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ABSTRACT

This paper explores whether phenomenology, in general, and the case of Johann Wolfgang von Goethe's phenomenological optics in particular, provides a case and a location for "minimal realism," located between the extreme positions of absolute scientific realists and "radical rhetoricians." The paper begins with a description of the multi-definitional terms "rhetoric" and "science." The paper employs the variety of rhetoric that considers scientists and the content of their work by case analysis. The paper notes that, although the rhetorical discipline is relatively young, a standard approach to discussing rhetoric and science is to discuss the rhetoric of science, exposing the non-scientific elements of science or scientific writing. Outlining the history of optics before Newton, the paper also discusses Goethe as a scientist, his theory of color and contribution to optics, and his phenomenological science. The paper offers an illustrative application of phenomenological optics in practice in the regulation of air pollution in the Commonwealth of Pennsylvania. The paper concludes that the discipline of rhetoric has historically been called upon to facilitate "getting on with public business" such as environmental regulation as epistemological certainty continues to erode and mathematics no longer carries the day. (Contains 57 notes.) (RS)

Goethe's Phenomenological Optics: The Point Where Language Ends and Experience Begins in Science

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> Oh, but the authorities of the temple of Zeus at Dodona, my friend, said that the first prophetic utterances came from an oak tree. In fact the people of those days, lacking the wisdom of you young people, were content in their simplicity to listen to trees or rocks, provided these told the truth. For you apparently it makes a difference who the speaker is, and what country he comes from; you don't merely ask whether what he says is true or false.
>
> --Plato, Phaedrus, 275b-c

Introduction

In traditional epistemology, science is presented as neutral subjects observing objects for the purpose of knowing the truth of those objects. In 1927, physicist Werner Heisenberg successfully challenged the possibility of such a practice of science--subjects cannot observe objects neutrally. His "uncertainty principle," as it came to be called, announced that it is impossible to determine accurately two variables, such as position and momentum of an electron, simultaneously.[1] This came as a shock to much of the scientific world, and to much of scientifically-determined culture in general in 1927 because it challenged the role we had ascribed to science practice-the role of knowing objects objectively. One hundred thirty-five years earlier, Johann Wolfgang von Goethe had already observed what Heisenberg later announced. But

Goethe was not shocked. He rather welcomed it, because for Goethe, the role of science was not so much to know objects objectively, but rather to gain insight into the metamorphosis of the scientist as he or she interactively observes nature.

This essay is divided into three parts: the placement of Goethe's phenomenological optics as a case study of the rhetoric of science; an outline of Goethe's practice of phenomenological optics; and an illustrative application of phenomenological optics in practice in the regulation of air pollution. In defining the parameters of the essay, I am of course at the same time excluding many things which the essay shall not discuss-most notably, quantitative optics. In doing so, I shall nevertheless try very much not to make this essay a "turf battle" in the field of optics specifically, nor in any other area generally. I recognize this to be a serious task, as evidenced by the two thousand year-old debate between the disciplines of rhetoric and philosophy. In that debate, I take epistemology to be philosophy's celebrated offspring, and science to be the favor of the brood. Rather than denigrate the philosophical tradition of science and extol the advantages of the rhetorical world view, I shall attempt to break from that "either-or" mentality and locate the case of qualitative optics in a different place altogether . . . I shall locate it in phenomenology.

Within the disciplines of rhetoric and science, a polarization of extreme positions has developed which would place so-called "radical rhetoricians" at one pole and absolute scientific realists at the other. (For the purposes of this essay, one may substitute "logical positivists," "science made," "classic view of science," or "the received view of science" for the "absolute scientific realist" in the previous sentence.)[2] These extreme positions are indeed extreme, and also somewhat exclusive. At the radical rhetoric end, one may find Alan G. Gross, working the Derridean claim "Il n'y a pas de hors-texte" in science,[3] and at the other end, good old-fashioned scientific realism, steadfastly remaining guard under the Royal Society's motto, "Nullius in Verba." Within the rhetoric of science field, as it is currently emerging, the discussion has not been joined by the voice of the absolute scientific realists. The intolerant realists, in their hegemonic power position, refuse to admit the possibility that rhetoric can be constitutive of science. As one proceeds away from the absolute scientific realism pole toward radical rhetoric, however, one comes at some point upon the more congenial position of "minimal realism." Minimal realism, as represented by Trevor Melia and J. E. McGuire,[4] allows for rhetoric to be recognized as somewhat constitutive of science, but does not allow rhetoric to be all encompassing, as would Gross' "sub specie rhetoricae" agenda. For the minimal realist, although rhetoric may account for much (hence, "minimal"), at some point the real world "out there" becomes recalcitrant and refuses to be constructed by text alone (hence, "realism"). The task is now at hand to locate this point. In this essay, I shall explore whether phenomenology, in general, and the case of Goethe's phenomenological optics, in particular, provide a case and a location for this point.

Three Varieties of "Rhetoric"

Before examining the substantive interface of rhetoric and science, let me first offer what I mean when I use these multi-definitional terms "rhetoric" and "science." First, the use of "rhetoric." What manner of rhetoric is being applied to science in the discipline known as the "rhetoric of science?" As Kenneth Burke has pointed out, the word "rhetoric" has several denotations. At another level, one may use "rhetoric" is an act of persuasion, or as Aristotle defined it, "the faculty of observing in any given case the available means of persuasion."[5] In addition to that, one may use "rhetoric" to refer to the analysis of acts of persuasion. One may analogize this distinction to that between "criminal" and "criminologist."[6]

The distinction between rhetoric as acts and rhetoric as analysis of acts presents a difficult sort of paradox in academic analytic prose such as this because once a distinction among the uses of the word "rhetoric" is articulated, one has automatically moved into the analysis of rhetoric and is not engaged in the act alone. Of course, one can still engage in persuasion while talking about persuasion (and perhaps most effectively then!), but one cannot be <u>only</u> operating under the first variety of "rhetoric" at this point. As applied to other texts and discourses, rhetorical analysis which mobilizes the first two varieties serves to analyze the packaging of an otherwise non-rhetorical substance. All forms of text and discourse, due to their sheer linguistic make-up can be analyzed in this way. Therefore no limits shall be encountered when employing the first two varieties. Consequently, the limits of the application of rhetoric to science shall not be found within these first two denotations of the word "rhetoric." "Presumably even those who believe that science qua science is immune to rhetorical critique would nonetheless grant that situated acts of scientific discovery, science policy, science popularization, priority claims in science and so forth are susceptible to rhetorical scrutiny of the first varieties."[7] In short, the identification of tropes from allegory to zeugma may indeed enhance an appreciation of style, but such an exercise will not help to determine how much of science is constituted by rhetoric.

This brings one to a third variety of rhetoric--rhetoric as world view. It is only with this third variety that one may encounter a limit to so-called "radical" rhetorical analyses, for only here is rhetoric constitutive.

> [This] third usage owes its currency to the so-called sophistic tradition in rhetoric. . . . On this view, the rhetorical resort to aesthetic instead of epistemic criteria is not, contra Plato, the result of a willful and perverse determination to exploit the vulgar susceptibilities of popular audiences but an acknowledgment of the necessity of getting on with public business in the face of a tragic and paralyzing <u>loss of certainty</u>.[8]

Employing the third variety of rhetoric, I shall consider scientists and the content of their work by case analysis. Case analysis is at least one point upon which the radical rhetoricians, as represented by Alan G. Gross, and the minimal realists, as represented by J. E. McGuire and Trevor Melia, do agree:

> The radical rhetoric of science I advocate does not foreclose on the possibility that McGuire and Melia are correct, that there is a limit to rhetorical analysis. But the persuasiveness of any demarcation between rhetoric and science does not depend on <u>a priori</u> considerations; instead, it relies on the ultimate failure of radical rhetorical analysis.[9]

Although Melia and McGuire may find Gross' above statement to be loaded in his own favor, it does suggest that case analysis is necessary to determine the limits, if any, of the discipline known as the rhetoric of science. Melia also requires case study for making this determination when he writes that

> [inside] the once impenetrable walls of hard science . . . lies terra incognita for rhetoric. And no amount of debate about the work of the philosophers of science, whatever its merit, will secure scientific territory for rhetoric. . . . Fortunately there is a sizable, and growing, body of literature by scientists on science. . . . There appears to be no reason why a rhetoric of science should not be based on the pronouncements of these pivotal scientists.[10]

Next one must ask what use of the term "science" is being considered in the discipline known as the rhetoric of science. Although the discipline is relatively young, the corpus of literature is growing, and a standard approach to discussing rhetoric and science is, as noted above, to discuss the rhetoric of science.[11] Even when specific cases of science via scientists are considered, they have been most often cases of the "received" views of science subject to rhetorical scrutiny of the first two varieties, resulting in critiques of the packaging of science, but not in the content of science. Thereby, to varying degrees, authors have hoped to "expose" the non-scientific elements of science or, at least, of scientific writing. This approach and its work product have served to keep the "turf battle" mentality alive between radical rhetoricians and absolute scientific realists alike. One should note that as between rhetoric and science, the application of rhetoric to science is the only direction in which the dialogue between rhetoric and science occurs, even for the radical rhetoricians. In this forum, neither rhetorician nor scientist is concerned with something like the "science of rhetoric." Before turning to the case of phenomenological optics, several questions must yet be addressed. The "case" with which I am concerned is Goethe's theory of colors and his contribution to optics, qualitative analyses of light, vision, and color. In considering this case I shall try not to make this a contest with Newton's Opticks,[12] as has previously been the unfortunate treatment.[13]

While phenomenology speaks to all sciences, optics is of special concern for several reasons. Among the classical scientists, the fields of optics, harmonics, mechanics, and astronomy were studied together. Therein, optics and harmonics ostensibly maintain explicit human-sense elements; that is to say that seeing and hearing are intrinsically part of the nature of these disciplines. For Goethe, this human interaction with the phenomena is constitutive of science. Furthermore, as between sight and sound, sight metaphorically represents knowing, as in "insight" and "idea."[14] Goethe recognized this connection in the relation of his theory of colors to the theory of music: "Both are general, elementary effects acting according to the general law of separation and tendency to union, of undulation and oscillation, yet acting thus in wholly different provinces, in different modes, on different elementary mediums, for different senses."[15] In addition, in many religious traditions, including Christianity and Islam, (which account for many of the scientists concerned with optics in this discussion) light is associated with knowledge.

In order to place my discussion in historical context, I shall briefly outline the path of "light" which preceded Newton. In the ancient world, several different theories of light and vision developed. "The common premise of all ancient theories of vision was that there must be some form of contact between the object of vision and the visual organ, for only thus could an object stimulate or influence the visual power and be perceived.[16] Much of the literature on ancient theories of vision concerns the debate between intromissionists, who believed that objects somehow emitted rays which travelled to the eye, and extramissionists, who believed that it was the eye which emitted the ray, which ray then travelled to an object. Once a direction for the ray was established, much of the ensuing discussion concerned whether the ray was a real entity, and the medium through which these rays passed en route to either the eye or the object.

> But to classify ancient theories of vision in terms of the direction of radiation or the role of the medium in vision is to overlook fundamental aspects of ancient optics--and also to make the debate among the various theories seem trivial and those who debated it for a thousand years look foolish. There is another scheme of classification, based on the aims and criteria of visual theory, which is far more basic and, therefore, more significant.[17]

Included in the group of optical theories, based on the aims and criteria of their respective proponents, is a mathematical theory, a physiological theory, a physical theory, and the mixed theory of Plato. The mathematical theory, originating with Euclid and Ptolemy in Greece, and al-Kindi in Persia, offers a geometrical explanation of the perception of space. It is classified as an extramissionist view. The aims of these theorists are to develop a "mathematical theory of perception in which the visual cone [the apex of which is at the eye] accounts for the localization of objects in the visual field, and the apparent size and shape of the objects."[18] Ptolemy and al-Kindi added physical content to this theory as well, whereby they posited actual physical rays as real entities. This added physical extension of rays is not a part of the criteria for judging the plausibility of the theory based on its mathematical explanatory powers, however.

The physical theory, originating with Aristotle in Greece, and advocated by al-Razi, al-Farabi, Averroes (Ibn Rushd), and Avicenna (Ibn Sina) in Persia, and Albert the Great and Thomas Aquinas on the Continent, is divided between Aristotle's notion that vision occurs when objects have information transmitted to the eye via a medium,[19] and the atomists theory of eidola (or simulacrum, in Latin), whereby the eidola, which are thin films like the skin of a cicada or snake, and are composed of atom assemblies, are capable of communicating the visible attributes of objects to the eye, so as to create an impression of the object. As such, both types of the physical tradition are intromissionist in nature. The aims of works by researchers in this field are to provide a causal or physical account of vision and to explain in physical terms how the visible qualities of objects are communicated to the organ of sight.

The physiological theory, as announced by Galen in Greece and brought forward by Hunain ibn Ishaq in Persia, is concerned with the theory of the eye's anatomy. The aims of the works in this tradition are to provide a physiology of sight through the anatomy of the eye. The physiological tradition fails to account for the psychology of the observer, however, or for his or her "functional capacities," as Aristotle would call them. That is to say, we do not directly observe rods and cones, but rather people and houses and other three-dimensional objects. For Aristotle, explaining what one picks up as a visual input, that is, integrated three-dimensional objects, is first and foremost in the aim of a theory of vision.

After the translation of Greek works became available in the Arab world, many scientists had all of the above variety of theories of optics at their disposal. In his essays "The Science of Optics"[20] and "Late Thirteenth-Century Synthesis in Optics"[21], historian of medieval science, David C. Lindberg, suggests that Alhazen then accomplished a synthesis of these previously distinct traditions, which Roger Bacon carried forward, accompanied by his followers, John Pecham and Witelo. That synthesis is known as "perspectivism" and eventually formed the foundation for Kepler's theory of vision, according to Lindberg. In support of his proposition, Lindberg juxtaposes excerpts from the writings of Bacon, Pecham, Witelo and Alhazen, inter alia, which ostensibly treat the same subjects in the same ways and yield similar results. This self-serving comparison is carefully edited to present only those areas where the authors do seem to agree, however, and fails to acknowledge that in some instances, scientists use language conventions of one theory in one discussion and conventions of another theory in another discussion area (cf. Aristotle's intromissionist approach in De Anima and his extramissionist approach in Meteorology) but do not subscribe to theories underlying those conventions necessarily. Lindberg's "synthesis" account also fails to admit the importance of the intromisionist-extramissionist debate, a debate which not even Lindberg suggests was "synthesized." As one studies Newton's and Goethe's theories of optics, it becomes clear that indeed the separate ancient traditions continued on past the middle ages, and while Newton carried the mathematical tradition of optics forward, Goethe carried the physical and physiological traditions of optics forward.[22] The interesting question is why has the mathematical tradition not only been carried forward, but carried the day as well?

Goethe as Scientist

> "There appears to be no reason why a rhetoric of science should not be based firsthand on the pronouncements of these pivotal scientists."
>
> —Trevor Melia[23]

Although I am somewhat certain that Melia did not have Goethe in mind as one of "these pivotal scientists" when he wrote the above, there is compelling evidence to suggest that Goethe nevertheless is. Goethe's name may not immediately come to mind, however, when looking for pivotal scientists. Even when his friend, the Grand Duke of Sachsen-Weimar, Karl August, called Goethe to serve as Privy Councilor of Legation to the Weimar Duchy, he did so because of Goethe's reputation as a poet, not because of his legal (Goethe practiced law as well) or scientific abilities.[24] Yet Goethe regarded himself much more importantly a scientist: "I don't flatter myself in the least for all I have accomplished as a poet. Some of my contemporaries have been fine poets; even finer poets have preceded me and there will be others after me. However, that I have been the only one in my century who knows the truth in the difficult field of color theory, that is a fact concerning which I take some pride . . . ."[25] In the current age of specialization, we have accepted, as a general rule, the idea that for an individual to truly specialize to the point of being "pivotal" in his or her chosen field, he or she must endeavor therein to the exclusion of all else. Thus Goethe's notoriety as a poet serves to exclude his name from the list of pivotal scientists.

A second, and perhaps more important, reason why Goethe's name is not often mentioned in scientific circles is the current privileging of quantitative over qualitative science.[26] Rejecting the wisdom of the ancients, current scientific explanation tends toward quantification without proportional qualitative considerations.

Goethe was clearly conscious of the existence of an earlier attitude which accepted non-mathematical science, when he wrote, "Daß eine Physik unabhängig von der Mathematik existiere, davon schein man keinen Begriff mehr zu haben."[27] [It seems that no one has the concept of physics existing independent of mathematics any longer.] Yet, one should consider Goethe as a scientist not only because he himself did, but also because other scientists did, as evidenced by such noteworthy references as: August de Saint-Hilaire's many references to Goethe's plant morphology in his standard textbook Leçons de Botanique (1841); Alexander von Humboldt's acknowledgment of Goethe's science and his dedication of his first book on plant geography to Goethe; Werner Heisenberg's support of Goethe as a scientist of merit in Wandlungen in den Grundlagen der Naturwissenschaft (Zürich, 1947) and also in "Das Naturbild Goethe's und die technisch-naturwissenschaftliche Welt" (Jahrbuch der Goethe Gesellschaft, xxix (1967) 27-42); biologist Agnes Arbor's support of Goethe's plant morphology and botany in her "Goethe's Botany" (Chronica Botanica, X:2 (1946); and the assertion by biologist Ernst Haeckel, K. H. Meding (1861 pamphlet), Ludwig Büchner, David Friedrich Strauss and zoologist Valentin Haecker (1927) that Goethe's biology is a precursor to the theory of evolution.[28] It is also generally accepted that Goethe discovered the independent intermaxillary bone in the human skull.[29] Because he rejected explanations of natural phenomena by means of causal sequences and because he was interested in a science that is not based on mathematics, Goethe is not considered a scientist in the modern sense. Goethe's rejection of the humanly-constructed gloss of causality is resoundingly Humean:[30] "In der lebendigen Natur geschieht nichts, was nicht in einer Verbindung mit dem Ganzen stehe, und wenn uns die Erfahrungen nur isoliert erschienen, wenn wir die Versuche nur als isolierte Fakta anzusehen haben, so wird dadurch nicht gesagt; daß sie isoliert seien, es ist nur die Frage: wie finden wir die Verbindung dieser Phänomene, dieser Begebenheit." [In living nature, nothing occurs which is not connected to the whole, nothing is said when we consider only simple isolated experiences, and regard experiments as isolated facts; that they would be isolated raises the question: how do we find the connections of these phenomena, these occurrences.][31] But most importantly, to consider Goethe a scientist, one must look to his work.

Goethe's Theory of Color and Contribution to Optics

In considering Goethe's theory of optics as an example of the rhetorical world view and a case testing the limits of radical rhetoric, I note that Gross, in his The Rhetoric of Science, does present a "rhetorical analysis" of both Newton's 1672 paper "Philosophical Transactions," in which Newton discusses the "phaenomena of colours," and his treatise, Opticks.[32] As indicated by the title of the chapter in which these analyses are found, however ("Style, Arrangement, and Invention"), Gross' analysis is limited to what Melia calls the second variety of "rhetoric," that is, the analysis of acts of persuasion. Gross writes: "In Newton's early paper ["Philosophical Transactions"], the dominant arrangement is narrative; in his Opticks, virtually the same material is set out as Euclidean deduction. In his early paper, Newton uses narrative to dramatize the clash between past and present; in his Opticks he uses Euclid to display the present as a deductive consequence of the past . . . ."[33]

What are the features of Goethe's theory of optics? For purposes of this essay, I am suggesting that Goethe's theory of optics provides a "rhetorical" consideration of light and vision. I am of course using the word "rhetorical" here in an expansive sense, and mean by it a world view based not upon objectivity or certainty, but upon phenomenology. The rhetorical world view, in consideration of aesthetic rather than epistemic criteria, is, as Melia has noted "not, contra Plato, the result of a willful and perverse determination to exploit the vulgar susceptibilities of popular audiences,"[34] but is also not, contra Melia, merely "an acknowledgment of the necessity of getting on with public business in the face of a tragic and paralyzing loss of certainty."[35] On the contrary, when one considers that for Goethe, "a human consciousness is as much a part of nature as is the life of a plant or the color of the moon seen through an evening mist,"[36] one need not limit a rhetorical world view of nature or science to "getting on with public business in the face of a tragic and paralyzing loss of certainty." Rather than being a second choice when certainty cannot be obtained, or a detour to epistemology,[37] the rhetorical world view may indeed be a first choice in recognition of the aesthetic quality of human experience.[38] Goethe's detractors would have his theory of colors branded "subjective." For them, the world is neatly divided into subjects and objects, and since Goethe is largely not interested in describing and explaining "objects out there," they feel he must be explaining subjects, and thus his theory and method must be subjective. Such a simplistic reduction of the world of experience ignores Goethe's sincere and fruitful effort to avoid the prejudices of the simple subject-object dichotomy, and assumes the positivists' world view of subject and object to apply universally. The pervasiveness of the subject-object world view since Descartes is so strong that it is difficult for us to imagine a world without it, let alone practice a science without it. Yet I tend to agree with Peter Salm when he states that "I have become convinced in the course of this study that to gain access, no matter how tentative and ephemeral, to the singleness of Goethe's vision, which perhaps more than ever before or since fused abstract theory with vital experience, is worth a great deal of effort."[39]

Goethe's Phenomenological Science

> "The object of research is no longer nature itself, but man's investigation of nature."
>
> --Werner Heisenberg[40]

Goethe's refusal to accept the subject-object split is at the root of his science. Although Goethe himself never used the term "phenomenology,"[41] he repeatedly deals with what he calls "phenomena" in his science.[42] Goethe's phenomenology not only dispenses with the subject-object dichotomy, it also bridges the theory-observation (what Galen and other ancients would have called the "dogmatist-empiricist") debate. Goethe comments that "Theories are usually overhasty fabrications of an impatient mind which would like to do away with phenomenon and consequently will inject pictures, concepts or even just words in their place."[43] He goes on; "the highest boon would be to understand that all facts are already theory. The blue of the sky reveals to us the basic chromatic laws. If we would only stop looking for things behind the phenomena; they themselves are the theory."[44] Yet Goethe is not advocating a simple empiricism either:

> It is sometimes unreasonably required by persons who do not even themselves attend to such a condition, that experimental information should be submitted without any connecting theory to the reader or scholar, who is himself to form his conclusions as he may list. Surely the mere inspection of a subject can profit us but little. Every act of seeing leads to consideration, consideration to reflection, reflection to combination, and thus it may be said that in every attentive look on nature we already theorise. But in order to guard against the possible abuse of this abstract view, in order that the practical deductions we look to should be really useful, we should theorise without forgetting that we are so doing, ...[45]

The process of experiment is Goethe's method. It is only in the actual doing of the experiment, with the incumbent interaction of the phenomenon under examination and the experimenter, that one can truly understand nature. Peter Salm sums it up neatly when he says "for Goethe, the ultimate aim of science is nothing other than <u>the metamorphosis of the scientist</u>."[46] By contrast, with the standard hypothetico-deductive method in science, one first posits a hypothesis and then deduces whatever one logically can from the hypothesis. The source of the hypothesis is of little importance, but rather the product of the process is. Goethe does not posit a hypothesis first, but rather seeks a pattern in the phenomenon themselves. Then only through the labor of experiment can an active idea be developed. In a 1792 fragment entitled "Versuch als Vermittler von Objekt und Subjekt" ["Experiment as Mediator of Object and Subject"], Goethe provides a succinct definition of what he means by "experiment":

> Wenn wir die Erfahrungen, welche vor uns gemacht worden, die wir selbst oder andere zu gleicher Zeit mit uns machen, vorsätzlich wiederholen, und die Phänomene, die teils zufällig, teils künstlich enstanden sind, wieder darstellen, so nennen wir dieses einen Versuch.
>
> [If we ourselves, or at the same time with another, intentionally repeat the experiences which have been done before us, and the phenomena, which now originates in part by chance and in part artificially, occurs again, this we call an experiment.][47]

Thus to proceed scientifically, one must him- or herself perform experiments, not read or write about them. Science that is reading and writing about nature is an abstraction, and it removes one from the phenomena such that the scientist can not accede his or her intentionality to the phenomena. In a letter from his celebrated Italian journey, Goethe wrote that his scientific system of plant morphology was "hard to write in any case and impossible to comprehend from mere reading, even if everything were written ever so sharply and properly."[48] Here then, in phenomenology, one finds a potential limit to the constitutive nature of rhetoric for science: Only those in the practice of experimenting can properly experience the phenomena in an interactive way. Without written or spoken text, a rhetorical analysis must redefine itself to encompass non-linguistic practices. While I recognize that radical rhetoricians may already claim such practices for their own, they must demonstrate the rhetorically-constituted nature of interactive experimenting to maintain that claim.

Goethe offers a helpful analogy for understanding how the back and forth exchange between observer and observed presents the phenomena. In the Preface to his Theory of Colour, he writes: "We should try in vain to describe a man's character, but let his acts be collected and an idea of the character will be presented to us."[49] Goethe's scientist is constantly self-conscious. If one ceases to be self-conscious, his or her experimentation becomes simple habits of perceptions. In this way, the scientist is dealing not simply with empirical observations of phenomena, but with what Goethe calls "scientific phenomena," which will order themselves out of themselves. From the observation of the patterns of the phenomena, the scientist develops what Goethe refers to as an "intuition" with which it is possible "to deduce [ableiten] all the phenomena in their ideal relationships."[50] These ideal relationships are then called "Urphänomen." One must keep in mind that these relationships are not abstract, however, they are an intuited ordering of qualities. As one reads Goethe's Theory of Colours, one is invited to work the experiments out for him- or herself. First, Goethe asks the observer to look at the surroundings through a prism and note that light is not refracted except at the point where it meets the fringe of an object. Next, he has the reader look at a clear blue sky and notice that no colors appear through the prism except the blue of the sky. Refracted colors only come into view when a cloud appears, and then only at the outer edge of the cloud. Now he asks us to use some of the specially prepared printed cards included with the Theory of Colours. (In the current English edition, these cares are not included, but colored plates are printed halfway through the book.) One by one, the experimenting reader looks at irregularly curved black and white lines, a regular pattern of squares, narrow black and white stripes, white stripes on a black background and a black stripe on a white background. This series of experiments provides pure boundary colors which constitute Urphänomen. Still more complicated arrangements are then depicted which show how these boundary colors are manifested. This process illustrates how the experimenter experiences the phenomenon—the process, not the product are important. "The primary aim of science as Goethe understands it must be self-development, the metamorphosis of the scientist."[51] The notion of metamorphosis is even more pronounced in Goethe's work in botany, and is present in his mineralogy, meteorology and osteology as well. All serve to present boundary situations which demonstrate that perception is not located within the subject-object split. For instance, "when following botanical development, we do not <u>see</u> movement, but rather <u>intend</u> it, in the way that we unify intuitively the very different projective views of an object as we walk past. Nor do we actually see light, but rather only the ways in which it is darkened by objects: hence color is also in a very real sense an intentional construct."[52]

<u>An Application of Goethe's Method</u>

I will now return to a question that I had raised earlier, that is, "Why has the mathematical theory of optics carried the day?" One may be tempted to answer, "Because it works." But in actual practice, Goethe's phenomenological optics in the tradition of Galen and Aristotle "works" as well. To illustrate, I will now turn to an example from applied science, as found in the Commonwealth of Pennsylvania's air pollution regulations.

The Pennsylvania Environmental Quality Board, an executive agency charged by the Pennsylvania General Assembly with the duty to promulgate regulations "for the prevention, control, reduction and abatement of air pollution . . ."[53] promulgated regulations in 1971 wherein the emission of air contaminants is limited by visual observation of the contaminants' opacity. This regulation, 25 Pa. Code §123.41, states:

> A person may not permit the emission into the outdoor atmosphere of visible air contaminants in such a manner that the opacity of the emission is either of the following:
> (1) Equal to or greater than 20% for a period or periods aggregating more than 3 minutes in any 1 hour.
> (2) Equal to or greater than 60% at any time.

The Pennsylvania Department of Environmental Resources is a separate executive agency, charged by the General Assembly of Pennsylvania with the power and duty to inspect any air contamination source for the purpose of ascertaining compliance with 25 Pa. Code §123.41.[54] To provide a method of enforcement of 25 Pa. Code §123.41, the Environmental Quality Board promulgated 25 Pa. Code §123.43, which states:

> Visible emissions may be measured using either of the following:
> (1) A device approved by the Department and maintained to provide accurate opacity measurements.
> (2) Observers, trained and qualified to measure plume opacity with the naked eye or with the aid of devices approved by the Department.

Here, in 25 Pa. Code § 123.43, one can readily see that both Newton's method of measurement (by a device which produces numerical abstractions) and Goethe's method (observers who measure the opacity with the naked eye) are available. Yet in actual practice, the Pennsylvania Department of Environmental Resources has consistently used observers' naked eyes for the measurement.[55] An admonition of Goethe's is here brought to mind:

> Insofar as he makes use of his healthy senses, the human being is the greatest and most precise scientific instrument that can exist. And precisely this is the greatest disservice of modern science: that it has divorced the experiment from the human

being, and wants to know nature only through that which is shown by instruments--indeed, wants to limit and demonstrate nature's capacities in that way.[56]

Although Pennsylvania courts have consistently upheld the application of the Goethean standard, they have not agreed as to whether it is "scientific." This is not surprising, given the dominance in our culture of the Cartesian view of science, with its subject-object. In Commonwealth, Department of Environmental Resources v. Locust, ___Pa.___, 396 A.2d 1205, 1210, the Pennsylvania Supreme Court quoted from the Pennsylvania Commonwealth Court in Commonwealth v. United States Steel Corporation, 15 Pa. Commonwealth Ct. 184, 190, 325 A.2d 324, 328 (1974) and stated that "Courts are not scientific experts in the field of air pollution and should not be called upon to solve the scientific problems which the regulators and regulated should solve." The Court went on to find that Locust's challenge to the sufficiency of visual observation evidence presented by the Department of Environmental Resources "must fail. The [Department] presented two witnesses, 'environmental protection specialists,' who testified to visual observations . . . ." (Emphasis added.)

In another case, Midway Coal Company v. Commonwealth of Pennsylvania, Department of Environmental Resources, ___Pa. Commonwealth___, 413, A.2d 1139, 1140 (1980), the Court allowed visual observation to serve as evidence, but discounted it as non-scientific, and clearly made it subservient to "scientific" (that is, quantitatively scientific) evidence: "it has been held that, if an acceptable scientific test is available to measure the rate of emissions from a pollution source, proof of a violation of the Act must include evidence of such a test. [citations omitted] . . . On the other hand, it has also been held that, if no scientific (again read this as quantitatively scientific) test is available to measure the alleged pollution, proof of violation of the Act may rest on the evidence as a whole, including witnesses' observations. Rushton Mining Co. v. Commonwealth, 16 Pa.Cmwlth. 135, 328 A.2d 185 (1974)." (Emphasis added.) A close look at the Rushton decision reveals that the Court in Midway did not read closely. In Rushton, the Court was dealing not with 25 Pa. Code §123.43, but rather with a section of the Pennsylvania Air Pollution Control Act, 35 P.S. §4003(5), which defines "air pollution" as:

> The presence in the outdoor atmosphere of any form of contaminant including but not limited to the discharging from stacks, chimneys, openings, buildings, structures, open fires, vehicles, processes, or any other source of any smoke, soot, fly ash, dust, cinders, dirt, noxious or obnoxious acids, fumes, oxides, gases, vapors, odors, toxic or radioactive substances, waste, or any other matter in such place, manner, or concentration inimical to the public health, safety, or welfare or which is, or may be injurious to human, plant or animal life, or to property, or which unreasonably interferes with the comfortable enjoyment of life or property.

The Rushton Court stated "While scientific evidence (once again, quantitatively scientific) may be helpful in this type of case, it is not necessarily the most persuasive nor the exclusive means of proof." (Emphasis added.) Rushton, 328 A.2d 185, 189. While at first blush the Court's opinion in Midway may serve as evidence of the position taken by Melia that rhetoric in its third variety, that is, as world view, is a regrettable necessity resorted to only when quantitatively scientific evidence is unavailable, the Rushton Court supports Goethe when it states that "This Court has no knowledge as to the availability of a scientific measurement instrument which could gauge whether an atmospheric contaminant 'interferes with the comfortable enjoyment of life or property,' 35

P.S. § 4003(5), or of a method for determining whether such interference is 'unreasonable,' 35 P.S. § 4003(5)." Rushton, 328 A.2d 185, 189. The tone of this pronouncement by the Court echoes Goethe's very relevant insight: "Mathematics cannot dispose of prejudices; it can neither prevent obstinacy nor mitigate factionalism. It is impotent on all ethical matters.[57]

Conclusions

A review of the history of optics indicates that several explanatory theories were considered by the ancients--physical, physiological, and mathematical--and that these traditions continued up until the middle ages. A close look at scientists engaged in optics even after the middle ages indicates that tendencies toward one or the other of these separate traditions persisted thereafter. Although Newton's corpuscular model of light has been largely rejected, his mathematical method and content have remained popular and constitute, in many instances, the received theory of the nature of light.

In the Eighteenth and Nineteenth Centuries, Goethe, himself an established scientist in the fields of botany, mineralogy, osteology and optics, rejected the mathematical approach to science and sought instead a theory of colors founded in the Aristotelian tradition of physics. Why then, do we hear so little today of phenomenological science? Does it not "work"? No, indeed it does work, and it also functions in practice as seen in Pennsylvania's air pollution regulations. Ironically, it is traditional quantitatively-abstracted science which can be taken on board without the engagement of experimentation. Indeed that is one of the beauties of abstraction-- one can simply consume the reduced product without having undergone the process of experimenting. By comparison, Newton's theorizing, without repeated experimentation, has less to do with what is "really going on out there" than Goethe's experimental engagements. Thus the appeal of quantitative optics lies elsewhere; it lies in the ways in which it can be employed precisely without engagement.

But more importantly, Goethe's phenomenological science provides a possible case by which one can escape the trap of dichotomous thinking which grows out of Cartesian science, and perhaps provides a case-point where upon one may place minimal realism between absolute realism and so-called radical rhetoric. As epistemological certainty continues to erode, and as the guarantor of certainty, mathematics, no longer carries the day, we are reminded that it has been at just such junctures in history that the discipline of rhetoric has been called upon to facilitate "getting on with public business," such as environmental regulation, an enclave traditionally held in the empire of epistemological science.

Footnotes

[1]Alexander Hellemans and Bryan Bunch, The Timetables of Science (New York: Simon and Schuster, 1988) 451.

[2]See Merrilee H. Salmon et al., Introduction to the Philosophy of Science, Englewood Cliffs, New Jersey: Prentice Hall, 1992, 458.

[3]Alan G. Gross, The Rhetoric of Science, (Cambridge: Harvard University Press) 1990.

[4]J. E. McGuire and Trevor Melia, "Some Cautionary Strictures on the Writing of the Rhetoric of Science," 7 Rhetorica (Winter 1989): 87-99; "The Rhetoric of the Radical Rhetoric of Science," 9 Rhetorica (Autumn 1991): 301-316; "How to Tell the Dancer from the Dance: Limits and Proportions in Argument About the Nature of Science," Argumentation (Spring, 1993); Trevor Melia, "Essay Review," Isis, 83: 100-106 (1992); "Scientism and Dramatism: Some Quasi-Mathematical Motifs in the Work of Kenneth Burke," The Legacy of Kenneth Burke, ed. Herbert W. Simons and Trevor Melia (Madison: University of Wisconsin Press) 1989, 55-73; "And Lo the Footprint . . . Selected Literature in Rhetoric and Science," QJS 70 (1984), 303-13.

[5]Aristotle, Rhetoric, Book I, W. Rhys Roberts, trans. (from the R. Kassel text, Berlin, 1976), The Complete Works of Aristotle, Vol. 2, The Revised Oxford Translation, Bollingen Series LXXI-2 (1984) p. 2155.

[6]In "Rhetoric--Old and New," Journal of General Education, 5 (1951): 202-209, Kenneth Burke elaborates on the use of "rhetoric" when he identifies the "old" rhetoric with persuasion, and the "new" rhetoric with identification. While the stress of persuasion was deliberate design, identification can include an unconscious factor in its appeal. Identification can be deliberate, as when a speaker seeks to identify with an audience, but it "can also be an end, as when people earnestly yearn to identify with some group or other."

[7]Trevor Melia, "Essay Review," Isis, 83 (1992): 100.

[8]Trevor Melia, "Essay Review," Isis, 83 (1992): 100. This is to suggest that, for instance, when Nietzsche writes that "God is dead," he is, at the same time, announcing the end of certainty and the rebirth of rhetoric. See, Kenneth Burke, "Dramatism," Communication: Concepts and Perspectives, Ed. Lee Thayer, Washington: Spartan Books (1967) 352.

[9]Alan G. Gross, "Rhetoric of Science without Constraints," Rhetorica, IX (Autumn 1991): 298.

[10]Trevor Melia, "And Lo the Footprint . . . Selected Literature in Rhetoric and Science," QJS, 70 (1984): 311. Cf. "die Geschichte der Wissenschaft die (footnote continues next page)

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Wissenschaft selbst sei . . . ." ["the history of science is science itself . . .."] Goethe, Theory of Colour, preface to first edition, p. xliv.

[11]Melia, "And Lo the Footprint . . .," 311.

[12]Sir Isaac Newton, Optics or a Treatise of the Reflections, Refractions, Inflections & Colours of Light (Based on the Fourth Edition, London, 1730) New York: Dover (1952). Melia notes in his "Essay Review," (Isis, 83 (1992): 102) that for Gross, the Copernican revolution and Newton's Optics "are less obvious targets for rehetorical analysis, particularly of the radical, sophistic, variety . . ."

[13]See Jeremy Adler, "Goethe und Newton: Ansätze zu einer Neuorientierung am Beispiel der chemischen Verwandschaft," Goethe im Kontest: Kunst und Humanität, Naturwissenschaft und Politik von der Aufklarung bis zur restauration; Ein Symposium, Ed. Wolfgang Wittkowski (Tübingen: Niemayer, 1984) 300-309; Frederick Burwick, The Damnation of Newton: Goethe's Color Theory and Perception (New York: De Gruyter, 1986) 308; and Sir Charles Scott Sherrington, Goethe on Nature and on Science, second edition (Cambridge: Cambridge University Press, 1942) 53. (Sir Sherrington's piece hardly rises above being ad hominem war propaganda. Its style and content are unapologetic "Bosch bashing," all to the credit of Sir Newton's work.)

[14]The English word "idea" comes, via Latin, from the Greek verb "idein," meaning "to see." In about the Fifth Century, idein came to be equated with knowing as well as seeing.

[15]Goethe, Theory of Colours, 299.

[16]David C. Lindberg, "The Science of Optics," Science in the Middle Ages, David C. Lindberg, ed., Chicago: University of Chicago Press, 1978, 339.

[17]Lindberg, "The Science of Optics," 341.

[18]Lindberg, "The Science of Optics," 341.

[19]Aristotle, De Anima, Book II, Chapter 7. For Aristotle, the medium is capable of taking potentially-illuminated objects and making them actually-illuminated objects. This is then moved through the medium to the eye, and from the eye it is carried to the heart via the blood. Thereby the senses can perceive the form of an object without the matter. (Of course, Aristotle does not just mean shape by "form.")

[20]David C. Lindberg, "The Science of Optics," Science in the Middle Ages, David C. Lindberg, ed., Chicago: University of Chicago Press (1978) 338-367.

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[21]David C. Lindberg, "Late Thirteenth-Century Synthesis in Optics," A Sourcebook in Medieval Science, E. Grant, ed., Wisconsin: University of Wisconsin Press 392-435.

[22]In the Introduction to his Theory of Colours, Goethe wrote that "the attempt to describe and class the phenomena of colours has been only twice made: first by Theophrastus, and in modern times by Boyle." The translator notes at this sentence that the first treatise to which Goethe "alludes is more generally ascribed to Aristotle." See, Goethe, Theory of Colours, trans. Charles Lock Eastlake (Cambridge, MA: The M.I.T. Press, 1970) li. In the introduction to that same translation, Deane B. Judd observes on page xv "how closely Goethe adheres to Aristotle's view that color arises from the transition of brightness to darkness."

[23]Trevor Melia, "And Lo the Footprints . . .," 311.

[24]Calvin Thomas, Goethe (New York: Henry Holt and Company, 1917) 65.

[25]Johann Wolfgang von Goethe, note of March 19, 1829, as reprinted in Peter Salm, The Poem as Plant: A Biological View of Goethe's Faust (Cleveland: The Press of Case Western Reserve University, 1971) 4.

[26]Because I insist upon a qualitative undestanding of the word "science" in this essay, rather thanb the more popularly accepted quantitative understanding, I had originally left Goethe's "Wissenschaft" in its original German. That now appears ostentatious to me, so I have opted for the English "science." nevertheless, I wish to emphasize the sense of knowingness in the german (and Latin) roots of "Wissenschaft" (and "scientia") and persuade the reader not to understand "science" merely in the quantitative sense.

[27]Goethe, Werke, Hamburger Ausgabe, XIV, 265.

[28]See Rudolf Magnus, Goethe as a Scientist, trans., Norden Heinz, New York: Henry Schuman, 1949, 116; and Gunther Schmid's forward to Magnus' book, p. x.

[29]Charles Coulston Gillespie, ed., Dictionary of Scientific Biography (New York: Charles Scribner's Sons, 1972) 442-43; Alexander Hellemans and Bryan Bunch, The Timetables of Science (New York: Simon & Schuster, 1988) 233; Nicholas Boyle, Goethe: The Poet and the Age, vol. 1 (New York: Oxford University Press, 1992) 349-50.

[30]See David Hume, "An Inquiry Concerning Human Understanding," Ten Great Works of Philosophy, Robert Paul Wolff, ed. (New York: New American Library, Inc., 1969) 176-295.

[31]Johann Wolfgang von Goethe, "Versuch als Vermittler von Objekt und
(footnote continues next page)

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Subjekt," Goethes Werke ("Hamburg Edition") ed. Erich Trunz, 10th ed., vol. 13 (München: C.H. Beck'sche Verlagsbuchhandlung (Oscar Beck), 1981) 17. (The rough translation is mine.)

[32]Alan G. Gross, The Rhetoric of Science, Cambridge: Harvard University Press, 1990, 119-128.

[33]Gross, The Rhetoric of Science, 123.

[34]Melia, "Essay Review," Isis, 83 (1992): 100.

[35]Melia, "Essay Review," 100.

[36]Salm, 35.

[37]See Robert Scott, "On Viewing Rhetoric as Epistemic." Central States Speech Journal 18 (1967): 9-16; and Robert Scott, "On Viewing Rhetoric as Epistemic: Ten Years Later." Central States Speech Journal 27 (1976): 258-66.

[38]See John Poulakos, "Nietzsche and the Aesthetics of Rhetoric," Quarterly Journal of Speech, 79 (1993).

[39]Salm, xix.

[40]Werner Heisenberg, The Physicist's Conception of Nature, trans. A. Pomerans (New York: Harcourt, Brace and Co., 1958) 24.

[41]Goethe predates the recognized discipline of phenomenology. Franz Brentano, Edmund Husserl's teacher, used the term in his writings not long after Goethe's death. See Franz Brentano, Von der mannigfachen Bedeutung des Seienden nach Aristoteles (Freiburg: Herder, 1862); [in English, On the Several Senses of Being in Aristotle, trans, Rolf George (Berkeley: University of California Press, 1975)]. Beginning with Husserl, phenomenology became a formal discipline. See Herbert Spiegelberg, The Phenomenological Movement: An Historical Introduction, 3rd ed. (Boston: Martinus Nijhoff, 1982).

[42]The only reference to Goethe as a phenomenologist that I have found was a somewhat mechanical application of the notion in Fritz Heinemann, "Goethe's Phenomenological Method," Philosophy (The Journal of the British Institute of Philosophy), IX, 1934.

[43]Goethe, "Betrachtung über Morphologie überhaupt," Jubiläumsausgabe, ed. E. v. d. Hellen, 40 vols. (Stuttgart and Berlin, 1902-12) XXXIX, 64; also quoted in Salm, The Poem as Plant 10; and Magnus, Goethe as Scientist, 228.

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[44]Goethe, Jubiläumsausgabe, XXXIX, 72; also quoted by Salm, the Poem as Plant, 11.

[45]Goethe, Theory of Colours, xli.

[46]Frederick Amrine, "The Metamorphosis of the Scientist," Goethe Yearbook, 194.

[47]Goethe, "Versuch als Vermittler von Objekt und Subjekt," Werke in vier Bänden, vol. 3 (Salzburg: Caesar Publishing Co., 1983) 422. [The rough translation is my blame.]

[48]Amrine, 200

[49]Goethe, Theory of Colours, xxxvii.

[50]Amrine, 197.

[51]Amrine, 200.

[52]Amrine, 202. The interconnectedness of intentionality with phenomenology serves as further support for my calling Goethean science "phenomenology." See, Niels Ole Bernson, Heidegger's Theory of Intentionality. trans. Hanne Voltz, Odense University Studies in Philosophy (Odense: Odense University Press, 1986); Hubert Dreyfus, ed. Husserl, Intentionality and Cognitive Science (Cambridge, MA: MIT Press) 1982.

[53]35 P.S. § 4005

[54]35 P.S. § 3004.

[55]Similarily, one finds "malodor" defined in Pennsylvania's regulations on air pollution as "An odor which causes annoyance or discomfort to the public and which the Department determines to be objectionable to the public." (25 Pa. Code §121.1.) The limitation on malodors is as follows: "A person may not permit the emission into the outdoor atmoshpere of any malodorous air contaminants from any source, in such a manner that the malodors are detectable outside the property of the person on whose land the source is being operated." (25 Pa. Code §123.31.) The method of detection here is the nose, just as it is the eye in reading visible emissions--not technology which abstracts numbers for the phenomena.

[56]Goethe, as translated in Amrine, 195.

[57]Goethe, Jubiläumsausgabe, ed. E. v. D. Hellen, 40 vols. (Stuttgart and Berlin, 1902-12) vol. XXXIX, 77.