Harnessing Agency for Efficacy

"Foldit" and Citizen Science

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One of the most challenging problems in microbiology today is predicting the structure of proteins. Proteins are essential to the operation of a cell and serve numerous critical functions such as breaking down starches in food for energy and carrying oxygen in our blood. Inside a living cell, protein functions (be they enzymes, antibodies, or code-bearers and messengers including DNA and RNA) are determined largely by their structural arrangements: their size, shape, and the reactivity of molecules on the outside of the structures. Single proteins, however, can contain thousands of individual amino acids in different combinations and configurations. The entire field of structural microbiology is dedicated to discovering structures and their related functions. And the field has recently grown branches, one of which concerns protein *design*. Rather than "discovering" structures in nature, scientists design protein structures with amino acids. Protein design depends mostly on (1) the amino acid sequence of a protein and (2) the way that the chain is "folded" into itself and connected to other proteins. While researchers understand the importance of these elements, no easy way to predict a structure currently exists. Protein designers often use computer visualization tools to manipulate virtual proteins. Computers can also be programmed to probabilistically fold proteins into as many variations as possible, but the automated approach is unwieldy because of the multiplicity of moving parts and possible combinations. Moreover, it is difficult

in computational approaches to determine the most important areas of the protein to focus on in a given protein puzzle.

As an alternative approach, Foldit (http://fold.it/portal/), an online scientific game from the University of Washington, enlists people to solve puzzles that correlate with protein folding possibilities to find the best outcomes. The game designers hypothesize that human beings are superior to their digital counterparts in this kind of puzzle-solving—and they are right. Foldit is a networked game that uses numerous players' interactions with game protocols to produce knowledge about potential protein structures that, in turn, are fed back to computers to make them more efficient at predicting protein structures. With computers unable to apply decision-making heuristics to solve the folding problems, the cultivation of a community of human players becomes crucial. Such work aligns more broadly with emerging trends in citizen science, where non-experts are enlisted for productive alliances.

In this article we examine Foldit as a new kind of discursive ecology of particular interest to the rhetoric of science and technology. We ultimately suggest that online games of this sort, which are commonly looked at as dynamic communities, actually have potential to be static enough to reproduce and maintain a set of power relations. We make this argument by combining perspectives from Rhetorical Genre Studies (RGS) and Actor-Network Theory (ANT).

Foldit is a multiplayer online game designed around protein folding, where players solving tetris-from-hell puzzles are actually designing protein structures by manipulating them into the most efficacious configurations for a given function. The interface is a three-dimensional, multi-coloured visualization that allows the player to rotate the protein 360 degrees, focus in on parts of the protein, and, most importantly, to tease out and re-fold problematic strands. One algorithmic contribution to the interface's code is to point out "prickly" points in the fold—places where molecules are too close and become electronically complicated in ways detrimental to the intended function of the protein. The computational method for solving this problem, as many popular and academic publications about the Foldit method note, is to test, probabilistically and indiscriminately, all potential re-foldings (Khatib *et al.*, 2011b). Foldit's developers speculate that the combined efforts of human puzzle-solving might function more strategically and efficiently than the computer's algorithm-based approach.

In fact, Foldit's developers formally tested their hypothesis. They published their comparison of the game method to the computer-only, probabilistic method in the *Proceedings of the National Academy of Sciences* in 2011. The article describes the team's struggles with finding a way to capture and "formalize" the Foldit players' actions, which would be helpful not only for describing what is special about human problem-solving in such contexts, but also for revising the computer's algorithm to provide it with an "intuition" for strategic protein-folding problem-solving (Khatib *et al.*, 2011b). In the study, the researchers enabled players to share what they called "recipes," or typically successful sets of "folds" (Khatib *et al.* 2011a, b). Other players could revise and re-distribute the recipes and, by so doing, the community quickly developed a library of 5,000+ specialized resources—a dynamically maintained, text-based discourse—to which they might return when faced with a new problem. The researchers noted that the two most-used player-produced recipes matched a new algorithm produced by scientists who were developing computational methods at the same time. We conceive of the comparison of the two approaches, human ingenuity versus machinic algorithm, as a competition that holds efficacy—the fastest route to the best solution—as its highest value. The Foldit game strives to translate (human) agency into efficacy.

APPROACH: TRACING TEXTS THROUGH GENRES AND INSCRIPTIONS

It is tempting to focus analysis on the Foldit game environment or even to characterize the game in terms of commercial genre categories (puzzle strategy, educational game, etc.). But here we wish to take a different approach, one that moves the focal lens from the game as an object of analysis to the discursive ecology within which it is embedded as the focus of analysis. Certainly game studies can contribute insightful perspectives about how Foldit functions as a game, but we want to contribute to understanding how Foldit illuminates the features of a citizen science community. Of course, the citizen science community is heterogeneous, but we wish to take this case to explore issues of agency in citizen science projects that are managed by credentialed scientists.

One way to look at community is as a rhetorically constructed discursive object. Rhetorical genres that are employed by the Foldit community can help us uncover some of these rhetorical features and underpinnings. Such an approach helps us to find a way to interrogate the community's—in this case, the community of Foldit players—purported actions through discursive actions, which in

turn enact social actions. We take this perspective on genre from Carolyn R. Miller and, thus, from the rhetorical tradition of genre studies (Miller, 1984). Genre studies tell us that genres are not formal but pragmatic ways of framing expectations, by both authors and audience (Miller, 1984, 154). Miller provides us with a useful definition of genre as "typified rhetorical actions based in recurrent situations" (Miller, 1984, 159). Rhetorical action indicates that the genre is situated within a particular social context with a particular kind of exigence, calling for a particular kind of response. Put another way, genre and culture must be understood together (Miller, 1994). In the case of the sciences, Bazerman, Gross, Harmon, and Reidy have shown us that the genre *par excellence* of science, the journal article, has evolved along with the culture of science (Bazerman 1988; Gross, Harmon, and Reidy, 2002). What we learn from this is that genres construct and are constructed by particular discourse communities. Our discourse community of scientists, for example, is centralized around the article, but participates in other genres, including abstracts, conference presentations, seminars, theses, and dissertations, and so on. Moreover, the discourse community's genres tell us something about the shared values of that community, about its "norms, epistemology, ideology, and social ontology" (Berkenkotter and Huckin, 1993, 475; for a primer on theories of genre see: Hauptmeier, 1987; Hyon, 1996; Campbell, 2009; Miller and Kelly, forthcoming). So, our argument suggests that genres can tell us something about newly emerging communities of scientists and citizens at work on scientific research problems. Genres are responses to particular social exigencies. When we learn something about those exigences and responses we learn something about a community. In the case of Foldit, we might learn, for example, that the community is committed to sharing strategies, a Mertonian sensibility about scientific discovery (Merton, 1979). We look to Foldit's user-produced "recipes" as a genre that reveals this alignment.

In this culturally oriented sense, genres can characterize typified rhetorical actions that call for particular sorts of inscriptions in response to an exigence. That is to say, genres are operating in discourse communities, such as our scientists and their research article genre, but genres as such are characterized by their typification and recurrence. Particular inscriptions become interesting when we consider the case of Foldit, in which two or more discourse communities have come together as a site of negotiation.

Here we advance an approach to the investigation of texts that may not be typified or recurrent, and to the understanding of what such texts reveal about a community and what rhetorical possibilities those texts afford. For our approach, we turn to Actor-Network Theory (ANT) as means to investigate how a system produces and maintains knowledge and objects as relational effects of particular texts in typified situations. Texts—and here we are talking about particular instances of a genre—are characterized as *inscriptions* in ANT. This is an especially important nexus of genre and ANT if we are concerned with where agency resides or how agency is a relational effect in a network. For example, when we compare a scientist to a player in terms of rhetorical agency, the genre system invoked by a network greatly affects the results of the comparison. Players have considerable rhetorical agency in the community of the game, but little or no rhetorical agency in the formalized genre system of the research article. The difference is between the relational effects of separate but linked networks of action and the genres to which each network ascribes power.

ANT's conception of the social, according to John Law "is relational and process-oriented" and "treats agents, organisations, and devices as interactive effects;" which are "heterogene[ous]," "uncertain," and "contested" (Law, 2002, 6–7). Relational effects that come to constitute stable entities are actors, or objects with agency. "Actors," writes Harman "become more real by making larger portions of the cosmos vibrate in harmony with their goals, or by taking detours in in their goals to capitalize on the force of nearby actants … the more connected an actant is, the more real; the less connected, the less real" (Harmon, 2009, 19). Actors increase their stability and agency by becoming more networked—that is, by having more and more constant potential to be produced (and reproduced) by relational effects. Non-human objects are among these actors. Inscriptions are most often textual artifacts, but more broadly rhetorical products of science—publications, figures and visualizations, and facts. In order to produce inscriptions, actors must be able to enlist and activate (in plainspeak: use) inscription devices (Latour and Woolgar, 1986), or tools designed to inscribe. These may be cameras, microscopes, pen and paper, word processors, and even interfaces that produce representational models, like Foldit. Latour asserts that inscriptions take on agency in scientific networks. They come to be actants themselves (Latour, 1987). And, important to note for scientific media like the visualizations of proteins in Foldit, "inscriptions," write Latour and Woolgar "are regarded as having a direct relationship to 'the original substance.' The final diagram or

curve thus provides the focus of discussion about properties of the substance" (Latour and Woolgar, 1986, 51). Inscriptions have power because they are the community-shared material mediations of knowledge; they are seen to contain and transmit the "true" or the "real." Genre conventions, then, are at work shaping these particular inscriptions, textual actants, which support certain kinds of social action.

ANT, sometimes in conjunction with genre, is commonly used as a means of mapping or visualizing human and non-human agents at work in a given communicative network. ANT-based mappings are often focused on the process of translation, or the conversion of a meaningful and agentive inscription into an equally or differently agentive object in a separate network. With such translational objects in play, networks themselves can become actants in larger networks or genre ecologies (Spinuzzi, 2007, 2008). Treatments of this kind have proliferated productively as scholars of technical communication and rhetoric of science and technology have dealt with communicative action afforded by increasingly efficient and ubiquitous networked technologies across space and time. Work such as that of Clay Spinuzzi, Jason Swarts, and others employs the core concept of the actor-network to characterize distributed work while integrating the fundamental concept of rhetorical genres (Spinuzzi, 2007; Swarts, 2008, 2010).

We suggest that Latourian Actor-Network Theory can be usefully integrated with a genre approach to help address questions about the relationship between genre and text (inscription) and genre and individual, situated agency. Others have already noted the utility of bringing together these theoretical approaches. For example, Scott Graham and Carl Herndl have also argued for rhetorical tools in the now ANT-dependent discourse that is science and technology studies (STS) (Graham and Herndl, 2013). We thus see bringing these discourses as an important engagement to expand rhetorical theory and criticism into the broader conversations in social studies of science.

One thing that all the current approaches share, especially because of the nature of knowledge work in the computer age, is that they strive to describe work being done asynchronously across distances enabled by digital technologies. Spinuzzi calls this action "distributed work" (Spinuzzi, 2007). Spinuzzi, whose research focuses mostly on how digital networks deploy distributed work in organizations across space and time, defines distributed work as "coordinative, polycontextual, cross-disciplinary work that splices together divergent work activities (separated by time, space, organizations, and objectives) and that enables the transformations

of information" (Spinuzzi, 2007, 265). Uptake of actor-networks into rhetorical research has focused on descriptive accounts of effective networks to determine what makes networks effective. Swarts, for example, conceptualizes single source content in the form of "recycled" text as the activation of an actor-network to maintain stable meanings across space and time (Swarts, 2010). The points of stability for Swarts and Spinuzzi are textual objects. The "measure" of stability is typification by genres. But genres do not exist in isolation within networks of distributed work; genres themselves are networked. Accordingly, Bazerman introduces the notion of "genre systems" (Bazerman 1994; see Devitt, 1991 on "genre sets"). These comprise "interrelated genres that interact with each other in specific settings" (Bazerman, 1994, 97). Within these distributed workspaces genres may have multiple patterns of arrangement with one another, in systems, sets, networks or even chains (Swales, 2004). And, of course, we might add Spinuzzi's genre ecologies to the possible ways of talking about these arrangements.

FOLDIT: EMERGING GENRES AND INSCRIPTIONS

Genre offers a way to examine different cultures of professionals, telling us something about how Foldit's two communities of expert professional scientists and non-expert public players are coming together. We can see this at the level of the texts, or inscriptions, which invoke certain genre features in the Foldit ecology. Outside of the game there are numerous genres used to coordinate game play; these also inform the scientists and designers about the strategy and reasoning behind players' actions. If we were to look specifically at each genre, we might see that they are co-evolving with certain community-held values, forwarded by certain ideological positions. First, we might benefit from situating these genres within a larger context of their work. Genre theory is certainly capable of doing this, but given the distributed networked environment we are interested in, not to mention the need for a shared language that bridges conversations in rhetorical theory and Science and Technology Studies, we believe ANT can provide different kinds of insight. That is, ANT can give us another perspective from which to critique the relative invisibility and lack of rhetorical agency that players have in the academic network/genre system we have just described.

In a short essay called "Objects and Spaces" published in 2002, John Law talks about how network-objects privilege Euclidean space and marginalize fluidity. Specifically, Law writes that though

"network space remains crucial … objects and realities depend on fluid work," and that the privileged, stable nature of network-objects renders fluid work "invisible" (Law, 2002, 101). In the set of relations around the scholarly publication (an established and relatively stable genre), Foldit, which is a complex network itself, also becomes a stable, distinguishable object, or a network-object maintained by the fluid work of its players. The players' contributions come in subordinated individual inscriptions: their foldings, recipes and the specific articles in which the group of players is listed as co-author. With the game as the object that the community maintains, except for additional token recognition of individual players in media coverage and promotional materials, the fluid work of the player community is quickly rendered relatively invisible.

Combining genre accounts of the communicative systems in evidence around Foldit and ANT-informed analysis of the same is productive in part because of the very different levels and kinds of concepts each perspective allows in its respective ontology. The examples we have chosen to juxtapose here are genres/inscriptions and networks of relational effects/genre systems. Inscriptions are material and singular instantiations of community-approved mediations of the "true" or the "real." Genres are the socially negotiated and sanctioned typifications that determine the form such inscriptions might take. In our case study, the genre conventions of a gaming community allow for the exchange of information in folding "recipes," which translate human agency into the equivalent of machinic efficacy.

The social conventions of the scientific community, however, which regulate and are regulated by conventionalized and stabilized-enough genres, have not yet adjusted to incorporate game play into the notion of authorship or to account for the massive communities that participate in this knowledge work. Because science comprises highly conventionalized and regulated communities, and genres from professional communities are highly stabilized and sanctioned within these well-established and rule-governed communities, changes in genre conventions are likely to require significant effort. In the case of authorship on scientific articles, we can see that situational elements and larger structures act on the genre and genre users to reproduce the genres in ways that block or dampen genre change, such as the innovative approach to crediting Foldit participants as authors. Less abstractly, the mechanisms of tenure and promotion in universities have codified rules that govern authorship practices and, thus, govern how authorship in the scientific genre is reproduced.

Challenges to these practices require significant agency among genre users and reproducers, namely research scientists. The utility of such stabilized genre work cannot be overstated, because this stabilization has partially afforded science its impressive contributions to human knowledge by providing ways to build upon, vet, and expand arguments in a conventionalized and thus comparable manner. Of course, there remains room for negotiation, as the author contributions including Foldit players suggest. Still, genre conventions that govern players doing the fluid work of game play and recipe production—the very work that produces the protein design—remain invisible in the discursive ecology of the scientific article.

The tension between the fluid work of players and their relative invisibility in the larger discursive ecologies presses upon is a need to combine theoretical lenses. Both actor-network accounts and genre accounts agree that the configuration of networks and the roles of the actors therein are dynamic. Genre systems and systems of relational effects are constantly (re-)negotiated through the very social/material action of which they consist—and by which they subsist. However, actor-network accounts of such systems tend to focus more on their dynamism. That is, ANT typically encourages the analyst to look at each activation of a network as specific to a unique event—the network forms to meet the need. The power of such a perspective is that it privileges the activist and his or her modes of resistance. In fact, such an account treats networks as entirely malleable. Moreover, such an account takes an intentionally naïve sensibility. Following other scholars who have used rhetorical concepts as a balance to such theoretical naïveté, such as Swart and Spinuzzi, we see genres as a way to talk about the discursive reproductions that also shape and structure networks. The presence of genres, much like the pre-existent wiring in a house, acts simultaneously to make network activations more efficient (a trait we will call *efficacy*) and to diminish the power of resistant forms of communication. A canonical example is the scientific research article which is not only highly stabilized but highly conventionalized and thus offers an "efficient" framework for recurrence of rhetorical responses. However, this severely restricts possible resistance and change, as we will see later with matters of authorship. Certainly, understanding these genres, how they function, at the very least allows us to talk about what ideologies and values are being reproduced and how those may struggle against certain kinds of resistance. Genres, then, allow us to talk about powerful emergent and pre-existing social relations more articulately than ANT alone does.

ANALYSIS

In this section we consider two features of the Foldit game effort: creation of data through networked strategy and dissemination of results. Through this case we will explore how a combination of genre analysis and an ANT approach can help us uncover certain epistemic commitments. Dividing up artifacts in this way is premised on the norms of scientific discourse communities, but because this particular game was created and is driven by an academic scientific effort we hold that this is indeed the primary situating and framing at work in the social positioning of the Foldit community. Such divisions are important features to note because the social positioning is part of boundary work – or scientific discourse employed to separate "legitimate" science from non-science – used to shape the purpose of and engagement with the game (Gieryn, 1983). Boundary work is at play here because online gaming is a very new method by which to manipulate data and produce publishable results and thus requires re-establishing the boundaries of "legitimate" science. Through some characterization of rhetorical genres and special attention to the inscriptions, this section details some of this boundary work through textual possibilities. We also attend to the locus of agency.

GAME PLAY: NETWORKED STRATEGY

In the case of Foldit, there are several genres that interact to facilitate game play and subsequently the conduct of "important research for science" according to Foldit's home page. Genre theory has been broadly applied to a number of professional discourse contexts, including health and medicine (e.g., Schryer, 1999; Schryer, Lingard, and Spafford 2005, 2007; Segal, 2007), science (e.g., Bazerman, 2000; Myers, 1990; Mehlenbacher, 1994), and business (e.g., Devitt, 1991; Yates, Orlikowski, and Rennecker 1997). Recently, researchers have also begun to use genre theory to understand the changes digital technologies have brought to our communicative spheres (e.g., Askehave and Nielsen, 2005; Bazerman, 2002; Crowston and Williams, 2000; Dillon and Grushrowski, 2000; Giltrow and Stein, 2009; Kelly and Miller, forthcoming; Miller and Shepherd, 2004, 2009; Swarts, 2006; Starke-Meyerring, 2008; Yates, Orlikowski, and Okamura, 1999).One of the early web texts discussed as a genre is the homepage (Askehave and Nielsen, 2005). A homepage, Askehave and Nielsen suggest, has two functions: it "introduces the user to the general content of the site by presenting 'informative' tables of contents and providing 'enticing' text bits" (Askehave and Nielsen, 2005, 123–124). Second, "It functions as the official gateway of the

web site as it enables the reader to access and navigate the site by providing navigational tools or links that branch off into the web site as a whole" (Askehave and Nielsen, 2005, 124–125).

Importantly, Askehave and Nielsen remind us that in the case of the homepage, while it has antecedents in newspaper front pages, the internet and digitally networked texts become important to the genre and its function. Thus we must consider the interaction of genre and medium together (Askehave and Nielson, 2005, 125). Foldit's homepage functions as a portal to the application itself and the community of users. That is, the website homepage provides access to the Foldit game application and also to the forums where community members congregate. Accordingly, it contains links for downloading the game and logging in as well as posting a leaderboard with various players' scores, and other news bits. There is also a link to a blog, which provides more detailed news about the project and information about related research. But a new player might rather begin on the "about" page, which provides some detail about protein folding, the goals of the game, and how to interact with the community the website assembles. The "about" page is one of the many text types that appear to have emerged on the web (Santini, 2007). Another typification is the Frequently Asked Questions (F.A.Q.), which like other web genres has interesting antecedents pre-dating the web, elaborates on some of these points addressed on the "about" page: the goals of the project, including generating interest in the game method and automating player strategies (Foldit, "Goals of Foldit," F.A.Q. page). This page also clarifies strategies players might use, answers questions about game rules and terms, and provides troubleshooting advice for players encountering technical problems.

There are also terms of service, designer credits, and feedback forums contributing to scientist/designer-based genres or perhaps proto-genres. Many of these genres are established, particularly professionalized genres, such as the terms of service with its serious legal implications. As well, some are associated with research articles, which we will take up below. In addition to top-down genres like these there are those that might be described as bottom-up or emergent, which are generated by players. These are texts that have been produced by the player community and have developed recognizable, typified features that enable better communication within the community. The Foldit player community's main player-negotiated genre is the "recipe"—a name that evokes another genre, an "antecedent" of sorts (Jamieson, 1975)—or, put simply, a set of instructions for a protein fold that prevents players from repeating hours of work that another player

has already done. In Foldit, recipes allow one player to start where another left off.

These emergent, player-negotiated genres are particularly interesting because they mark a more elevated level of engagement than we might expect from anyone strictly classified as "user." It is not uncommon for gaming communities to generate supplemental materials and documentation. In any case, the creation of a Wiki by users as well as a "Cookbook" of "recipes" (or procedural strategies) signals a certain ownership of the social action they are participating in as well as an ability to influence the community structure. While initially invoked by the players, these bottom-up genres of Wiki articles and recipes were subsequently sanctioned by the scientists who designed the game—incorporated as crucial elements of the discursive space in which this community negotiates between expert and non-expert. For example, the cookbook was a negotiation between players' desires for a space to design strategies and designers' desire for players to work efficiently: "The cookbook allowed players to write, share, and run recipes, which were automated version of their strategies" (Cooper *et al.,* 2011, "Cookbook"). It was a genre-focused approach to doing distributed work, and the introduction of a typified inscription made that work more efficacious.

GAME PLAY: DISSEMINATING THE RESULTS BY INSCRIPTION

The classic Latourian inscription produced by projects such as Foldit, of course, is a scholarly research article that takes its place among others, a potentially powerful actant in a larger network that produces and reproduces academic power, position, and expertise. At the time of this writing, Foldit's designers have published seven major articles, seven inscriptions, in journals with interdisciplinary influence, some of which have great influence: *Nature*, *Nature: Biotechnology*, the *Proceedings of the National Academy of Sciences* (*PNAS*), and *Nature: Structural & Molecular Biology* (Eiben *et al.*, 2012; Khatib *et al.*, 2011; Khatib *et al.*, 2011; Cooper *et al.,* 2011) as well as being featured in a presentation at a digital gaming studies conference (Cooper *et al.*, 2011). The primary authors of these publications are members of the Baker Lab. Khatib and graduate student Eiben are first authors in a lab that specializes in bioinformatics, genetics, and synthetic biology at the University of Washington; Cooper, is a game designer and programmer in the Computer Science and Engineering Departments at the same school. Each of their publications is one of two types: articles authored by computer scientists and

bioinformatics researchers concerned with the development of the game as a method for managing the special bioinformatic problem of protein folding or publications by protein designers (also bioinformatic researchers) reporting actual findings of the process—the successful and most efficacious folds derived by Foldit players, the first step from puzzle solution to designed protein applicable to a real medical context.

In all of their collective scholarly publications, Foldit researchers rhetorically gesture towards the players as co-authors. The list of authors at the top of "The Challenge of Designing Scientific Discovery Games," for example, devotes one author line to ">57,000 Foldit Players"(Cooper *et al.*, 2010). But for the biological scientists and computer scientists involved in the project, protein folding, whether by algorithm or by hand, is a method, and Foldit is an ingenious methodological tool. The enlistment of more than 57,000 human actors with agency whose combined power rivals the best bioinformatic algorithms is a methodological choice, a new and exciting design that uses the affordances of the massively multiplayer online game (MMOG) to harness a kind of collective intelligence. The method is called "community computing" by the Baker Laboratory (Baker, n.d.).

In a set of power relations that describes the networked action of Foldit (actant), Foldit players (actors), scientists (actors), and journal article (inscription/actant) in the scientific community, the players, who might be called "subjects" in other ontological frames, quickly become folded (pardon the pun) into the object/actant of the game itself. The more than 57,000 Foldit players, although noted as "authors," are more truly present in the methods section of the publication. The players in assemblage with the Foldit interface are, in terms of flat ontology, inscription devices, tools by which scientists remediate the "truths" of protein folding solutions and make them shareable in the community. In this specific network tracing, players have little or no agency in the set of relations produced and reproduced by the primary genre—the journal article.

GAME MASTERS

At this point, our claims about Foldit players' invisibility/lack of agency are true only in the network in which the academic article is a powerful actant. It is entirely possible that in another related tracing an entirely different set of power relations could appear. To further interrogate the position of Foldit players in at least one more traceable network, Foldit the game, an object composed of code, interface, and protocols, can also be described as an inscription—a particularly tricky inscription. Characterizations of

Foldit as an inscription might be drastically different depending upon our focus. Consider two examples of the types of relational effects that might be traced around the game as inscription/inscription device: (1) The game as a designed tool is an inscription that stands in for real proteins and, in true Latourian fashion, becomes the focus of the research endeavor in place of the "original substance." This inscription, its design and code, has scientists and programmers functioning also as authors. We have already begun to address this first network in our discussion of the scholarly publication and the academic network of power and prestige that Foldit as scientific methodology enacts. (2) The folded protein as solution to the game's puzzle, obeying the protocols inscribed within the game's design, and its related "recipe," are themselves new inscriptions, with player(s) as author(s); in this frame, the game's interface is an inscription device, and the player re-emerges as an actor with more agency.

As we have noted in the genre approach above, in the framework that sees the game as the network and the discussion and documentation of the game as inscriptions (that is, where players are not merely "working parts" within a machinic device), players have agency—the ability to incrementally affect change in the *status quo*. An account of relational effects changes when we focus on the second kind of inscription and its less clearly defined network: the individual elegant solution, the folded protein, as inscribed by means of an individual player or a group of players. What can the author of that particular inscription do with her inscription? Does it become a means of strengthening her own connection, a means of access to power in the Foldit gaming community? The player may have no need or desire to be an actor in the network of academic power/expertise. A separate set of relational effects that produce power and prestige outside of the scientific community by a material connection to the scientific community may be at work. But then again maybe not.

LESSONS OF FOLDIT FOR MULTI-MODAL AND NETWORKED METHODOLOGIES

The conclusion of Khatib *et al.*'s study is that "human-driven computing," as they call it, competes favorably with a cutting-edge algorithm (Khatib *et al.*, 2011a). We affirm that human communal reasoning can be used to improve algorithmic problem solving. At first glance, then, the research question seems to be a human-affirming one: a large group of humans can do it better than a computer program—the humans still dominate the machines. We might question, however, the need for algorithm as a standard and

the choice to study community computing merely as a means to improve algorithm design. Why not design better community computing networks? Though the algorithm is the traditional tool of the bioinformatics researcher, what might arise from depending more fully on gaming communities such as Foldit?

Of course, the answer to this question may be simply that Foldit's design must first be compared to the community's standard to gain epistemic purchase. Still, we hope that projects like Foldit continue to test the boundaries and conventions of scientific knowledge-making communities with human-centered research designs. We also question the concept of "human-driven computing" and what the term means for (human) agency. Can humans who are configured as working parts inside a knowledge-making "machine" retain, or regain, power in knowledge-making social networks? By granting a group of game players an author line in publications, the Foldit designers gesture towards such an idea. We suspect, however, that such gestures are more performative (for the purposes of resistance) and power-gathering rather than power-granting. That is, the novelty of a "human-driven computer" as a method that adds hundreds of authors to a journal article about a new protein garners more power for the game designers, the primary authors, than it does for those hundreds of authors themselves. Though the scientists themselves may garner prestige for explicating an innovative method, the community norms will likely prevent them from initiating major disruptions to conventional approaches in protein-folding problem solving, i.e., supercomputing with electronic machines. The players, who are not even credentialed members of the community in question, are not true agents in this network; rather they are the parts of an unconventionally assembled computer, as the term "human-driven computing" rightly labels them.

We have teased out preliminary readings of genre, rhetorical agency, and the complexity of entangled contexts, networks, and objects inherent in the relational effects of Foldit. But this essay has certainly not exhausted the potential for analysis of games of this and related sorts. Indeed, the almost daunting complexity of Foldit's multiplicity of media is the best argument for continued attention by rhetorical critics. Wherever genres are emergent social patterns that stabilize in typified texts, specific inscriptions can be particular interventions that work either to reproduce or challenge that stability. The combination of ANT and genre perspective allows for productive play between micro and meso-levels of analysis—of genres and of particular invocations of the genre meant not only to reproduce, but also to challenge. ANT might let us momentarily

shift our lens to look at the particulars in a new way. Genre gives us robust tools for describing texts in (often pre-existing and stabilized) social contexts; ANT can help us attend to the *possibilities* of genres through particular inscriptions.

Finally, we want to note that a continued incorporation of rhetorical theory into the language of science and technology studies (STS) can be beneficial to both scholarly communities. ANT has already proved productive in rhetorical studies of health communication, which has many affinities with STS. ANT has been used as a frame for rhetorical action, and it is often paired with a theoretical language that can account for distinctions between rhetorical actants and subject entities adequately (that is, although ANT takes all objects as equal, some approaches find they need a distinction between human and non-human nodes in a network) (Graham, 2009; Greene, 2004; Miller, 2007). Here we have proposed that, by juxtaposing rhetorical theories of genre and Actor-Network accounts of networked action, we can better explore relational effects that come about when new media objects become part of scientific knowledge-making networks. We have pressed upon the social conception of genre in these situations by asking how genre plays out in power relations among actors in Foldit's entangled networks. Systems and relations of genres and the various modalities they produce challenge genre theory to continue to theorize these emerging rhetorical spaces and problems. Genre has proven a profitable approach to rhetorical studies of science and its increasing intersection with ANT provides an already-established inlet to STS. The same might be said of the import of STS into rhetorical studies of science via ANT-genre, although that direction has already had much more purchase than the former. Such combined applications hold promising analytical potential for questions about our conceptions of participation, community of practice, and citizen science.

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