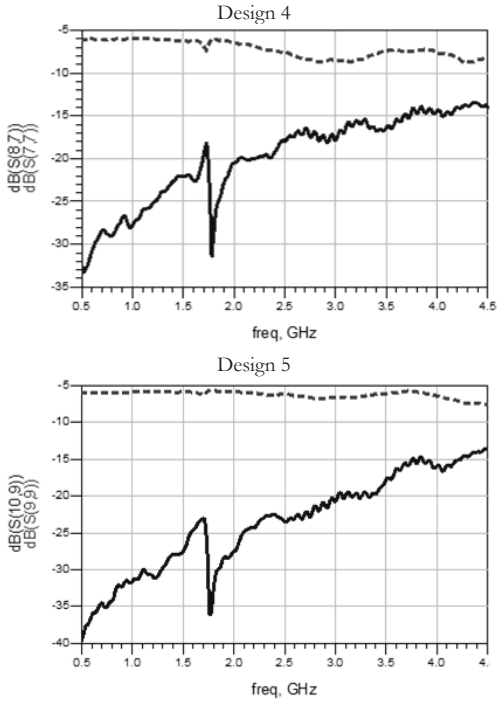


Figure 8 – The dashed lines are the S_{11} parameters for each line, and the solid lines are the S_{21} parameters. Clearly the bottom two graphs show a more unusual behavior with the sharp transmission null and indicate the proper function of a split ring resonator.

Experimental Composite Right/Left-Handed Transmission Line Design and Results

After receiving the positive result from the negative μ lines, the physical layouts of the circuits were modeled using Computer Simulation Technology (CST) Microwave Studio, a program with electromagnetic simulation capabilities. These capabilities allow the program to simulate the S-Parameters of a circuit based on its physical model, using the materials and dimensions of the layout to predict electrical behavior with stunning accuracy. Using the ADS layouts as a guide, several more resonator designs and several composite right/left-handed transmission lines designs were created. However, circular resonators are now used because circles and cylinders are easily implemented in CST Microwave Studio.

Figure 9 shows a profile of one possible design. The design consists of a microstrip line on top, a substrate layer in the middle, and ground plane on the bottom, on which the complementary split ring resonators are etched. Several similar designs were created and simulated; a few of the ground plane designs are presented in Figures 11-13. Figure 10 represents the compact single ring complementary split ring resonator design, corresponding with the one resonator shape that had appropriate measured behavior when implemented in the negative μ lines of Figure 7. Figure 11 shows a more conventional complementary split ring resonator design, and Figure 12 shows a three-stage composite right/left-handed transmission line. In reality, each of these figures represents two designs—a complementary split ring resonator design and a composite right/left-handed transmission line design. The only difference between the two is that the composite right/left-handed transmission line design has a gap in the microstrip directly above the center of the complementary split ring resonator. This feature is required because the capacitive series gap is needed in conjunction with a complementary split ring resonator to create a left-handed passband.

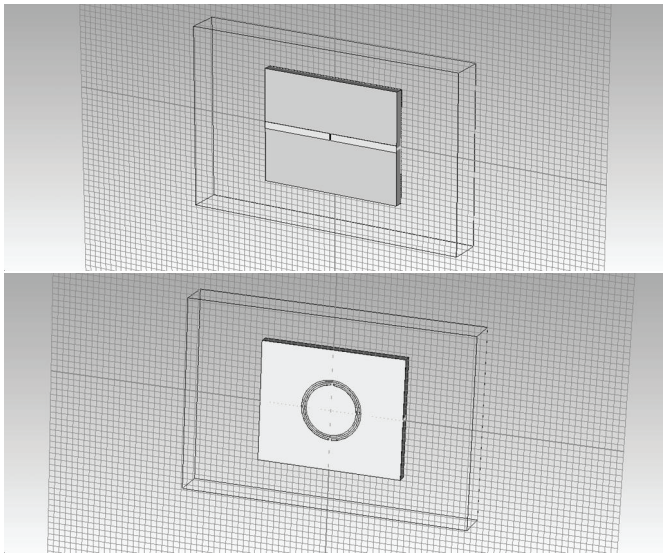


Figure 9 – This is an example of an overall design layout in CST. The top half is the front view, where the microstrip line is centered on the substrate. The bottom half shows the ground plane with a complementary split ring resonator etched into it.

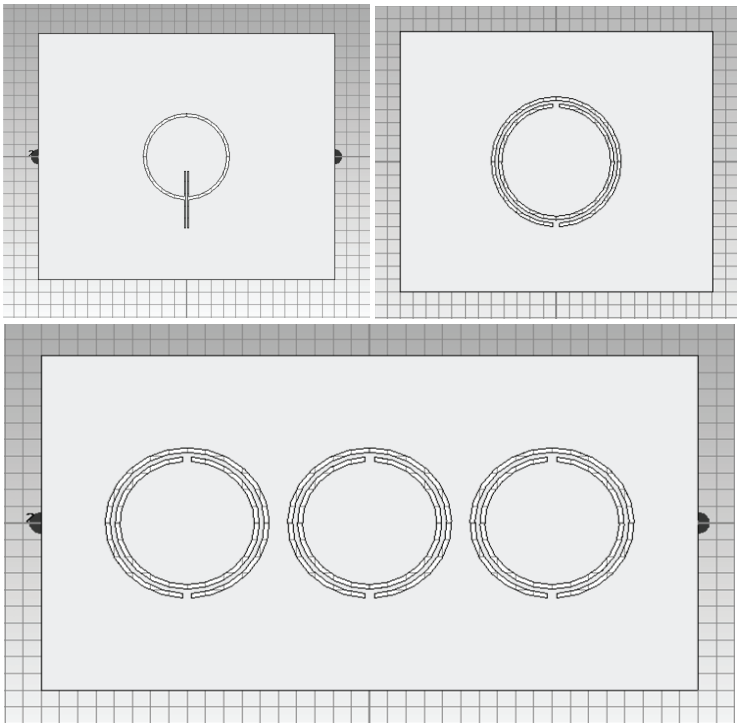


Figure 10 (top left) **Figure 11** (top right) **Figure 12** (bottom)
These are the complementary split ring resonator designs. The solid grey is the ground plane, and the complementary split ring resonators are etched into it.

Several electromagnetic simulations were run for each design. Lossy FR4 was the substrate simulated, and copper was simulated as the metal. The simulations were run using discrete ports and a transient analysis. All of the boundary conditions were set to zero. The significant dimensions of each layout are depicted in Figure 13. These dimensions were chosen after several optimizations and simulations were run with CST software, tailoring the complementary split ring resonators until desired S_{11} and S_{21} curves were achieved.

Model	Outer Radius	Width of Rings	Stripline Width	Stripline Length	Slot Width	Capacitive Gap Width
Figure 10	3.5	.24	.40	12	.25	.09
Figure 11	4	.27	.60	12	.25	.10
Figure 12	4.5	.27	.80	18	.25	.09

Figure 13 – All values are in millimeters

The results received in the simulations were very encouraging. All of the results displayed either the S_{11} or S_{21} parameters. S_{11} is the reflection of the transmission line as seen from the input. S_{11} and S_{21} are inversely related; as the reflection increases, transmission decreases. However, both parameters are needed to show certain results. For the single complementary split ring resonator (Figure 10), a strong transmission null was seen in the negative ε line (a line without a capacitive gap). The transmission null corresponds with the resonant frequency of the complementary split ring resonator. Several simulations were run as the radius of the complementary split ring resonator was varied, with 5, 4, 3, and 2 mm used as radii. As the radius of the complementary split ring resonator increased, the resonant frequency decreased and exhibited a larger null. The complementary split ring resonator with a radius of 5 mm exhibited a null of 18.79 dB at 2.33 GHz (Figure 14), which is a very sharp transmission null for a smaller frequency.

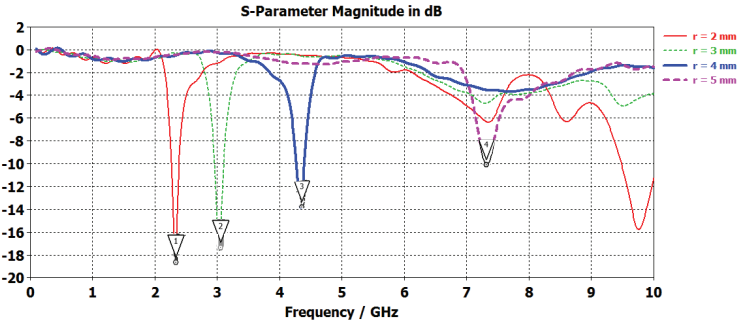


Figure 14 – This shows the transmission nulls for a complementary split ring resonator of radii of 5, 4, 3, and 2 mm from left to right

Sharp transmission nulls are necessary to design an effective composite right/left-handed transmission line. Figure 15 shows the design simulations for S_{11} and S_{21}. All simulations showed a left-handed passband and a right-handed passband, demonstrating a successful

design. The narrow left-handed passband occurred near the resonant frequency of the complementary split ring resonators. At the higher frequencies, parasitics dominated and another right-handed passband was observed. The passbands are defined by the S_{21} curve when the value of S_{21} is closest to 0 dB. The ideal passband has a S_{21} value of 0 dB for complete transmission. These composite right/left-handed transmission lines had about 2 to 4 dB attenuation for the left-handed passbands. Minor resistance losses and the Q-factor (efficiency) of the resonator account for most of this attenuation.

The first two graphs show the relation between the reflection and the transmission. Here, the capacitive gap in the stripline caused a reflection null at the resonant frequency of the complementary split ring resonator instead of a transmission null. The effects of the gap and the complementary split ring resonator combined to create the left-handed passband. In other words, when combined with a gap, the complementary split ring resonator created transmission rather than inhibited it, since the ε and μ of the transmission line is simultaneously negative. The three-stage composite right/left-handed transmission line (the bottom graph in Figure 15) showed the most distinct right and left-handed passbands, with the peak of the left-handed band denoted by a marker. This pattern was expected because using more complementary split ring resonators creates a stronger negative ε at the resonant frequency, creating a more effective passband, in this case occurring at 2.7 GHz.

These simulations demonstrate effective composite right/left-handed transmission lines with a narrow left-handed passband at low frequencies. Using these design techniques, creating even lower frequency passbands is possible by increasing the radius of the complementary split ring resonators. In addition, these resonators have a very small size, about 2-10 mm in radius, when compared to other resonator designs with low resonant frequencies.

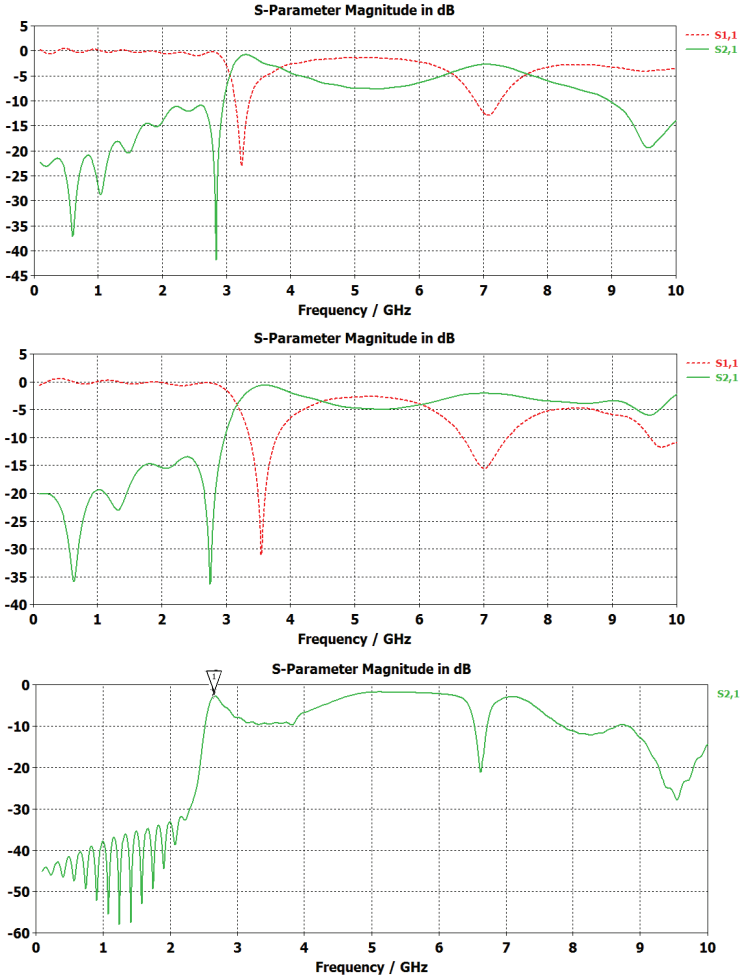


Figure 15 – CRLH TL S_{21} and S_{11} simulations. For the first 2 graphs, the bold line is S_{21} and the other line is S_{11}. The top graph is the simulation for Figure 9, the second graph is the simulation for Figure 10, and the third graph is the simulation for Figure 11.

Future Research

In future studies, new transmission lines will be fabricated from the layouts simulated using CST Microwave Studio, and the measured

S-Parameters will be compared to the simulated values in order to assess the accuracy of the simulations. More fine-tuning and optimizations will be run using CST to create even more distinct passbands for the composite right/left-handed transmission line. Ideally, complementary split ring resonators with even larger S_{21} nulls may be designed using CST. In addition, different substrates will be used in simulations to see how much effect the substrate thickness has on the interaction between the complementary split ring resonators and the microstrip line. Lastly, we plan to explore designs of very low frequency resonators as the lower limits for the resonant frequency of different complementary split ring resonator designs are yet to be determined.

Most importantly, a similar design process will be used to create multi-resonant mode resonators. At Baylor University, Dr. Randall Jean and his research group are investigating a way to measure the glucose level in blood non-invasively. As part of this design, a resonator with several low frequency resonances will be needed. These resonators will use split ring resonator and complementary split ring resonator designs. An early concept of the objective is shown in Figure 16. The goal is to develop a resonator with several sharp nulls in the S_{21} graph. Hopefully this can be accomplished using metamaterial transmission line techniques developed over the course of this research project.

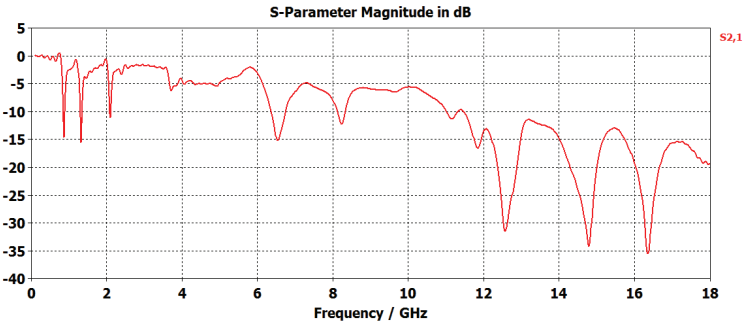


Figure 16 – An example of the goal for a multi mode resonator. The goal is to achieve several sharp transmission nulls, similar to the graph shown but much more efficiently and at lower frequencies.

Conclusion

Metamaterials research has the potential for many novel and revolutionary applications. One exciting area with applications for

metamaterials is microwave engineering in which metamaterials may be used to design planar circuits such as composite right/left-handed transmission lines. An experimental verification of negative permeability lines was accomplished during this research project. CST Microwave Studio was then used to design much more effective resonators for composite right/left-handed transmission lines using electromagnetic simulations. Several designs were created, ranging from single complementary split ring resonators to three-stage composite right/left-handed transmission lines. Among the design lessons learned was that increasing the radius of the complementary split ring resonators decreases the resonant frequency of the complementary split ring resonators, allowing for tuning the frequency at which the S_{21} passband is located. Results for each of these designs were simulated and found to have S-Parameters that agreed with metamaterials theory.

The potential applications for these composite right/left-handed transmission lines are limitless. The very narrow left-handed passband that may be tuned simply by adjusting the complementary split ring resonator radius can be incredibly useful in filter applications. The small size of the designs means circuits may be fabricated at much smaller sizes than before. The left-handed passband also has a positive phase shift, a characteristic that has already proven to be valuable to coupler design, and may be even more valuable to other planar microwave circuits. In fact, specially designed composite right/left-handed transmission lines have been proven to be both feasible and effective at Baylor University, helping researchers, such as Dr. Jean's research group, utilize metamaterial designs. Though this research project was investigative in nature, now that metamaterial technology has been shown to work effectively at Baylor, engineering researchers may expand this project to include several innovative applications.

Acknowledgements

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