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Parks, Sara (2014). Neither Journalist nor Scientist: The Challenge of Science-Funded "Science Communications". https://doi.org/10.31274/sciencecommunication-180809-105

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Neither Journalist nor Scientist: The Challenge of Science-Funded "Science Communications"

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ABSTRACT: This paper proposes a heuristic of *ethos* indicators that could be used to shed light on how embedded science communicators juggle competing professional norms. Embedded science communicators combine often-opposing journalism, science, public and internal relations, education, and advocacy norms to create rhetorical products that may not be identified as advocacy.

KEYWORDS: ethos, norms, science communication, advocacy, science journalism, science education, public relations

1. INTRODUCTION

The role of science communicator has traditionally been considered a challenge of dichotomy; the science journalist, bound by the norms of journalism, versus the scientist, bound by the norms of science (Hartz & Chappell, 1997). According to Hayes and Grossman, authors of *A Scientist's Guide to Talking with the Media* (2006, p. 36), journalists and scientists have different *ethos* in how they "seek, verify, and publicize" science. The authors juxtapose the habits of science with the necessities of journalism. For example, well-trained journalists cover a complete story, or an identifiable piece of a story. Therefore, journalists tend to report on just one set of new findings as an event, instead of viewing science as an always continuing process, as scientific *ethos* dictates. (Hayes & Grossman, 2006, pp. 40-41)

However, in practice this simple dichotomy between journalist and scientist does not capture the messiness of modern science communication. This paper will argue that science communication is not a science *ethos* versus journalism *ethos* problem. In the current media world embedded science communicators, communicators who are paid by the lab or science institution about which they write, juggle communication norms from science journalism, rhetoric of science (scientist to scientist), science education, public relations, and advocacy to create science communications that mix these norms in creative, though sometimes concerning ways. This paper outlines a large set of norms that could be used to analyze embedded science communication to shed light on how embedded science communicators handle some traditional features of textual argumentation, particularly indicators of *ethos*, as they juggle competing professional norms.

In their book, Hayes and Grossman (2006, pp. 31-50) go on to identify financial gain and the pressures of a capitalistic media as the main extrinsic motivation for common journalistic "shortcuts" such as "viewing research in isolation," "using interviews to support a predetermined angle," and even using a binary of opposing views to achieve "balance." Hayes and Grossman juxtapose these unflattering "shortcuts" with an idealistic vision of scientific

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endeavor that is less burdened by the temptation for shortcuts and capitalistic pressure. The authors conclude their chapter by urging scientists to shape messages that conform to the perceived limitations of modern journalism so that journalists are not as tempted by the "shortcuts."

This exhortation for scientists to simplify their own work or to learn how to better communicate with publics of all types is common enough to have entered the *topoi* of National Science Foundation (NSF) grant requirements and university curricula. However, there has been pushback from the science community as they police the boundaries of a science *ethos* that at times includes uncertainty (Walker, 2013), the concept of an altruistic "honest broker" (Pielke, 2007), and the traditional normative aspects as identified by Robert Merton (1973): universalism, communism, disinterestedness and organized skepticism. Although the concept of a different or special normative *ethos* for science has been challenged, the question of how science and scientists ought to communicate or ought to be presented to the public seems to be in perpetual debate and a convenient scapegoat for perceived failures of public science literacy and science-informed decision-making. (Hodson, 2008; Brossard & Shanahan, 2006; Nisbet & Scheufele, 2009)

With science journalism and science at a seeming impasse, why is the communication of science flourishing in popular culture, at least by the numbers? In March of 2014 there were 2,752 hits for "science magazine" available for subscription on Amazon.com, with 58 hits for "science magazines for children." Science communication on Twitter is thriving, supported by websites such as tweetyourscience.com and the NSF's "Becoming the Messenger" seminars. As of March 2014, the AAAS Science facebook page had 1,191,538 likes. The highest "liked" science-related facebook page, "I Fucking Love Science," with over 11 million likes, was planning a show on the Discovery TV channel. TV channels seemingly dedicated to portraying scientific inquiry are immensely popular, with NOVA being the "highest rated science series on television and the most watched documentary series on public television" (PBS.org, 2013) and FOX re-introducing the science-based series, "Cosmos."

In this receptive media environment, public figures act as science advocates, ethically questionable but easily identified influencers of policy who take on the norms of public advocacy. These advocates complicate the traditional dichotomy of science communication since many are scientists-turned-media stars. (Goodwin, 2012) The promotional rhetoric of celebrities like Neil DeGrasse Tyson, Mireya Mayor, Bill Nye, or Michael Mann may infiltrate other areas of science communication.

One such place may be the recent emphasis on persuasive communication by agencies such as the NSF. Recent public communications requirements implemented for NSF grant programs nail home the message that expertise in public communication is important and expected. Because scientists themselves have qualms about learning yet another skill set, and the relative ease of publication by even non-science-experts in a fragmented news media environment, a fourth role in science communication has been established, that of paid, embedded science communicator. This isn't a new position, professional science communicators have been hired by government entities since the days of world war propaganda (Lewenstein, 1992), but the ability of relatively small grant programs to directly interface with the public via websites and social media has likely led to more embedded science communicators being hired. At the same time, the recent push from the NSF and other science funding agencies to initiate "broader impacts" has leant *kairos* to the argument that grant money should be spent to hire professional communicators.

Broader impacts as a concept means different things to different science bodies. However, the NSF defines the term as, 1. advancing discovery and understanding while promoting teaching, training, and learning, 2. broadening participation of under-represented groups, 3. enhancing infrastructure for research and education, 4. broadening dissemination to enhance scientific and technological understanding, and 5. giving benefits to society. (2007) This mixing of broader impacts goals into science grant requirements goes hand in hand with efforts at the university and industry levels to influence economic, political and social policy via public opinion. Due to long standing injunctions on government agencies employing public relations, terms related to communication and education are explicitly preferred over public relations and advocacy terms, even when communication is performing a public relations or advocacy function. For example, the NSF's broader impact criterion is a case study in language that distances the agency from advocacy and explicit public relations. It reads:

> Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to the project. NSF values the advancement of scientific knowledge and activities that contribute to the achievement of societally relevant outcomes. (nsf.gov, 2013)

In practice, the open-ended phrase including activities "complementary" to the research serves as a catch-all for many of the public science communicator's duties, such as educational support for schools, news release writing, and website promotion. The "societally relevant outcomes" include a multitude of potential impacts, from institutional issues, like increasing diversity in faculty hiring, to policy outreach, like educating legislators on the newest models of policy implications.

This mixed environment of competing demands on science communication leads embedded science communicators to combine the often-opposing norms of journalism, science, public (and internal) relations, education, and advocacy to create rhetorical products that often adhere to the arrangement, style and delivery of journalism or education but are beholden to the interests of the science employer. Thus, these products may be less easily identified as advocacy. This paper proposes a heuristic that could be used to shed light on how embedded science communicators handle some traditional features of textual argumentation, particularly indicators of *ethos,* as they juggle competing professional norms.

2. METHODS

The purpose of this study was to explore the challenges of laboratory-produced, funded science communication adherence to the norms of science *ethos* and other communicative disciplines' *ethos* simultaneously. To do this, a multi-disciplinary heuristic of embedded science communication *ethos* was created (see table 8). The heuristic is intended to test the adherence of embedded science communication to the newly identified *ethos* norms of embedded science communication.

2.1 Ethos

For Aristotle, the concept of *ethos* was an element of persuasion tied to a rhetor's personal character. He defined *ethos* as an artistic, interpretation of evidence that shows the rhetor morally trustworthy. He claims, "This kind of persuasion, like the others, should be achieved by what the speaker says, not by what people think of this character before he begins to speak." This is important because it necessitates we look for *ethos* as part of the rhetorical act itself.

Problematically, the public science communication and education fields' traditional ideal has been the objective conveying of fact or results, rather than rhetorical communication. The idea that science communication and education are rhetorical, even persuasive, is still highly resisted by practitioners. For example, in a letter to the editor published in *Nature* MIT biology professor Yarden Katz cautions against adherence to a controlling narrative in public science communication. He says, "Biological systems are difficult to measure and control, so nearly all experiments afford multiple interpretations – but storytelling actively denies this fact of science" (2013, p. 1045). The resistance of scientists to nailing down the broader implications of their research may be related to a fear that such a narrative will influence the perceived objectivity of their research. Katz comments, "Storytelling encourages scientists to design experiments according to what constitutes a 'great story,' potentially closing off unforeseen avenues more exciting than any story imagined a priori." Since pure objective inquiry is a public value of science (see table 2), scientists see the potential to lose *ethos* by giving up that special level of credibility. Unfortunately, claiming objectivity also makes a critique of the persuasive power and success of the science communication or education nearly incommensurable.

However, science communication and education are rhetorical forms of communication, and some could be persuasive enough to be considered advocacy. There is a long history of considering the persuasive power and social success of both public and internal science communication and education. In fact, whole academic disciplines in science studies are built around doing so. For example, sociology of science studies the institutionalization of science as an agent of social change, the organizational determination of research, and how science is a social structure. (Ben-David & Sullivan) History of science studies the development of scientific knowledge, natural philosophy, and scientific methods in a historical context. (History of Science Society) Philosophy of science considers the purpose and reliability of science, particularly in its relationship to truth. (The Philosophy of Science Association) Rhetoric of science studies the persuasive aspects of science activity, particularly the deployment of strategic language. The work of these disciplines necessarily overlap and they all rely heavily on similar sets of thinkers, such as Merton and Kuhn.

The importance of *ethos* creation to the authority of scientific texts both within science disciplines and in the public is well established. Work in science studies has established both the *topoi* of general scientific *ethos*, the boundary issues and problems of credibility that occur when experts disagree or when scientists take on advocacy positions. (Gross, 2006; Harris, 1997; Prelli, 1989; Collins & Evans, 2007; Segal & Richardson, 2003) However, how indicators of *ethos* differ by communicative discipline and the repercussion for those science communications that exist on the nexus of those disciplines has not been investigated. Nailing down exact phrasal indicators of *ethos* is a judgment call, however some inferences can be determined based on adherence to the norms and values of each discipline.

2.2 Disciplinary Indicators of Ethos

Science journalism explicitly treats issues of credibility as part of disciplinary guidance on craft. In hard science journalism, a credible writer or broadcaster attempts to balance values of science with values of journalism. Since both hard science and journalism value objectivity, the journalist will rarely explicitly tout their own *ethos*. Instead, the subject of the work will likely be epistemic. *Ethos* is instead indicated by the science journalists' resistance to sensationalism (Christenssen, 2007) and ability to frame evidence in ways that consider the abilities and interests of their audience. (Dahlstrom, 2014; Fairhurst & Starr, 1996) However, softer forms of science journalism, such as literary journalism, special topics pieces, or editorials have more room for narrative, artfulness, and the intrusion of the journalist into the story. (Roorbach, 2001) Generally, in these types of stories, the journalist creates *ethos* for themselves and their observations by identifying themselves with the readers as an observer, rather than with the scientists as an expert.

Table 1 Hard science journalism/Soft science journalism norms of *ethos*

Objectivity - journalism should show both sides to every story	**Narrative** – journalism should find and tell the story in the issue/topic
Epistemic subject – journalism should be about the topic, not the writer	**Identification with audience** – journalism should be written from the viewpoint of an observer, not an expert
Resistance to sensationalism – journalism should not overstate findings	**Framing for audience** – journalism should frame stories to the interests and understanding levels of its audience

Rhetoric of science and other science studies disciplines have constructed several frameworks for *ethos* within science. Merton's (1973) sociological heuristic of norms for science have been modified by many, however, the most commonly cited thinking about these norms within rhetoric of science is Prelli's (1989) use of the heuristic to describe the rhetorical construction of scientific *ethos*. Prelli points out that Mittroff's set of counter-norms (such as particularism vs universalism and solitariness vs communality) problematizes a view that science has a standardized set of norms that do not conflict. Instead, Prelli proposes that these norms and counter-norms constitute a rhetorical *topoi* for managing scientific *ethos.* He points out that which *topoi* are valued as a positive or negative quality is context-dependent. This challenges the possibility of a static, decontextualized heuristic, or set of best practices for the creation of *ethos* in varied situations.

However, this problem does not negate the use of Merton and Mittroff's norms and counter-norms as rhetorical *topoi*. In fact, Prelli calls for a "topical inventory" of the *topoi* scientists use in various situations. Many subsequent case studies in multiple disciplines have added to this knowledge. (Anderson et al., 2010; Brathwaite, 2010) For the purposes of this study's context, there are no previous inventories of common *topoi.* Therefore, we will begin with the Merton/Mittroff norms and counter-norms heuristic as a set of *topoi* familiar to science and the science studies fields.

Table 2 Merton/Mittroff norms and counter-norms of science *ethos*

Communality – science should value collaborative research and shared results	**Solitariness** – science should keep findings

	secret for publishing primacy, patents, etc.
Universalism – science should evaluate findings on impersonal criteria	**Particularism** – science should determine expertise by taking into account indicators sometimes unrelated to the research itself, such as access, funding, and reputation
Disinterestedness – science should have altruistic motives	**Interestedness** – science should have a stake in the reception of research
Organized skepticism – science should use empiricism and logic to scrutinize beliefs	**Organized dogmatism** – science beliefs should change slowly due to interestedness, authority, and consensus

There are many disciplines involved in researching and refining best practices for science education. Public science education as a category is especially tricky because it encompasses so many different audiences. Generally, public science education breaks down into three categories: pre-K-12 education, post-secondary education, and adult or continuing education. To pin down the most traditional norms of public science education ethos, this study relies on guidelines from the National Science Teacher's Association (NSTA). This reliance on the NSTA may be problematic since the association focuses on pre-K-16, and particularly public K-12 education. However, this decision is justified as adult education research and *praxis* norms are less well established and in a state of renewal, particularly through institutions of adult and continuing education such as Cooperative Extension. (eXtension.org)

The NSTA-authored position statements provide leadership in settling the norms of science education as a discipline of *praxis*. Their website claims these position statements identify, "the qualities and standards for good science education" and that they should guide "the improvement of science education at all levels." (NSTA.org, 2013) Some of the position statements are about particular subjects (such as evolution), some concern institutional issues (such as gender equity), and focus on particular audiences (such as high school-level students). However, the statement that currently guides the rest is the NSTA Position Statement (2003), "Beyond 2000 – Science Teachers Speak Out." The statement is a lead paper that updates the previous lead paper from 1990. The norms that appear in table 3 are the main sections and paraphrased descriptions from this NSTA position statement.

Table 3 NSTA established norms of public science education ethos

Societal Changes – science education should have flexibility in the face of increasing complexity of science, technology, and the application thereof	**Scientific Knowledge is Changing** – science education should have flexibility in content of instruction
How Students Learn Science – science educational praxis should be informed by the most current research	**What Students Are to Learn and Understand –** science education should standardize context of inquiry as the way to engage students in similar activities and

	thinking processes as scientists
Assessment as a Component Integral to Learning Science – science education should create learning outcomes and gather feedback from summative assessments to enhance and inform learning	**Professional Development that Support Learning Science –** science education should support teacher professional development for both content knowledge and pedagogy
Science Curriculum Programs that Support All Students – science education should manage pedagogy coherence and scaffolding across years to aid student transfer, connection building, and deep understanding	**Systems that Support the Development of Scientific Literacy for All Students –** science education should create program-wide continuing assessments that account for context and demographics

For the discipline of public relations, the Public Relations Society of America (PRSA) Code of Ethics (2000) is considered the industry standard. According to the PRSA website, the code is based on a set of fundamental values that translate into ethical practice. Potentially problematically for capturing the norms of the entire profession, the PRSA has eliminated a mandate to enforce the code by identifying, publically shaming, and kicking out members who violate it. In 2000 the PRSA revised the code of ethics after nearly half a century of unsuccessful punitive focus. Now the code of ethics acts as motivation and guidelines for ethical practice and professional development, rather than as a deterrent in itself. (PRSA.org, 2014) The first part of the code is a member statement of professional values. These values then inform the practice of public relations. The member values are listed in table 4 with a paraphrased explanation.

Table 4 PRSA Code Member Statement of Professional Values

Advocacy – public relations should advocate responsibly to aid informed public debate	**Honesty** – public relations should adhere to the highest standards of accuracy and truth
Expertise – public relations should acquire specialized knowledge and experience through continuing professional development, research, and education	**Independence** – public relations should be objective in counseling those represented and be held accountable
Loyalty – public relations should be faithful to those represented while also serving the public interest	**Fairness** – public relations should respect all opinions and support free expression

The values in table 4 combine with provisions of conduct in the code. While the values above seem very similar to those of other communicative disciplines, the provisions of conduct distinguish the *praxis* of public relations as participating in the marketplace. There is no 1:1 connection between the values and conduct provisions. These provisions of conduct are listed below in table 5 with paraphrased explanations.

Table 5 PRSA Code Provisions of Conduct

Free Flow of Information – public relations should protect and advance accurate and truthful dissemination of information to contribute to informed decision making	**Competition** – public relations should promote fair competition among professionals and preserve intellectual property rights in the marketplace
Disclosure of Information – public relations should reveal all information necessary for informed decision making, including inaccuracies, sponsorship, and financial interest	**Safeguarding Confidences** – public relations should protect confidential or private information of those represented
Conflicts of Interest – public relations should avoid and disclose real, potential, or perceived conflicts of interest, including those that put one at odds with the interests of democratic society	**Enhancing the Profession** – public relations should strengthen the public's trust by ensuring ethical conduct and pursuing professional development

A reoccurring theme in the public relations norms is a sense that practitioners should be responsible, ethical, honest advocates. This theme also pervades recent discussions of appropriate advocacy for scientists as they attempt to help decision-makers make choices and develop policies based on scientific evidence. As discussed earlier, scientists who choose to respond to pleas for expertise or who are moved to advocate a particular policy based on their deep knowledge of the subject area are faced with walking a tightrope between the norms of argument and the norms of science.

The norms of science advocacy are not settled and are currently being debated in disciplinary journals and conferences. In her (2012) article "What is 'responsible advocacy' in science? Good advice." Goodwin identifies several problems and possibilities for scientists who want to guide policy without violating the *ethos* norms of their disciplines. Goodwin suggests that the frustration scientists encounter at the crux of advocacy and science is actually a good thing, and a by-product of the democratic process. The more authority an expert has, the less trust they retain if they argue strongly for a particular policy. This phenomenon is understandably exasperating for scientists who hesitate to enter the policy arena in the first place and the lack of settled norms make navigating the line that much more difficult. However, in practice there are some normative stances of public advocacy scientists are successful in holding along a spectrum of weak to strong argument.

Brussard and Tull (2007) identify four types of advocacy specifically used in conservation biology, a discipline that often bumps into the political realm. The norms below, "professional advocacy" and "advocacy for science" are based on their advice for conservation biologists. The other norms below are from Pielke's (2007) book. His spectrum of choices for science advocates culminate with the "honest broker" as the most desirable position. However, in practice, science advocacy recognizes all of these positions including, unfortunately, Pielke's Stealth Issue Advocate, which is not necessarily an ethical position. Since Pielke's choice of "pure scientist" is distinctly not on the advocacy spectrum, I have not included it in the table below.

Table 6 Normative stances (potential norms) of science advocacy ethos

Honest Broker – science advocates elucidate and expand on the choices available within a science framework	**Professional Advocacy** – science advocates inform about issues that arise in one's area of expertise relying on transfer via academic books and journals
Science Arbiter – science advocates meet demands for assessment and information without attempting to steer policy or take a side	**Advocacy for Science** – science advocates stress the importance of understanding scientific inference, of science-based policy making, and of science education, particularly within their discipline
Issue Advocate – science advocates openly attempt to steer policy by presenting science that supports a particular side or policy	**Stealth Issue Advocate** – science advocates present science that steers policy in a particular direction without declaring their intentions or purposes

The five main sets of forty professional norms compiled above are already complex within the boundaries of their own areas. Hard and soft journalism norms already delineate two types of practice. The norms/counter-norms of science already create a communicative tightrope. The values statement and following conduct norms for public affairs do not necessarily follow each other, which creates tension. And norms for science advocacy aren't hardly codified yet. To help see where science communicators may feel more comfortable creating a firm sense of *ethos* in their communications, I coded the forty norms into the following table to categorically identify areas of overlap between these five sets of norms.

The following table is a color-coded key and new, combinational, multi-disciplinary heuristic for the forty *ethos* norms to which embedded science communicators are often expected to adhere. They ended up falling into six main categories.

Table 7 Coding for multi-disciplinary heuristic for *ethos* in embedded science communication

Key	
Hard/Soft journalism norms	Norms/Counter-norms of science
Values/Conduct for public affairs	Potential norms of science advocacy
Norms of science education	

Coded Categories	
Particularism/ Professional Development that Support Learning Science/ Communality/ Expertise/ Enhancing the Profession/ Advocacy for Science	Professionalism

Epistemic Subject / Scientific Knowledge is Changing/ Advocacy/ Fairness/ Free Flow of Information/ Issue Advocate	Topic Focus
Identification with Audience/Narrative/Framing for audience/ Interestedness/Assessment as a Component Integral to Learning Science/ Societal Changes/ Systems that Support the Development of Scientific Literacy for All Students/ Science Curriculum Programs that Support All Students/ Loyalty/ Safeguarding Confidences/ Stealth Issue Advocate	Audience Focus
Resistance to sensationalism /Organized Dogmatism/ What Students Are to Learn and Understand / Honesty/ Disclosure of Information/ Professional Advocacy	Decorum
Objectivity/Universalism/Organized Skepticism/How Students Learn Science/ Independence/ Science Arbiter	Conservative Restraint
Solitariness/ Disinterestedness/ Competition/ Conflicts of Interest/ Honest Broker	Extreme Restraint

The first category, Professionalism, which compiles Particularism, Professional Development that Support Learning Science, Communality, Expertise, Enhancing the Profession, and Advocacy for Science, is a category that forwards the necessity of particular expertise within disciplinary fields.

The second category, Topic Focus, which compiles Epistemic Subject, Scientific Knowledge is Changing, Advocacy, Fairness, Free Flow of Information, and Issue Advocate, is a category that forwards the necessity of focus on the subject of communication and values it, perhaps more than audience or context.

The third category, Audience Focus, which compiles Identification with Audience, Narrative, Framing for Audience, Interestedness, Assessment as a Component Integral to Learning Science, Societal Changes, Systems that Support the Development of Scientific Literacy for All Students, Science Curriculum Programs that Support All Students, Loyalty, Safeguarding Confidences, and Stealth Issue Advocate, is the largest and perhaps most controversial category. This category forwards the necessity of focus on the audience and purpose of the communication.

The fourth category, Decorum, which compiles Resistance to sensationalism, Organized Dogmatism, What Students Are to Learn and Understand, Honesty, Disclosure of Information, and Professional Advocacy, is a category that forwards the necessity of openness and working within established parameters of communicative behavior.

The fifth category, Conservative Restraint, which compiles Objectivity, Universalism, Organized Skepticism, How Students Learn Science, Independence, and Science Arbiter, is a category that forwards the necessity of established science and action based on that establishment. These set of norms are conservative and require restraint in persuasive tactics and enthusiasm on the part of the science communicator.

The final category, Extreme Restraint, which compiles Solitariness, Disinterestedness, Competition, Conflicts of Interest, and Honest Broker, is a category that forwards the necessity of tremendous moderation on the part of the science communicator. It is almost self-removal from the impacts of science communication.

Table 8 Embedded Science Communication *Ethos* Norms

Decorum – embedded communicators should be open and let the disciplinary traditions of communication curb behavior	**Professionalism** – embedded communicators should have or rely heavily on expertise in the field of science being reported
Conservative Restraint – embedded communicators should be skeptical and let the disciplinary traditions of science curb enthusiasm and persuasion	**Topic Focus** – embedded communicators should ensure science topics are as accurate and thoroughly conveyed as possible
Extreme Restraint – embedded communicators should be very moderate and removed in reporting science	**Audience Focus** – embedded communicators should ensure communication is tailored for the audience with great consideration of purpose and influence

As with nearly any method of coding, not everyone will agree with the combinations of norms or the categories I identified. Firstly, for the purposes of coding the norms into a heuristic I chose not to duplicate norms into multiple categories. Instead, I used grounded theory to sort the norms into groups based on a sense of similarity. Then I reviewed the coded groups, named and described the categories. For example, the norm of Professional Advocacy, which currently resides in Decorum, may also fall into the Professionalism category. Also, the category of Audience Focus could have been broken into two categories, however I did not see the norms falling separately. Future studies could refine and redefine these categories.

The act of coding the norms into new categories wrought some surprises. I was pleased to find the general categories ended up fairly balanced in representation from the different disciplines, which was not one of my conscious goals in coding, but seems to support the accuracy of the categories I identified in coding. It also seems norms from the conservative end of the spectrum sorted into three categories, Conservative Restraint, Extreme Restraint, and Decorum with fewer norms represented in those categories, while the Audience Focus category balances the other end of the spectrum with many norms that stuck together. Two categories, Topic Focus and Professionalism, seem to lie outside the conservative/permissive spectrum entirely.

2.3 Context

This preliminary application of the heuristic of embedded science communication focuses on the challenges faced by Ames Laboratory communications. The news magazine produced by Ames Lab, *Inquiry Magazine*, was chosen as the corpus of study because it bridges the disciplinary boundaries described above. It circulates to all Ames Lab affiliates, is publically available in print and in web formats, and attempts to engage the public while also remaining fairly technical. It is distinct from the internal Ames Lab employee newsletter, named *Insider.*

Ames Lab is owned by the U.S. Department of Energy (DOE) and operated by Iowa State University, in Ames, Iowa. According to its website (2014), the lab specializes in energy-related research into rare-earth and other materials research, high-performance computing, and environmental science. Ames Lab has its roots in atomic energy research, having developed the process for producing high-purity uranium for the Manhattan Project. Today Ames Lab promotes itself as completing interdisciplinary energy-security related research by developing, "new ways to produce and use existing materials" and creating, "new, environmentally friendly materials." Basic science research in several disciplines, such as computing, chemistry, and physics support these engineering goals. The Lab is comprised of several grants and projects, including a DOE Energy Innovation Hub, the Critical Materials Institute, and the Materials Preparation Center, which "prepares, purifies, fabricates and characterizes materials" for research and development programs throughout the DOE lab network. Nearly 750 people are employed or associated with Ames Laboratory.

Ames Lab's communication team combines experts in public affairs with specialties in marketing communications, web content development, community outreach, educational programming, corporate and governmental fundraising. The team creates fact sheets, web content, *Insider* newsletter, *Inquiry* magazine, press releases, and other physical content as well as handles media relations, photography, videos, tours, and interviews. Their communications team exemplifies the nexus of these disciplines and is a highly skilled and successful example of funded public science communications.

3. RESEARCH

Five issues of *Inquiry Magazine* from 2010 to 2013, totaling 40 science-related articles and 5313 words, were chosen as the corpus. For better generalizability, the contents page, the "From the Director" page, the awards page, and the front and back covers were not included. Files were imported into the corpus analysis concordancer software AntConc3.2.4w for ease of coding.

3.1 Indicators of Embedded Science Communication Ethos Norms

The five issues were coded for indicators of two of the identified *ethos* norms. Discourse analysis indicators included lexical bundles (multi-word groups and phrases) that explicitly indicate the *ethos* norm. In cases where the *ethos* norm was not explicitly indicated in the discourse itself, rhetorical layout choices such as call-outs, captions, and supporting image use were analyzed for features of *ethos* norms. Standardization of analysis is a potential critique of this preliminary analysis. Rhetorical and basic linguistic methods are combined here. What follows is a trial of how to apply the heuristic in useful ways.

3.2 Results for Professionalism

Coding documents for professionalism in this context is challenging because part of professionalism is the communicator's expertise in both the subject area of science and the organization of the Lab. For these articles, the authors' expertise levels are never explicitly discussed, but the professionalism *ethos* is inferred by these articles' appearance in the magazine produced by the Lab. So, just by their appearance in this context these articles gain the professionalism *ethos*. However, there are a few lexical indicators of professionalism for this context. They are comprised of reliance on paraphrased explanations and use of quotes from experts.

Issues were coded for the words "said," "says" and lexical bundle "according to" as indicators of reliance on paraphrase or quotations from experts. Instances were then double-checked for a science or advocacy context. For example, "Leath said the university and federal partnership…" was not included as science professionalism because Leath is the university president discussing the context of the Lab's partnership with the university, not the science of the lab itself. Instead, this example was coded as organizational professionalism. Occasionally the distinction between science and organizational context is fuzzy, for example, "Ames Laboratory's excellence in designing and synthesizing the materials… characterization techniques make it a valuable partner, Johnson says." This example was coded as organizational since the subject of the sentence was Ames Lab, not the science. Uses of the indicator words outside the context of professionalism were discarded. For example, "do not currently separate out scrap according to composition" was not included as an indicator of professionalism.

Examples of Science Professionalism indicators:
"It's a more complicated version of the original research," ***says*** *Chumbley.*
"in any way that we want, with any resolution we want, at any angle we want," ***says*** *Zhang.*

Examples of Organizational Professionalism indicators:
Leath ***said*** *the university and federal partnership…*
"Ames Laboratory's excellence in designing and synthesizing the materials… characterization techniques make it a valuable partner," Johnson ***says****.*

Table 9 Use of indicators of science or organizational professionalism *ethos*

	said	*says*	*according to*	Total
Science Professionalism	6	142	8	156
Organizational Professionalism	9	24	4	37
Total occurrences	15	166	12	193

The analysis showed 193 total occurrences of the lexical indicators of ethos chosen to examine. By far the most common indicator was the use of *says,* either with a quote or paraphrase. By far the most common usage of this indicator is to bolster the *ethos* of science professionalism. This also holds true for the total indicators.

Two contextual reasons may influence this particular corpus to have many strong indicators of organizational professionalism *ethos*. The first is the prevalence of profile-type articles in the 2012 issue 2, entitled, "Faces of Ames Laboratory" which is half-composed of that genre. In these profiles, the scientists often credit Ames Lab with influencing their careers positively. The second reason is that in 2013 the Lab added a Critical Materials Institute. So, several articles from 2013 contain quotes from administrators who promote the Institute. Both of these reasons may be typical of embedded science communication contexts, so these are not reasons to disregard this data. Based on this corpus of articles and the indicators chosen to examine, it can be asserted with confidence that *Inquiry Magazine* has a strong *ethos* of professionalism of both science and organizational expertise.

3.3 Results for Topic Focus

Article titles were chosen as the indicator to determine the topic focus of the articles. Each article's title was coded for whether it portrayed science as the topic, or some other aspect. Other aspects were then also sorted into categories. No article titles were coded into more than one category. For unclear titles or titles that could fit two categories, the article was analyzed for main frame. For example, "Ames Laboratory leads with new cutting edge NMR technology" could be either a science research focus or an Ames Lab focus. A quick skim of the article revealed the main takeaway was the importance of the new technology tool to the lab. Therefore it was coded as Ames Lab focus. Final categories determined to be the focus of the articles in this corpus are: science research, scientist (profile), Ames Lab (promotional), and educational impact.

Examples of science research topic focus:
Using defects in diamond to probe magnetic properties at the nanoscale
Growing single crystals under pressure

Examples of scientist topic focus:
Faces of the Ames Laboratory: Emily Smith
Ames Laboratory's "Mr. Rare Earth" Speaks Out

Examples of Ames Lab focus:
East meets Midwest: Ames Lab to collaborate with Japanese energy R&D organization
Ames Laboratory begins new era in research with Critical Materials Institute

Examples of educational impact focus:
Battin' a Thousand in SULI Success

Table 10 Topic Focus in Titles

Science research	19
Scientist focus	13
Ames Lab focus	7
Educational impact	1
Total	40

The analysis showed just about half of the article titles had a science research focus. About a third of the titles focused on the scientist.

Again, the results for the scientist focus may be skewed by the 2012 issue half-comprised of nine scientist profiles. These could have been coded as one article, however their layout and their multiple authorship suggests each should be considered an individual story. There is also a possibility that titles hide the true focus, particularly promotional focus, of articles and are untrustworthy for coding. To further investigate this possibility, the ranking a frequency of the words "Ames," "Laboratory," "Lab," "materials," and "research" were determined.

Table 11 Lexical indications of topic focus through rank and frequency (corpus size 5313 words)

Word	Rank	Frequency
Ames	10	385
research	17	264
materials	18	257
Laboratory	21	240
Lab	23	204
Ames Lab/Ames Laboratory	n/a	369

The repetition of important words considered by themselves leaves inconclusive any determination between topic focus versus promotional focus on Ames Lab. It also leaves open the possibility that the titles could be misleading. This possibility is furthered by the determination that the lexical bundles "Ames Lab" and "Ames Laboratory" make 369 combined appearances in this corpus, almost 100 more times than the word "research." This uncertainty suggests a conclusion that this corpus has a moderate usage of the topic focus to build *ethos*.

4. ANALYSIS AND DISCUSSION

The preliminary analysis completed has shown 2/6 norms in the newly created heuristic of *ethos* norms for embedded science communication can be used to analyze and gain insight into examples of embedded science communication. Method choices for the heuristic's application are still questionable.

In the examples analyzed here using the heuristic's norms of professionalism and topic focus, textual *ethos* indicators most quantitatively apparent include paraphrased explanations and use of quotes from experts for the professionalism ethos, title subjects and particular lexical frequencies for topic focus. The contextual information needed to qualify these indicators suggest the heuristic may be more usefully applied for a purely qualitative rhetorical analysis, however.

Preliminary results based on these two norms suggest Ames Lab communicators seem to rely on heavily on professionalism to build *ethos* and in topic slightly favor framing stories to promote Ames Lab as an organization over focusing on the research itself. The question of why these tendencies exist could be partially answered through a full analysis, but may also be related to the history of the organization – and so answered only through supporting interviews of the communicators and their administrators. Whether readers pick up on these tendencies could also be a fruitful area of study.

This paper has proposed a heuristic for embedded science communication that could be used to shed light on how embedded science communications strategically employ *ethos* norms of journalism, science, public and internal relations, education, and advocacy to create rhetorical products which function in a grey area of advocacy. A preliminary analysis has shown the heuristic could be useful in determining which norms are preferred by a particular set of communications, and may be an appropriate first step in identifying hidden advocacy in science communication.

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