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AN EXAMINATION OF SCIENTIFIC AND TECHNICAL COMMUNICATION FOR FORENSIC ENGINEERING AND FORENSIC PATHOLOGY.

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AN EXAMINATION OF SCIENTIFIC AND TECHNICAL COMMUNICATION FOR FORENSIC ENGINEERING AND FORENSIC PATHOLOGY.

By

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Abstract

Police communication sits at the unique intersection of risk communication, scientific and technical communication, and medical communication, as we see in forensic reports. In this dissertation, I examine the communicative underpinnings of forensic pathology and forensic engineering reports. I argue that there is not only an inherent link between the unpredictability of a written text and the reception of said text by both its intended and unintended audience, but also a link to the broader socio-cultural contexts. I will examine an atypical forensic pathology report (autopsy report) of George Floyd, a more standard forensic pathology report of an inmate who died of lethal injection, John Grant, and a standard forensic engineering report of a fatal collision. Using Voyant Tools, the analysis will show the link between readability index and unpredictability of a text as well as demonstrate how the surrounding, rather charged socio-cultural contexts can have an impact on the text's underlying structure. Unpredictability will be defined as and examined as a key facet because that is how textual analysis measures a readability index. Through my analysis, building on Claude Shannon and Warren Weaver's understanding of randomness and unpredictability as entropy in a system, I found that the higher the unpredictability (entropy) in a written communication system, the lower the readability index. Unpredictability in a text can increase noise and contribute to the loss of information in a communicative system. This is especially important as the genre of the forensic report is deeply embedded in the moral economies of police science. It is also deeply impacted by the seeming necessity to remain objective in reports that are intrinsically human centered.

Keywords: Police, Forensics, Scientific Communication, Genre, Information Theory

Chapter 1: Introduction of the Topic and Problem

Police scientific and technical communication includes many important implications for academic work. Though it is established in its genre conventions, paradigms, and standards, the communication in this field has not been studied explicitly on the microscopic level. This dissertation aims to study the intricacies of police scientific and technical communication in an effort to articulate a model of that specific scientific and technical communication. Moreover, an integral facet of police scientific and technical communication that I will examine is the role of textual unpredictability within this communicative system. This will be done through the scope of information theory and the digital humanities by utilizing Voyant Tools. I hypothesize that this information loss is the result of a high textual unpredictability in the forensic reports causing a low readability index. It should be noted that it is likely this textual unpredictability leads to information loss.

This phenomenon is demonstrated by a forensic report's readability index. To examine this phenomenon, I will examine two textual systems, forensic pathology and forensic engineering, otherwise known as accident reconstruction. It should be noted that I attribute the loss of information and data in a communication system to entropy, per Claude Shannon's (1948) definition of information from "A Mathematical Theory of Communication." To clarify, "loss of information" can be also attributed to the level of unpredictability of a written text. It is the latter form of entropy, unpredictability, in which I am interested. I argue that there is not only an inherent link between the unpredictability of a written text and the reception of said text by both its intended and unintended audience, I also argue that that unpredictability in a text is informed by the broader socio-cultural contexts. That said, I see unpredictability as a form of entropy in a communication system. In the chapters following, I will explore the role I see entropy (unpredictability) playing in police scientific and technical communication. I will explore the genre conventions of forensic pathology reports and forensic engineering reports. I see these reports as scientific and technical communication artifacts which illustrate the manifestations of entropy in these otherwise closed communicative systems. Further, the intent of highlighting entropy as an integral facet of a communicative system is to illustrate how past articulations of "noise" in communication systems may have not only a negative connotation, but may have also encouraged a disregard of important communicative elements. While the main focus of my dissertation is textual unpredictability, I think it is important to consider what additional textual elements are viewed as noise and/or interference, as that could be the direct result of unpredictability in a text. Genre conventions in technical communication are strict and rigid; it is important to note that my dissertation considers unpredictability as it pertains to the highly formulaic structure of texts in forensic science.

Given the general expectations of a rigid genre structure found in technical communication, consideration of the cause and magnitude of unpredictability is integral for understanding its effects in a communication system. These communicative elements that have previously been disregarded as "noise" could offer important insight into rhetorical context. Moreover, I aim to contextualize "noise" in entropy, thereby hopefully mitigating the seeming tendency to disregard communicative noise and highlight communicative elements that inform the larger communicative system. Moreover, since noise and interference may be the result of unpredictability in a text, I see it as contributing to a low readability index. It is important to consider textual unpredictability as a part of the communication system, and by extension a communication model, to ensure adequate accountability.

It should be noted that a "readability index" is how easy or difficult a text is to read. According to linguists Zamanian and Heydari (2012) in their text "Readability of Texts: State of the Art," the formula for calculating a readability index is the total number of words divided by the total sentences in a document minus the total syllables divided by the total words. In essence, I aim to articulate a model of police scientific and technical communication that accommodates unpredictability (entropy), and by extension noise and interference. This will thereby account for seemingly micro communicative elements that have an arguably significant impact on the larger communication system. This will aid in understanding the low readability indexes present in forensic pathology and forensic engineering reports.

That said, it is important to note my subject position in this matter. Being a doctoral candidate studying scientific and technical communication and being a former Police Officer, I sit at a unique position to remark upon both the theoretical as well as the practical elements of police communication. That is to say, as a student, I studied these phenomena I am examining theoretically, and as a Police Officer, I engaged in such practices. During my time as a Police Officer, I found some concepts work in theory, but not in practice, and some communication practices I engaged in as an officer worked in practice but had not been articulated in an explicit theory. In this dissertation, I aim to build a theory of police scientific and technical communication grounded in both related graduate studies and practical experience of policing.

Scientific and Technical Police Communication

Now, I want to briefly consider that everyday language may not have been designed to accommodate explanations of micro phenomena of language, and by extension, communication itself. It is in the articulations of our interpretations of what occurs on the micro scale of human communication where we see a gap in language. Scholars such as Buarqoub (2019) in the text "Language barriers to effective communication" discuss language barriers as they pertain to productive communication. While I am not explicitly discussing language barriers, Buarqoub raises an interesting and pertinent point; that is, barriers that inhibit productive communication arise from an issue of one or more of the following: a sender, a message, a receiver, or a channel (Buarqoub, 2019). What this suggests is that some obstacles might be reduced if a given genre allows for the adjustment of one of the four aforementioned obstacles. Perhaps, this also suggests a gap in our rhetorical understanding of police scientific and technical communication. This could be argued to be a "gap" in that particular paradigm, thereby leading to a gap in the genre itself. What I am suggesting is, until we observe communicative anomalies that warrant descriptive language regarding police scientific and technical communication, we will have incomplete models of communication that were not designed to describe our perceptions of it.

Scientific and technical communication transgresses multiple fields and disciplines. Whittemore (2015) in the text, "Rhetorical Memory : A Study of Technical Communication and Information Management" discusses some of the challenges associated with the far reaching nature of the field of technical communication. Whittemore focuses on the workplace and business communication specifically. However, there is value in his articulation of the challenging nature of technical communication as a field to "juggle" multiple standards, audiences, and genre conventions. While my dissertation will focus on the genre of forensic science, police science, and associated scientific and technical communication reports, I will occasionally acknowledge medical rhetoric and communication, as that pertains to scientific and technical communication and rhetoric. To that end, it is important to note that there are other significant forms of rhetoric that apply here, namely mental health rhetorics. While said rhetoric is outside of the scope of focus of this dissertation, it is important to consider. Moreover, I concede that the majority of police-driven communication is similar in style and genre conventions perhaps because of the interworking of a moral economy of police science. It should be noted that there are several models of scientific and technical communication that overlap into what I will group together as police scientific and technical communication.

Broadly my argument has two main components; one, police scientific and technical communication exists as its own moral economy, and as such, not only creates its own paradigms, but also creates its own specific genres; and two, police scientific and technical communication is a relatively closed, nonlinear, dynamical communication system. As such it requires an accommodation and explanation of entropy, rather than attributing information loss to noise. In articulating my entropic model for police scientific and technical communication, I will also articulate possible ways to measure, or at the very least quantify, entropy and "noise" in an otherwise closed nonlinear dynamical communicative system.

One such method is found in probability theory. Probability theory, often used in quantifying bits of language, will be applied to several language bits, as well as case studies, in the latter half of my dissertation. If we accept that nature is inherently probabilistic, we ought to accept that human language, being a byproduct of our nature, is then also probabilistic. Skorokhod (2005) in the text, "Basic Principles and Applications of Probability Theory," articulates the nature of mathematical randomness and chaos as it pertains to non mathematical entities. Since the product of language is not inherently deterministic, logic would follow that randomness must be present in that system. The level to which the randomness and unpredictability is present depends on various factors that I will examine in the later chapters of this dissertation. What's interesting in Skorokhod's text is that he highlights the reciprocal nature of certain elements in a system when they are explained through a probabilistic lens.

This probabilistic lens is one in which I view entropy in communicative systems. A probabilistic approach to understanding the role of entropy in police scientific and technical communication would be productive in that what we are articulating as "noise" could be unpacked and placed into a conceptual framework of entropy that would account for the associated effect on the communicative system, while simultaneously accounting for the probabilistic nature of language. By acknowledging this, I will articulate a scientific and technical communication model built on the probabilistic idea that the product of communication is not necessarily everything that *is* said, but everything that *could* be said. This probabilistic nature of language is what informs the nature and magnitude of entropy in a communication system. This is why I utilize probability theory to examine entropy, more specifically unpredictability. In short, entropy helps us almost quantify and/or articulate the potentiality for what could be interpreted as noise resulting from textual unpredictability; this could be the culprit of data or information loss in an otherwise closed communication system.

This, however, raises the question of how, then, we measure entropy in a communication system. This question comes with the acknowledgement that I will be adopting the definition of entropy from mathematical physics in order to better articulate the phenomenon I see occurring. That is, I am using the term entropy to describe the level of unpredictability of a text. There are various elements that make a text unpredictable, for example, jargon, use of acronyms, and a sporadic distribution of information throughout a document. Those aforementioned elements will be examined regarding the three forensic science reports in chapters two and three. Nonlinear, dynamical, chaotic systems generally articulated by entropy can be described by certain quantifiers used in probability theory. Those articulations describe an underlying unpredictability in a text. Such a use of probability theory builds on the approach to understanding the dynamics of a communication system in Borovkov et. al 2013.

Let us now move on to thinking about the role of textual unpredictability (entropy) in a probabilistic, nonlinear, dynamical communicative system. Entropy has several definitions, and depending on the field, that definition will change. I am utilizing entropy as a description of the magnitude of unpredictability in a text. Such unpredictability, I argue, has a direct effect on the readability index, which is a measure of how digestible information is in a given text. Entropy has its origins in physics, specifically the second law of thermodynamics. The second law of thermodynamics is a primarily physical law that concerns itself with heat and energy in a system. Moreover, the second law of thermodynamics maintains that the concept of entropy is a physical property of a system.

There has been work done examining this particular system. My dissertation builds, for example, on: Murray Lee and Alyce McGovern's "Logics of risk: police communications in an age of uncertainty" (2015); Keith V. Erickson, T. Richard Cheatham, and Carrol R. Haggard's "A survey of police communication training" (1976); and *Symbolic Communication: Signifying Calls and the Police Response* by Peter K. Manning (1988). Police communication, specifically scientific communication in forensic engineering and forensic pathology, provides robust textual artifacts to examine such communication from an information structure methodological approach. This will allow for the manufacturing of a framework in which I investigate how communication in both forensic pathology and forensic engineering function as a non-linear, dynamical system. Unfortunately, one rather apparent shortcoming in my approach to examining the role of entropy in a closed communication system is that I had to limit the source of the data to two forensic pathology reports and one forensic pathology report. That said, of the two forensic pathology reports, one report is considered standard, the other is an outlier due to the context in which it was written; the third artifact that I will examine is a standard forensic engineering report.

Often, in scientific writing, objectification of data and information overrides deeper subjective meaning, whether it is intentional or unintentional. I view entoptic communicative instances in scientific writing as essential pieces of meaning that could easily be discounted as noise or interference. Therefore, we ought to consider entropy as an integral factor, as that affords us a framework for describing these types of systems on a micro-scale. If we accept entropy as an integral factor, then we must consider a specific, more productive, model of forensic scientific communication that places entropy at the center. Given that presupposition, I argue entropy is a necessary factor to consider for a conceptual framework and description of how information and data are lost in a nonlinear dynamical communicative system. Thus, this dissertation is proposing an entropic model of scientific communication.

Entropy itself is conceptually basic in the sciences in that it has applications in statistics, information theory, and thermodynamics. As articulated in the text " Basic Principles and Applications of Probability Theory," entropy is generally thought of as a measure of disorder in a system (Skorokhod, 2005). In information theory, specifically in considering the quantification of communication, entropy is useful in measuring uncertainty in a system, or in measuring an outcome of an otherwise "random" process. This is articulated by Manning (1988) in his text "Symbolic communication: Signifying calls and the police response." Manning provides the following table (Figure 1) as an example of the relationship between language and entropy.

Message source[a]	Level of information	Meaning	Action	Resultant sequences of behavior
Highly organized (low entropy)	Low	Various, conventionalized, restricted, and explicit.	Ritualized	Highly predictable
Semi-organized (medium entropy).	Medium	Semiconventionalized, limited, and implicit.	Semi-ritualized.	Predictable
Poorly organized (high entropy).	High	Complex, elaborated, and implicit.	Instrumental, practical.	Unpredictable

a. Noise and equivocality accompany transmissions from all three sources.

Figure 1. Manning, 1988. Permission for Reproduction Provided by MIT Press.

What the table above illustrates is a highly organized textual system, with little information, will have a high textual predictability. It then follows that a poorly organized, high information system will have more textual unpredictability. The higher unpredictability will thus result in a higher entropy for that particular textual system.

When the meaning underpinning information is complex, like in forensic reports, it will increase the unpredictability and reduce the readability index, which will result in a higher systemic entropy. I will explore this more in chapters two and three.

Moreover, in this dissertation, language is treated as intrinsically nonlinear, dynamical, and chaotic. Claude Shannon, in his text "A Mathematical Theory of Communication," introduces the concept of information entropy. Shannon defines information entropy as "the entropy of a random variable that is the average level of information, surprise, or uncertainty inherent to the variable's outcome" (Shannon, 1948). I adopt Shannon's concept of information entropy in communication. That is to say, I am not thinking of entropy as being a measure of heat and energy escaping a system, but a measure of information/data/meaning escaping a system. For Shannon, the decoding process in communication was a fundamental issue. That is, the receiver of data/information must be able to identify and unpack the data or information generated as well as identify the source of that transmission. What I will examine is where and how information is lost along the communication channel, based on Shannon's model of communication.

Briefly, Shannon and Weaver's model of communication from Warren Weaver's Introduction to Claude Shannon's *The Mathematical Theory of Communication* (1998 [1964]) is as follows: a message is generated from an information source which then goes through a "transmitter," which functions to create a symbol (encoding). This signal/information is then transmitted over a medium, either written or verbally. That information or signal then reaches the receiver of information, which is where decoding takes place. That decoded signal is then "received" by the intended party. Shannon and Weaver place "noise" at the stage of the signal being transmitted and the signal being received. "Noise" in this context is thought to corrupt a signal or information, and the receiver then acquires a corrupted version of the original message sent (Littlejohn, 2002). It is this element of noise that I am most interested in because I propose that noise is not a corruption of data or information per se, but is embedded in the fabric of the communicative system which is made of and influenced by cultural elements that shape meaning.

Though building on some assumptions from Shannon and Weaver, I think it is productive to consider noise in a different way. Discounting instances of noise interference as corruptions might disregard an integral facet of communication that has a measurable impact on the meaning of the message received. Moreover, if we think of these "corruptions" as entropy rather than noise, then we might be able to unpack the broader implications of those instances. That is to say, I think it is important to understand that unpredictability may be perceived, incorrectly, as noise. Such perceptions could allow one to not consider unpredictability factors that impact readability index and underlying structure of a document.

To that end, if we consider unpredictability rather than noise as a way of understanding loss of information, we can see some pitfalls of particular genres. That is, writing in the genre of forensic pathology and forensic engineering requires elements that lower the readability index, raise unpredictability, and thus manufacture a text with a high entropy. Further, thinking of noise as entropy removes the place of "noise" in Shannon's model of communication. That is to say, insead of thinking of noise occurring at a set point in the communicative process, it is instead an ever-present force in the communicative system that is composed of integral rhetorical, cultural elements that shape meaning, and the understanding of that intended or unintended meaning. This, by extension, will allow for one to consider unpredictability or that particular form of entropy, as a separate factor than noise. It should be noted that I am using the term "unpredictability" to describe a type of entropy. Even though it is outside of the immediate scope of focus for my dissertation, as alluded to earlier in this chapter, noise should not be considered as a counterproductive element. I see noise in a communication system as a residual form of cultural elements manifesting in said communication system. Noise helps shape meaning, even if it adds to the unpredictability of a text. Entropy, as I understand its function in a communication, exists in the background as an ever present mechanism affecting the output of information.

Communication in forensic pathology and forensic engineering sits in the intersection of several different types of communication models that are not tailored to the specific needs, challenges, and volumes of entropy associated within forensics. This is why it is important to examine the nuances present in forensic pathology and forensic engineering communication. In this particular section, I will explore the nature and magnitude of entropy (unpredictability) present in communication models and how that has an impact on a conceptual model for forensic pathology communication. In the later chapters of this dissertation, I will consider several possible quantitative, qualitative, and mixed methods approaches for addressing entropy in an otherwise closed communication system. This is all to argue that communication in forensic pathology, specifically in forensic science, requires its own conceptual model of scientific communication that will productively utilize components from other types of communication models to address the specific issues of entropy in a closed communication system.

The more one progresses through the communicative process, the more unpredictability increases, not necessarily due to noise or interference. The source begins with tactical considerations in the field. That is to say, forensic pathology informs tactical consideration in policing. How Police Officers write their reports, what questions they ask the subjects, and what investigational clues Police Officers look for are all decisions informed by forensic pathology and forensic engineering reports. It is essential for officers to know and understand this because it will have an impact on the outcome of the investigation. The communicator must convey the scientific information to establish the ethos of the primary Police Officer. Information theory is a framework that is most commonly used. However, it does not consider the meaning behind the message or the noise and entropy in an otherwise closed communication system. Consider one way transmission versus a more participatory system.

Scientific communication, by virtue of its engagement with the public, necessitates or warrants a participatory element for the information to be received to be productive, as opposed to a strictly deficit model. The goal of scientific communication in the strictest sense is to inform the public about science, and perhaps make it digestible. The purpose of communicating about forensics, ballistics, engineering, or pathology is to inform the courts and juries, but it is only to compile information to aid attorneys and inform departments about the nature and specificities of a crime (Department of Justice, 2023). While this type of communication is intrinsically scientific due to the nature of forensic science, it is also inherently a risk type communication.

Unpredictability

Given that, I conceptualize entropy at its most basic definition, as a measure of disorder and randomness in a system, otherwise defined as unpredictability. I apply that definition to the idea of the low readability index present in these forensic reports as unpredictability that can be quantitative. Moreover, I argue that unpredictability in forensic reports can be and is influenced by the broader, socio-cultural contexts. Broadly, a probabilistic approach to entropy will allow for a measure of unpredictability in a communicative system. Further, if one accepts that “noise" can be productively thought of as entropy, and that it can be not thought of as a corruption of information and data received, we can come to accept the volume and magnitude of entropy could be measured in a communicative system. If this entropic information is indeed accurate, or at least productively quantifiable, then one should be able to draw conclusions about not only the magnitude of entropy, but also begin to draw inferences about the *nature* of that entropy. This is important because the nature of “randomness,” “disorder,” or “corruption” of information in a communicative system will allow for the attribution of qualitative inferences to be drawn. Such inferences could then afford the opportunity to understand the sort of nonlinear dynamics of a communication system, and how those have an effect on the larger system. These microscopic entropic effects on a communication system, which then lead to larger impacts on the communication system in terms of information encoded and decoded, then lead to more systemic communication effects. Such effects could lead to a paradigm shift, or a shift in genre conventions.

Information theory is productive as the conceptual framework for articulating and understating the basics of relatively linear communication. Shannon and Weaver articulated this model of information theory based on the assumption that information and data loss is happening in a communicative system. Where we diverge, however, is I attribute that loss or "corruption" of information, or data, to entropy during *all* stages of the communicative process, with that "noise" or in my argument, entropy, happening between the stages of transmission and receiving. To appropriately and productively understand entropy, the measurement of entropy, and the nature of entropy, as well as the broader effects, I will develop a more complex theory of communication, one that will possibly accommodate or at least acknowledge such entropy in a nonlinear dynamical communication system. This is done by examining unpredictability as a form of textual entropy. What this acknowledgement will do, perhaps, is illuminate the ways in which the broader socio-cultural context can have an influence on communicative elements. I will refer to it as an entropic communication model.

Moral Economies of Police Science

One way to consider the more microscopic effects of the broader socio-cultural contexts is to examine the environment in which these forensic reports are being produced. Briefly, let us consider the macro implications for genre, paradigm, and moral economies of science, particularly police science. Let us begin with moral economies of science, as the subsequent base, buttressed by Weaver and Shannon's information theory. Moral economies of science maintain the power to pose new questions about cumulative scientific methodologies and practices (Daston, 1995). Conceptually, moral economies provide insights into the underlying structures of embedded scientific methodologies and practices, specifically here, practices within police science. The insights provided by moral economies afford the opportunity to also examine embodiment as the underlying mechanism that impacts police scientific methodologies, communication, and practices.

There are two main elements I will aim to unpack with regard to moral economies, objectivity and quantification. Within my proposed model of entropic scientific and technical communication, quantification of unpredictability is one goal, and to understand the broader socio-cultural contexts and its impact on perceived objectivity is of interest. These elements reinforce and uphold scientific methodologies and practices, and by extension police scientific methodologies. Underlying scientific methodologies and practices are far-reaching and complex. However, for the purposes of this dissertation, I will focus on the goal of police science and by extension police scientific and technical communication as being: clear, concise, objective, and productive communication of articulable facts and circumstances of a given situation involving criminal behavior and officer's response to that behavior. The text *Symbolic Communication: Signifying Calls and the Police Response* by Peter K. Manning examines communication models as they pertain to police communication and the associated effects of entropy in that communication system. From my personal experience as a Police Officer, I have learned that this aforementioned set of concise and articulable facts and circumstances often lead to decision making and articulations of why certain decisions were made. That said, an aspect of such methodologies has broader implications for the police scientific institution in that, on a macroscopic communicative scale, they create certain conditions for the development and impacts of genre conventions and paradigms. Such inquiry into moral economies and its role in a communication system is recast here to understand the nature of entropy, rather than merely its quantification.

In this section, there are several terms and concepts I would like to define: moral economies, objectivity, and quantification. Historian Lorraine Daston defines moral economies as an organized system of shared values. Daston states, "what I mean by a moral economy is a web of affect-saturated values that stand and function in well-defined relationship to one another" (Daston, 1995). Daston further suggests that shared values, traditions, and conventions about ways of doing, being, knowing, and exchange are expressions of the moral communities that hold them (Daston, 1995). Moving on to the concept of quantification, it is suggested, by Daston, that quantification is referred to as a “mathematical virtue” (Daston, 1995). Quantification also concerns itself with accuracy and precision. So if this concept is applied to quantifying entropy in a communication system, one ought to see both the value, as well as the shortcoming of such methodologies. That said, there is still value in attempting to quantify entropy in a communication system, as it could highlight trends or patterns in the magnitude and nature of the entropy that could then lead to an understanding of socio-rhetorical impacts on an otherwise closed communication system.

Moving on to the concept of objectivity as it pertains to communication systems, according to Daston, objectivity is a moral economy separated into two different concepts, mechanical objectivity and aperspectival objectivity. Mechanical objectivity aims to remove human involvement in observation by means of utilizing a machine. Daston states, “this is the form of objectivity that strives to eliminate all forms of human intervention in the observation of nature, either by using machines, such as self-inscription devices or the camera, or by mechanizing scientific procedures, as in deploying statistical techniques to choose the best of a set of observations” (Daston, 1995). Aperspectival objectivity, on the other hand, is concerned with removing peculiarities of observers. Daston states, “aperspectival objectivity is about eliminating the idiosyncrasies of particular observers or research groups. […] Aperspectival objectivity serves scientific sociability and therefore enlists the various techniques of standardization, both quantitative and experimental” (Daston, 1995).

Police scientific and technical communication utilizes both of the aforementioned types of objectivity. For one, mechanical objectivity may come in the form of a body-worn camera or a squad camera, which, by its very nature, uses a machine to relay observations. Though due to the body worn camera being placed on an individual, there will be the issue of framing and perspective with third party observation, the goal is to provide an objective perspective of an incident. Within police scientific and technical communication, aperspectival objectivity is applied by way of policing standards and genre conventions. That is to say, law enforcement individuals operate on a set of rigid standards that, through procedure, aim to mitigate idiosyncrasies. This is of particular importance when composing forensic reports.

Daston's text not only unpacks the ramifications of quantification but also parses out the mental habits, methodologies, and characteristics of scientific practices and research structures. Daston's argument hinges on the idea that we are not strictly rational Cartesian beings; we are embodied. Moral economies have the power to establish ways of knowing. It is these ways of knowing that are embedded in scientific methodologies and practices that are reinforced by moral economics, specifically, through quantification and objectivism. Daston's conceptions of moral economies outline the ways in which scientists are situated within those structures. What I aim to do here is expand on Daston's conceptual framework for underlying scientific structures in police scientific and technical communication. The moral economies of science manifests as common experiences; they provide spaces where scientific knowledge is negotiated. Here it is of particular importance to consider police scientific and technical communication as a moral economy of science. Police science demonstrates structures of shared values, shared ways of knowing, shared ways of doing, and shared ways of being. Most importantly, moral economies of science place scientists in a position in which they provide an equilibrium through their affective role, as through my case of police work.

Also, regarding entropy, there is a tendency for a closed communication system to tend toward disorder, but ultimately, this dynamical disorder will move towards, and eventually gain, systematic equilibrium. That said, one of the goals of police scientific and technical communication is to uphold standards of practice and articulations, similar to scientific spaces striving to uphold standards of practice and research. A productive way to consider elements of scientific practice is through understanding the ways in which those who are situated in moral economies might frame their experience. This is of particular importance in modern policing. Moral economies articulate the structures in which officers find themselves. The structure of moral economies relies on the situatedness of an observer and, by extension, acknowledgment of the frame(s) with which they view their experiments. In order to productively do this, the observer must understand their experiences that inform their methodologies and investigation. One way to understand the frames of observers is through considering the condition in which we experience objects and our metaphysical assumptions about reality.

We can draw some parallels between these discussions and Judith Butler's concept of framing, which I use to articulate the underlying structures of scientific systems. The following passage illustrates the way that lives are represented in a way that reinforces a normative framework. Butler states, “subjects are constituted through norms which, in their reiteration, produce and shift the terms through which subjects are recognized” (Butler, 2009). However, if we consider the ways in which subjects are recognized, that have an impact on their perceptions due to the embodied normative framework, then we can see how significant one’s position in a normative framework is.

In aiming to understand how the situatedness of the scientific observer impacts moral economies and by extension standards of scientific practice and methodologies, we must first understand how they came to that situatedness. This is pertinent because I view ‘situatedness’ as a phenomenon that is a significant part of embodiment. If we consider norms as a force that have an impact on embodiment, then we can see some of the more microscopic effects on moral economies and how that informs and reinforces standards, policing methodologies and communicative practices. In the earlier passage, Butler articulates the ways in which our lives are framed. Butler is suggesting that the ways in which we are recognized determines what we are able to obtain. If we think about this idea of framing being almost operationalized for certain purposes, we can apply it to instances of scientific observation. Within this idea, it is not lives being framed for a certain purpose, but an experiment being framed for a certain purpose. Within the realm of police communication, it is necessary to consider the framing resulting from an officer’s body-worn camera. The nature of their observations as articulated by their reports mostly depend on their first hand experience, whereas a supervisor's observation of the incident captured by a body worn camera is strictly dependent upon the instruments that are being used to aid in observation. It is important to note that each police agency will have different methods for reviewing an incident. Depending on the severity of an incident, an outside agency is required to review the incident. From my observation of supervisors at Sheboygan Police Department, a supervisor will review the report and witness statements. They will also review the other reports attached to the case. It is department policy that every Officer that responds to a call must write a report. It is therefore the norm at Sheboygan Police Department to have multiple officers on scene, including a supervisor.

If the supervisor determines that the report or associated statements are lacking important information, they will then review the body worn camera footage. If the incident in question is relatively significant, the supervisor will review all materials related to the case. That said, since Sheboygan Police Department is a mid-size agency, supervisors typically respond to calls with other officers. With the supervisor present, it is likely they will also have a first hand account of an incident. It is important to consider, however, if for some reason a supervisor is not on scene at the time of an incident that required supervision review, their perceptions of an incident would be influenced by viewing the body worn camera footage and reading the report. I would also suggest that whether or not the supervisor viewed the footage first, or read the report first would indeed alter their perception of an incident. Police scientific and technical communication standards are being reinforced by the ways in which the tertiary observer, the supervisor, experiences material and immaterial objects.

Let us consider now how framing works within a system of moral economies. The collective moral economy of the scientists can be the result of a standard of practice and research upheld by seeking to reach the virtue of precision through quantification. Similarly, the collective moral economy of police scientific and technical communication standards is created and maintained through seeking quantification and objectivity when feasible. While this is a cycle of reinforcing the ways of doing that narrows the parameters of research for the sciences broadly, it aids in the precision of language for police scientific and technical communication. Moral economies have a temporal element. They are built within specific scientific histories. In order to understand the role moral economies of science plays in observations articulated by officers and by extension the situatedness of the officer and tertiary observers, we need to unpack how one can be situated in a moral economy through the concept of retrospective framing. Butler states, "interpretation takes place by virtue of the structuring constraints of genre and form on the communicability of affect-and so sometimes takes place against one's will or, indeed, in spite of oneself" (Butler, 2009). The key here is that form and genre reify the ways in which emotion or affect is communicated.

As stated earlier, moral economies are a structure of affective values. Butler's passage suggests that not only are structures put into place to regulate perceptions and interpretations of historical events or moments, but the structures that inform perceptions transcend one's personal will and intention. Our interpretations of the past are framed through our subject position in history. This leads to a sense of belonging that can reinforce these ideas. This is key in unpacking the underlying mechanism of moral economies because affective values are a part of the officers being an embodied feature in this structure. Moral economies are often upheld by standards of practice and research. Police scientific and technical communication standards are reinforced by ideas similar to the ones Butler articulated.

Thomas Kuhn, in his earlier text *The Structures of Scientific Revolutions*, reinforces this idea that scientific histories are not linear and are reshaped by scientific interruptions that do not fit the norm (Kuhn, 1997). This is similar to the thinking that commonly held beliefs that center around simplistic notions of human progress that present ideas are superior to past ones. Sometimes scientific observers can erroneously reinforce these notions about scientific progress. This results in the valuing of specific epistemologies that uphold a narrow way of doing things, specifically quantification and objectivity. While this tendency to value specific epistemologies may be a limiting factor in the sciences, it can be very productive in policing, not just in terms of methodologies, but in the ways officers are are trained to not only articulate an incident to adhere along the lines of clear technical communication principles, to be able to reduce a complex situation down to a digestible report for a potentially wide audience. What this boils down to is a fundamental shift in the genre of police scientific and technical communication due to the structures of that particular moral economy of science. It is within moral economies we see genre coming together and the norms and genre conventions being created.

Let us briefly consider how genre informs police scientific and technical communication. In order to do that, I will first situate discussions of genre in Carolyn Miller's conception of genre, citing her text "Genre As Social Action" (1984). For Miller, genre is reliant on previous work. Within police scientific and technical communication, we often see remnants of past genre conventions meeting new, slightly modified genre conventions. These new genre conventions we see in that field are due to an external agent, often. If we look at the effects of external agents from Miller's perspective, we can see it as a part of an otherwise cyclical system. This cyclical genre system works by an external agent informing or informed by perspective, which then informs the resulting genre. For Miller, genre informs the way we perceive and therefore create texts, which is informed by genre. This facet of Miller's conception of genre is important because much of my argument is predicated on the idea that previous work builds into and thereby morphs the overall genre.

There are strict genre conventions for forensic engineering. The overall goal of the forensic investigation pertaining to an accident is to, one, document the results of the investigation; two, articulate the pertinent methodologies; while, three, being composed in a manner in which if the investigation should result in litigation, then it's digestible and clear for a judicial audience. That is all to say, there should be a clear and concise report written about what happened and why it happened, based on scientific methodologies. If we consider this purpose in terms of Miller's conception of genre, forensic science reports are written in a way that is built on not only previous work in the field, but also navigating litigious scrutiny.

Moreover, what this genre of forensic engineering attempts to mitigate is noise in the system. Entropy in this particular communication system takes the form of context in which the accident happened, and subject position of the people investigating it. Figuring out *what* happened can be inferred with scientific methodologies strictly. However, figuring out *why* something happened is seen to be more subjective. Noise in the later stages of articulations of these investigations, I would argue, serve a purpose. Such a purpose is productive to think of the noise in this communication system as contributing to textual unpredictability. This is not to suggest that noise is inherently counterproductive; it offers important, contextual information about the meaning of a message, and by extension why something may have happened. If we consider noise as contributing to textual unpredictability (entropy), we can think of these instances of deviation and messiness in the system as contextual clues that offer more insight into underlying meaning. In order to productively consider this, let us apply the concept of entropy to a specific type of police scientific and technical communication, forensic engineering.

For forensic engineering reports, precision of written language is, perhaps, one of the most significant facets for productive communication. This is the reason forensic engineering is valuable for my inquiry. When scientific and technical communication aims for precision of language, it can be inferred that an elimination of noise or interference in that particular genre is of the utmost importance. The goal of forensic engineering or accident reconstruction is to perform a type of failure analysis. The genre of forensic engineering reports have the goal of documenting methodologies and findings to support the engineer as well as other stakeholders involved in the investigation. Ziernicki (2007) in his text "Forensic Engineering Evaluation of Physical Evidence in Accident Reconstruction" offers an in-depth exploration on the field of forensic engineering. Considering the goals of the forensic engineering genre, it is helpful to consider Miller's articulation of genre. Miller examines the connection between situation and genre. The findings of an engineering report articulate a particular situation, which comes with an extensive range of subject factors, and the report documents it, most likely without having first hand witnessed the situation. Forensic engineering requires strict genre conventions to be applied. Miller additionally articulates a classification of discourse throughout her aforementioned text. Those conversations of discourse are not dissimilar to other academic conversations about semiotics, as it could be argued that semiotics buttresses discourse in a conceptual framework. Using a semiotic framework breaks down language into parts and meaning. Though beginning with small units, ultimately, this will lead to a macroscopic view of the effects of entropy on a communicative system.

Semiotics and Unpredictability

Let us consider Saussure's models of communication. Chipere (2003) in his text "Saussure's Theory of Language " suggests that a Sausserian perspective of communication is that language is constructed from an individual's experience (Chipere, 2003). A Sausserian approach allows us to understand language as units. To that end, language, and by extension communication, works as distinct units. Such units can be thought of in a mathematical way. In 1948, Shannon and Weaver co-authored a paper titled “A Mathematical Theory of Communication”. This was later published into a full book in the 1960’s titled *The Mathematical Theory of Communication* (1964). This book details a two way model of communication, expanding on their mathematical explanation of communication. The 1964 version, published by the University of Illinois Press, articulates that a transmitter seeks out a receiver. One point of interest is to measure that unit of language. A Sausserian approach would allow for the unit to be measured to be the sign itself.

It is also productive to refer to Chandler’s 2017 text *Semiotics: the basics* for articulations of a fundamental understanding of semiotics. Chandler articulates the following: “all experience is mediated by signs and communication depends on them” (Chandler, 2017, p.2). The aforementioned quote is rather fundamental, highlighting an important aspect of scientific and technical communication. In order to productively analyze the role entropy plays in a communicative system, we need to understand some of the external language factors contributing to what could be perceived as noise, which I argue, is productive entropy. Examining the semiotic aspect is a way to factor in the meaning underpinning a message. Semiotics aids in structuralist articulation of such meaning production through the encoding and decoding process. That said, similar to Chandler, my perspective on semiotics aligns with structuralists such as Ferdinand de Saussure, Louis Hjelmslev (1899–1966), and Roman Jakobson (1896–1982). Exploring various structuralist semiotic conceptions allow for the placement of meaning in a scientific and technical communication model. It is important to note that a Sausserian approach to understanding language, similar to Chandler's articulations, maintains that meaning is not "transmitted," it is "actively interpreted" through various subject factors and various frames of reference (Chandler, 2017, p.8).

If my goal is to articulate a model of scientific and technical communication that accounts for textual unpredictability, then semiotics can provide an explanation for what we have previously conceptualized as noise and interference. Semiotic theory and information theory could be seen as in a reciprocal relationship. Information theory focuses on the mathematical aspects of communication information loss and how entropy is productive for measuring that loss. Semiotic theory concerns itself with the use of signs and symbols to convey meaning. I see the relationship between the two as semiotic theory provides an explanation of signs and signifiers and what that means for a communication. The choice of a sign will determine how productively a message is conveyed and perhaps received. Information theory offers a framework for considering how those given signs contribute to information loss in a communicative system.

I would like to digress to briefly review the definition of entropy to which I am referring. As explained before, I am utilizing the definition of entropy from Shannon-Weaver's model of communication: "Entropy is the measure of uncertainty in a system" (1948). In communication systems, entropy is in a directly proportional relationship to the number and magnitude of messages sent and received. That said, interference or noise, as previously conceptualized in these systems, can be attributed to the informative value of an information bit in a message. These bits of information, even if they are redundant, have an impact on the meaning of a message. Unlike mechanical noise, communicative noise is not strict interference and counterproductive; instead, it adds a layer of sub-contextual meaning to the message being transmitted. Moreover, that sub-contextual meaning is not a detriment, but instead an added layer of information in a communicative channel. What this means for thinking of noise or interference as entropy, is that I can aim to isolate instances of entropy and articulate that nature of entropy through a structural semiotics lens. To do this, I find the triadic model of semiotics, as opposed to the dyadic model, to be of particular use.

Chandler's 2017 text "Semiotics: the basics" offers excellent insight into thinking about text as a system of signs. Within the genre of a forensic report, chosen words are more concrete in that the given words have little room for interpretation of meaning. It is productive to think about textual unpredictability as a byproduct of a sign. If entropy, and by extension textual unpredictability, results from a syntagmatic sign, then it can be assumed that signifier/signified was chosen for the purpose of accurately conveying given information. However, what Voyant Tools shows in its analysis is that heightened unpredictability in textual structure has an impact on readability index. That readability index is a direct result of the signs and signifiers in that system.

As for the dyadic model, Chandler states, "the Dyadic model: its two relata or correlates, being a sign vehicle and a referent" (Chandler, 2017, p.12). This particular model would fall short in unpacking the role of semiotics in entropy because it only accounts for two correlates. However, the triadic models not only account for dimensions of sense and reference, but it also accounts for the three relations commonly referred to as sign-object, sign-mind, and object-mind (Chandler, 2017, p.12). For conceptualizing the role of semiotics in entropy, if one is able to isolate an entropic element within a communicative system, the nature of that entropy could be attributed to one of the three aforementioned elements in one of the triadic models.

It should be noted that this is not to suggest that dyadic models are not productive; in fact, I would like to take a moment to consider the Saussurean model of semiotics. It falls into the category of a representational model that sits between a triadic and dyadic model. I understand representational models to include a sign, sense, and a reference, which results in meaning being made (Chandler, 2017, p.12). In thinking about the Saussurean model of language, I would like to isolate the elements of signified and signifier. In this model, a sign consists of signifiers and meaning. If we think about this in terms of entropy and a communicative systems tendency towards uncertainty, we can see how a sign, which prefaces meaning, can encourage uncertainty. This could be due to the language system of signs in which a signifiant/signifier and a signified/meaning produce outputs/words that do not stand for things per se (Chandler 2017, p.14). Instead, the output is a concept that is a mental representation from bits of information encoded followed by decoded in a communicative system. Further, the output here is more of a relational concept rather than a strict linguistic sign which does not represent reality (Chandler 2017, p.17). It is important to note that, within this system, the firm medium with which these processes are taking place is inherently intersubjective.

I highlight the intersubjective nature of signs and signifiers because it can be adapted into Daston's moral economies of science, at least on a linguistic level. To discuss this, linguistic signs should be abstracted into "codes" to adhere to Daston's conception of objectification. Moreover, the purpose of the objective codes is to move through an intersubjective medium which results in an output. That output/words or phrases, then requires a shared frame of reference for productive decoding (Chandler 2017, p.232). What I want to emphasize is that in order for a model of communication to be productive, it ought to account for code and intersubjective context, similar to a moral economy of science. To that end, it is important to note that while the semiotic codes generated during these processes maintain an objective nature, they should not be viewed as "fragments of reality" (Chandler 2017, p.235). To avoid a pitfall of the transmission model, we should think of these codes not as a way to reduce language, but as a way to adhere to a set of semiotic rules that allow for meaning making process without eliminating noise or interference, which should aid in reducing unpredictability, thereby increasing the readability index.

If we consider the role of semiotic codes in terms of Miller's conception of genre, then we might consider them as more of a formal entity in genre. That is to say, semiotic code can become the connection, or a point of connection between what Miller calls "intention" and "social effect" (Miller, 1984, p. 153). The aforementioned social effect is what I would consider as exigence, but on a smaller scale. In genre, I would argue that exigence steered a paradigm shift in the broader communicative system. However, the more microscopic exigence that I am discussing here is similar to Miller's social patterns and social motive (Miller, 1984, p. 158). Such social motives that influence genre could be thought of as the more performative aspects of scientific and technical communication. The role genre then plays in conceptualizing Daston's moral economies is more so in terms of performing scientific *methodologies.* In this case, those performing scientific methodologies strive for the virtue of precision and quantification regarding police communication. Police officers are mostly *responding* to quantification. That is to suggest that police officers are reactive by training. In my experience as a Police Officer, we receive statistics, varying in topic and detail, and we adjust accordingly. What is important here, is the situatedness of not only the officer, but the supervisor reviewing the incidents as well. Of course, it is important to note that there are a multitude of law enforcement agencies in the United States; the aforementioned procedure and experience has been mine through only three police agencies, the Michigan Technological University Police Department, Green Bay Police Department, and Sheboygan Police Department. This is key in understanding the role moral economies play in informing the situatedness of the scientific observer.

Daston states the following, "to examine a moral economy of science may render familiar scientific procedures such as quantification strange, but seldom devious. Insofar as the study of moral economies in science is about power, it is power of the microscopic, internalized Foucauldian sort, rather than of the political externalized kind" (Daston, 1995). I understand this passage as suggesting that the smaller value and affective features of a moral economy may not necessarily indicate a level of intentionality on the part of those working in this structure. Instead, the results of a scientist's affective existence in this system have unintended implications. The reason this is pertinent is because the situatedness of an observer directly speaks to the embodied element that informs and reinforces standards of scientific methodologies, and by extension police scientific and technical communication.

Let us now consider a police officer's situatedness in these economies. They are impacted by their own value systems, their emotions, and their cultural contexts. Daston states the following, "a moral economy is a balanced system of emotional forces, with equilibrium points and constraints. Although it is a contingent malleable thing of no necessity, a moral economy has a certain logic to its compositions and operations. Not all conceivable combinations of effects and values are in fact possible" (Daston, 1995). Daston considers how equilibrium in moral economies actually uphold three specific ideals: quantification, empiricism, and objectivity. These ideals have shaped the way scientific observers work within standards of practice and research frameworks and uphold such. Daston states, "much of the stability and integrity of a moral economy derives from its ties to activities, such as precision measurement or collaborative empiricism, which anchor and entrench but do not determine it" (Daston, 1995). This is why moral economies as Daston has conceptualized it are integral to understating the ways in which scientists are situated in their activities. Further, this can be applied to a police officer and that particular moral economy. Affect is an embodied feature of a moral economy of science that informs and reinforces standards of scientific methodologies and practices.

Another significant function of a moral economy is that it also informs and reinforces scientific methodologies and practices through the navigation of situations that are outside of the norm. It is within these instances that norms are negotiated and renegotiated. Moral economies have the power to establish ways of knowing. This is why it is important to understand the role of the scientific observer, whose function within these economies are informed by their subject position. Moreover, the norms that are shaped by standards of scientific practice and research buttress scientific observations. These are directly impacted by the external social morals, values, and ideals. This is important because that is the system that shapes and reshapes moral economies. What we need to consider here is how the behavior of scientists is impacted by and has an impact on this system of beliefs and values that shape scientific moral economies. Please note that Daston does not suggest any causal consideration for such behavior, instead Daston asserts that the external normative factors contribute either directly or indirectly to this behavior. Datson states, “I will nonetheless claim that not only does science have what I will call a moral economy; these moral economies are moreover constitutive of those features conventionally deemed most characteristic of science as a way of knowing” (Daston, 1995).

It is because of this core improbability that morality becomes required. This is important because Daston suggests that moral economies are necessary in understanding the role of the scientific observer. It is within these economies that scientific standards of practice and research are negotiated and established. Scientific observation does not exist in a bubble. It is influenced by an observer’s subject position and the broader history that informed those values. Daston states, "because it in principle encompasses all science, not just this or that ideologically tainted claim, the social-constructionist program comes closest to acknowledging the integral role of values in scientific work and its products: values do not distort science; they are science" (Daston, 1995). I interpret this passage to suggest that social constructionists, such as Kuhn or Butler, offer a productive insight into the ways in which values impact science, and by extension police scientific and technical communication. Moral economies are built upon microscopic instances of affect and value; this impacts the equilibrium in the system. Moreover, the role of values in moral economies that inform and reinforce standards, scientific methodologies, and practices are intrinsically embodied. It is within these economies that values are negotiated and reframed for the sake of precision of the scientific observer.

As stated above, values in a system of moral economies are embodied by their very nature. This places scientists in an integral position to provide equilibrium to the system of moral economies. One significant value that is held by those working within these moral economies of science is the virtue of precision. In order to consider the ways in which moral economies have embodied elements that inform and reinforce standard scientific methodologies and practices, we need to consider the specific values at work in these systems. The virtue of precision buttresses standards of scientific practices and research. Here, it is important to note that precision and quantification does not nullify the observer's subject position. In these instances of quantification, the observer is still situated; the observer is still embodied. Moreover, the acknowledgement of this situatedness is essential in understanding how that can impact the decisions of the scientific observer. Daston states, "for quantification, no matter how thorough and detailed, is necessarily a sieve: if it did not filter out local knowledge such as individual skill and experience, and local conditions such as this brand of instrument or that degree of humidity, it would lose its portability" (Daston, 1995). Daston considers the impact of quantification on the collective. Quantification exists to mitigate dissent within the collective itself. Furthermore, I would argue that the striving for and upholding the virtue of precision and quantification, are two of the features that inform and reinforce standards of scientific methodologies and practices.

Striving to achieve the virtue of precision is a lofty task which relies on some level of objectification. According to Daston, objectification is actually a moral economy itself. It is stated, "whereas the quantification of precision alone aims at impersonality in the service of a collectivity, the quantification of precision measurement aims at integrity, sometimes in defiance of the collectivity" (Daston, 1995). This is important because this is a different type of moral economy than what was articulated about quantification. In this moral economy of science, we can see instances of reinforcing standards of scientific practice and research. These standards exist in a reciprocal relationship with the scientific observer. The observer reinforces standards through their situatedness.

Moreover, through shaping moral economies, scientists are engaging, either directly or indirectly, embodied practices. Butler's conceptions of frames and situatedness can help us further understand the situatedness of an observer, as above. The scientific practices that are informed by the observer and their orientation to the experiment are practices and disciplines of the body. It is important to understand this because it speaks to what epistemic ideals are being upheld in these moral economies. Standards of practice and research norms circulate via embodied actions. Datson reinforces this idea that norms circulate in these economies. We should constantly consider and reconsider the embodiment of an observer, as in this case, the police officer.

Chapter Outline

In order to productively observe the presence of entropy in these communicative systems, there are various methods that can be employed. While some of these methodologies would fall into the category of linguistic analysis, in the chapters following, I will utilize genre analysis, rhetorical analysis, and examinations of latent manifest analysis. All of these analyses will be through the lens of a mathematical theory of communication or information theory, namely the Shannon-Weaver conception. The goals of these analyses are to essentially break written language into discrete pieces or informational units referred to as distinctive features. These distinctive features might be entropic in nature.

There are numerous forms in which a distinctive feature could take. For example, the distinctive feature could be a written version of a phoneme, not a grapheme-alphabet, but the smallest piece of meaning derived from written communication. With the focus of my analysis being two different types of forensic reports, there is a multitude of written phonemes to analyze. Though these could be viewed as noise or interference, I argue they are productive even in their influence of systemic entropy. Moreover, they offer insight into possible socio-cultural phenomenons present in the text, however unproductive for the readability index. The roles of entropy or textual unpredictability in these systems of written communication are the catalyst, which presents itself initially as noise and in some respects the smallest parts of language, thus informing the broader system as a whole which then has, perhaps infinitesimal, impacts on the genre of a piece of written communication, in this case both forensic pathology reports and forensic engineering reports.

While traditionally, linguistic analysis has been used to resolve oral speech into discrete parts, it is productive to utilize that linguistic method for written communication, especially when attempting to unpack the role of unpredictability in a communication system. That said, it should be noted that while I am investigating the distinctive features, such features are not as microscopic as graphemes. The purpose of my investigation is not only to highlight written instances of entropy, but also to characterize those distinctive features as productive entropic elements. To fully investigate the presence of such productive entropic elements, this dissertation is divided into the following chapters. The second chapter will discuss historical standards of forensic reports, namely how current standards are rooted in the forensic pathology report. There will be an analysis of George Floyd's autopsy report. This will be followed by John Grant's autopsy report.

The third chapter will then unpack a latent semantic analysis of a forensic engineering report to articulate how that genre builds off of forensic pathology reports.

Moreover, this chapter will highlight instances of textual unpredictability. This chapter will also discuss the connection between entropy, scientific and technical communication, forensic engineering reports, forensic pathology reports, and what role entropy plays in these written communicative systems. This is all to argue that what has been historically perceived as "noise" or "interference" manifests as entropy or textual unpredictability which results in low readability indexes. This unpredictability, of course, has an effect on the genre for forensic science reports. It also has had a larger effect on the perception of the genre by the broader, tertiary, audience. Those entropic elements that we see in these written systems of communication are moments of productive randomness or perceived disorder in a system which wildly fluctuates depending on numerous factors. Given the understanding of the presence and magnitude of entropy in a communication system, one can then determine if there is a positive or negative value attributed to it, then proceed to reduce said entropy which can only happen if the entropy of another system increases.

Chapter four will unpack pertinent models of entropy and communication. The goal here is to build a framework for positioning my proposed entropic model of scientific and technical communication. The concluding chapter will examine the last aforementioned factor of reducing unpredictability and its key implications. I will discuss the socio-cultural considerations of this study, the rhetorical situation as it relates to Human Subjects Research, and how that helps us understand forensic science as sometimes labeled "junk science."

Chapter 2: Analysis of Forensic Pathology Reports.

The chapter preceding alluded to the utilization of Voyant Tools as a way of not only creating visualizations out of pathology reports and forensic engineering reports, but also a way to quantify written language. It should be noted that entropy when used in reference to written language is used to describe the magnitude of uncertainty. How and where those uncertainties appear in the forensic reports is what I aim to highlight. The intent here is to recognize and unpack patterns present in the aforementioned documents in order to arrive at a conclusion about what could be perceived as noise, interference, or entropy. To offer a high level overview, the first forensic pathology report I examine is the autopsy report of Mr. George Floyd. The second forensic pathology report is from Mr. John Grant. The final report will be a forensic engineering report from a fatal auto accident that took place in Florida. This chapter will be dedicated to examining the forensic pathology reports in order to better understand how strict genre conventions can and do shift based on broader socio-cultural factors. The chapter following will be dedicated to the examination of the forensic engineering report. The goal of this chapter is to draw meaningful insight from the visualizations that are produced.

I would like to now discuss the two forensic pathology reports and the one forensic engineering report that I will use as artifacts for subsequent examination. There are many different types of forensic reports and examinations: for example, forensic pathology (autopsy reports), forensic engineering (accident reconstruction), computer forensics, and ballistic forensics. According to Peter R. De Forest, R.E. Gaensslen, and

Henry C. Lee in their 1983 textbook *Forensic science: an introduction to criminalistics,* each of the aforementioned fields all fall under the umbrella description of "forensic science" (De Forest et. al 1983). For the purposes of this project, I will focus on two branches of forensic science. Other than forensic pathology, one of the most common types of forensics is engineering forensics, otherwise known as accident reconstruction, as described by a classic book in the field (Noon, 2000). The purpose of this type of forensics is to investigate vehicular failures, and the goal at the end stages of this type of investigation is to attribute the accident to a reason, either criminal or non-criminal (Noon, 2000). For this chapter, I will examine forensic pathology reports, or autopsy reports, specifically the autopsy reports of George Floyd and John Grant. Those working in this field are concerned with finding a cause of death (De Forest et al, 1983). Yet again, the cause of death could either be criminal or noncriminal in forensic pathology reports.

Linguist Bikesh Ospanova in his 2013 text "Calculating information entropy of language texts" similarly began from Claude Shannon's information theory (Ospanova, 2013). However, where his analysis focused on genre as a key entropic element, I am focusing on word choice and the correlations with frequency or occurrences in my chosen forensic pathology reports. When examining textual entropy, the structure of the document, and by extension where and what words are present, offers insight about randomness in that communicative system. That said, in the analysis of the Floyd and Grant forensic pathology reports, and the forensic engineering analysis in the chapter following, I have adopted Ospanova's 2013 text "synergistic theory of communication" as a method for analyzing frequency of randomness and unpredictability of words in a given text. As mathematician András Kornai states, “in mathematical linguistics, the averages that matter (e.g. the percentage of words used correctly or correctly translated) are linked only indirectly to the measurable parameters, of which this is such a bewildering variety that it requires special techniques to decide which ones to employ and which ones to leave unmodeled” (Kornai, 2007). This is of particular interest to me because I see Kornai's explanation as about how mathematical linguistics methods can highlight microscopic instances of errors that are present in all communication systems. The language that is used in his text is predictive for articulating the type of microscopic phenomenon I will examine subsequently in this chapter. Additionally, mathematical linguistics will offer methodological parameters for studying such phenomena.

Unpredictability, as a concept, necessitates further analysis because of its roots in entropy. Engineers Abbas El Gamal and Young-Han Kim articulated the following in their 2011 text, *Network Information Theory*, "the uncertainty about the outcome *X* is measured by its entropy " (El Gamal & Kim, 2011, p.17). The reason I highlighted the aforementioned quote is because in subsequent chapters, I might refer to uncertain outcomes as the variable “x”. It should be noted, at times, I will discuss several different types of entropy: joint entropy, conditional entropy, and negative entropy. Joint entropy is determined and reliant upon variables (El Gamal & Kim, 2011). The measure of its uncertainty is in direct relation with certain variables. Conditional entropy is outcome dependent. That is to say, conditional entropy *A* is dependent on entropy *B*. Negative entropy is a system’s movement from disorder to order (El Gamal & Kim, 2011), rather than order to disorder. Entropy likewise will be used to reflect the conditions of broader systems.

The reason I am pulling terms from these fields is because I see communication as behaving as a nonlinear, dynamical system that moves towards and from entropy through different stages. Physicist Robert Hilborn, in his text *Chaos and Nonlinear Dynamics: An Introduction For Scientists and Engineers* (2000), discusses nonlinearity as it pertains to chaotic systems. While these terms are generally discussed in the context of mathematical physics, there is a conceptual value to applying the underlying ideas to gain a different perspective on scientific and technical communication systems, specifically forensic pathology and forensic engineering reports. These forensic scientific communication systems reinforce behaviors seen in nonlinear dynamical systems, which can be indicated through entropy. In information theory, entropy is defined as “the amount of chaos” or “the lack of information about a system” (Wehrl, 1978). In theory, if one has complete information, entropy should be minimal. If this concept of entropy is applied to the way written communication functions, then instances of ‘noise’ or ‘interference’ in communication systems can be attributed to a deficit in information given. To that end, examining these entropic instances in communications affords the opportunity for discovering productive communicative elements that have been discounted as noise or interference on the microscale. On the macro scale, it turns out these entropic commutative instances offer further insight into the meaning behind a message.

The Role of Unpredictability

In general, noise and entropy are present at almost every stage of the communication process. However, these two factors should not be conflated. The difference is the nature and frequency or intensity of noise is not in direct proportion with the nature and intensity of entropy. That is to say, while these factors are similar in their effects as well as their general nature, they are not in a cyclical relationship per se. One can exist without the influence of the other. However, often, they do reciprocate on the level of too much noise which will add entropy into a system. Where entropy happens in Shannon's model of communication is, I would argue, at the noise stage. However, similar to other scientific and technical communication systems, the model from which this is built does not consider, first, the meaning of the message and might not work to mitigate the problem of noise in and entropy in an otherwise closed scientific communication system.

Let us consider the usefulness of studying the role entropy plays in a communication system. In the text *Entropy* by Greven, Keller, & Warneke (2003), entropy is described through both its mathematical as well as conceptual foundations. A measurement of entropy is useful for a description of complexity. Within a system of communication as complex and multifaceted as forensic science, randomness, and by extension, complexity increases. This is an integral factor to consider and measure in order to understand the effects on encoding and decoding and information loss, the microstate that is informed by the constraints of the macro-state (Greven, Keller, & Warneke 2003). Understanding the magnitude and major sources of entropy in a communication system will also help us understand the stability of the communication system as a whole by examining the microscopic aspects of these systems. Moreover, by placing entropy at the center of my inquiry into scientific communication as it relates to forensics, I maintain the hypothesis that a forensic scientific communicative system in equilibrium will have a better chance at communicative success in terms of the encoding and decoding processes. In examining where and how and to what extent information is lost during the communication process, it is necessary to go from a microscopic point of view in a communicative system to a macroscopic point of view.

These systems of communication function similarly to a mathematical system that we would see in chaos theory or the study of nonlinear dynamics. Understanding communication systems in this way gives us a framework for breaking down these microscopic systems into manageable data points that allow for the manipulation of broader conceptual communicative elements that will then have a larger impact on the macroscopic communication system. Additionally, it is important to note that entropy is a result of probability theory. Probability theory had a significant impact on information theory as it relates to physics. Many communication models stem from mathematical information theory. The mathematical model of a communication system proposed by Shannon and Weaver utilized the concept of entropy indirectly. However, for a conceptual model for scientific communication for forensic science, entropy has an impact on the way communication models are understood.

From the second law of thermodynamics, an increase in energy (entropy) has an inverse relationship with a decrease in energy within a system. New events modify entropy; the more elements you add, the more entropy increases. If one can measure the average number of bits per symbol, you can measure efficiency within this discrete system and by extension the sources of noise in a system, where entropy is entering the system, what the biggest sources of entropy are, how to reduce them while accounting for and accommodating meaning in the systems. Shannon's first theorem is the coding theorem, and it is meant to measure the source coding efficiency. If we consider how this might look in a communication system, we can conclude that "noisy" words that muddle the final message conveyed are ones in which we should seek to eliminate. This would, of course, be in an effort to gain some control of unpredictability, and perhaps lower system entropy.

Moving on to considering entropy in a little more detail. Since I have defined and elaborated on the differences between noise and entropy, it is prudent here to go into more detail about the nature of entropy and specifically what I see as the intrinsic value in unpacking the dynamic and ever changing nature of entropy in an otherwise closed communication system such as a system as constricted as scientific communication in police communication and forensics. Entropy was originally conceptualized as a way to describe randomness, and by extension, equilibrium in a system. Much like information theory beginning in physics, entropy has its roots in physics, specifically the laws of thermodynamics. While a conceptual model takes a close look at a communication system, my proposed conceptual model for scientific communication will take an even more microscopic approach to understanding communication at its core. Entropy is an integral facet of that microscopic lens, as entropy deals with the microscopic view of a given system.

Within communication, there are many microscopic elements that are crucial to the dynamic and productive nature of that communication system. Each one of the elements are microscopic in scope, but each one of these microscopic properties necessitates a description of entropy. While each of these elements may only allow for the smallest bits of entropy to enter into the system, that smallest amount can throw the communication system out of equilibrium to the point where communication is no longer productive, and that often results in a communication breakdown, which in police communication in not only detrimental, but often have long-lasting and sometimes life-threatening consequences. In order to understand entropy and noise in any meaningful way, now it is my task to ensure that proper care is taken to consider meaning in the system. This could perhaps be done in the stage of quantifying data. Making sure to not quantify it too much, I will not break language down to binary but examine graphemes and phrases as well as analyze the output from Voyant Tools. Utilizing this tool, language is still quantifiable, but still has meaning attached.

Voyant Tools and Forensic Pathology

These visualizations, produced by Voyant Tools, are objects of interest derived from sentences, phrases, and associated meanings. Voyant Tools is an open-source website for the analysis of digital texts. It is used by those working in the digital humanities and linguistics. Voyant Tools software is used by scholars in many fields. I will consider the formed conditions as well as the contextual parameters surrounding these texts. It should be noted that these reports have specific and articulable goals. Those goals shape the grammar, syntax, word choice, and logic underpinning the writing. In thinking about the examination of context-sensitive-type objects and word forms, it might be helpful to think of the data proceeding in terms of graphemes. That is, these objects can be thought of as the focus on the *sign.* According to mathematician Kornai, "Nearly every communication system that we know of is built on a finite inventory of distinct symbols" (Kornai, 2008). In isolating distinctive features, I can take an inventory of distinct written features. Pathology reports have very strict genre conventions. This is important to note because each of the following case studies must adhere to these strict genre conventions.

While each of these reports has unique stylistic and contextual elements, there are still required communicative and written norms each report must follow. During the course of a death investigation, if a coroner concludes that an autopsy to assert the cause of death must be done, the medical examiner or forensic pathologist will begin their investigation. Please note that family members can also request autopsies. Regardless of the manner in which the autopsy is performed, each report of autopsy, as evidence, must be as complete as possible. Some necessary elements include: death scene photographs, investigator notes, laboratory analysis of evidence, any sketches done at the scene, all chain of custody forms, anything detailing who handled the evidence at any point in the investigation and when they did as well as any laboratory request forms. The forensic pathology report will detail either one or a combination of the following, as well: the cause of death, the manner of death, and mechanism of death.

There are several questions investigators ask when determining if an autopsy is necessary. Please note that the following questions do not have to be posed verbatim, but the general idea is to determine the necessity of an autopsy. The first question should be aimed at determining whether homicide or foul play has been ruled out. The next question should aim to answer to what extent the physical evidence left on the body points to a cause of death (Greenwood, Petersilia, & Prusoff, 1975). Next, the investigators should ask if toxicological specimens are needed. Then, an investigator will question if there is a chance of civil litigation. Following, there needs to be a determination of the the chances of suicide, as well as how well the deceased was known in their area, and were there any witnesses to the event that led to the death. The medical history of the deceased, for example, any history of disease, is taken, and where the death took place and if the body has been positively identified, as per the text "The Criminal Investigative Process" (Greenwood, Petersilia, & Prusoff, 1975).

Each of the questions helps build a story that will help investigators figure out what happened, why, and in what manner. Should a case require an autopsy, and appears to be homicidal in nature, these questions will become of great importance to the prosecution. To that end, there are certain circumstances that warrant an autopsy; for example, deaths that are attributed to fire, homicides, suicides, those involved in single car accidents, deaths related to occupation, sudden deaths of children, and deaths of those in police custody (Greenwood, Petersilla, & Prusoff, 1975).

George Floyd and John Grant Autopsy Reports

George Floyd's case represents an anomaly in these reports not only in terms of the social context, but in terms of the stretching of genre conventions within the report itself. That is to say that Floyd's report could represent the beginning of a paradigm shift in genre for forensic pathology reports because of the entropic elements becoming too numerous for the otherwise closed communicative system to handle. This could be thought of as entropy within a system reaching its maximum to the point where the system is forced to change to accommodate the magnitude of entropy. Moreover, as stated in the preceding chapters, I think of these communications systems as a nonlinear dynamical system that ebbs and flows to accommodate entropies of different types, for example, social, cultural, scientific, and other unknowable elements. What I observed in George Floyd's report was a relatively uneven distribution of information throughout the report, whereas Grant's report has a more even distribution of information throughout the report.

It seems this difference is because John Grant's report adheres more to the strict genre conventions of a classic autopsy report. Wyatt and Wyatt (2011) in the *Oxford handbook of forensic medicine* outline the fundamentals of the forensic pathology processes including the associated report genre conventions. According to Wayatt and

Wyatt (2011) the following sections should be present in a pathology report: legal authority for the autopsy, name and other identifying information, qualifications of the pathologist, date and place of examination, external examination, list of samples taken, toxicology samples taken, any other tissues or organs preserved, statement of the cause of death, opinions of the manner of death, and a summary outline of the conclusions reached. It should be noted that it is not required to provide a comprehensive description of the circumstance of death, a diagram of the body, negative findings, or relatives (Wyatt & Wyatt, 2011). Grant's report contains far more detail, including the information that is not required, with the exception of known relatives. Floyd's report does not include as many details as Grant's. However, Floyd's report does contain more mentions of the negative findings, unlike Grant's report. As recommended in the autopsy handbook, Grant's report has a section appropriately named "Opinions," and it offers a statement of a probable cause of death in the beginning of the report. Floyd's report does not have either one.

It should be noted that given the rather turbulent, socio-cultural contextual nature surrounding George Floyd, and by extension, his autopsy, I will work towards accounting for the uncertainty produced in the Voyant Tools analysis. Given the controversy surrounding the incident, I relied primarily on news sources such as AP, Reuters, and The WashingtonPost. According to the Washington Post, on May 25th 2020, George Floyd was detained and subsequently pinned down for eight minutes. The officer pinned George Floyd using his knee across his upper back (Bennett, Lee, & Calhoun, 2020). According to the BBC (2020), the police were called to approach Floyd as he appeared "drunk" and tried to use counterfeit money to pay for items. Floyd was initially sitting in his car with two other individuals when police arrived on scene. After the officer took Floyd into custody by placing handcuffs on him, a struggle ensued. During the struggle, Floyd was escorted to the ground, face down, and an officer placed his knee across Floyd's upper back and neck area.

After some time had passed, Floyd died in that position. It should be noted that my view of this incident comes from the perspective of a former Police Officer. Many departments have similar policies and procedures regarding on duty deaths. For both of my former police departments, Green Bay Police Department and Sheboygan Police department, any death of an individual under officer care, either by use of force or by other circumstances, will be treated and investigated as a homicide. In Floyd's case, his mistreatment at the hands of police officers led to a national, and even international, movement and the circumstances of his death received significant attention. The medical examiner chosen for this report was Andrew M. Baker M.D. His report was reviewed by another board certified medical examiner; Grant's report was not.

Entropy Fundamentals and Voyant Tools

Understanding the nature and magnitude of entropy in a nonlinear dynamical communicative system like that of forensic science would offer insight into not only the nature and magnitude of entropy when different fields collide, but also offer some insight into how data and information loss can be lessened. Entropy, as stated in the previous chapter, refers to the presence and magnitude of unpredictability in a communication system. The lessening of data and information loss in a now open scientific communication system becomes of particular importance when considering the broader implication of such loss. “Dispositions and trial testimony present their own special problems for the inexperienced and unsuspecting scientific expert” (Shiffman, 1999). Doing as much as possible to mitigate data and information loss on the macroscale of these nonlinear dynamical systems is vital and an understanding of the nature and magnitude of entropy can offer insight into: by how much, where, and in what ways entropy is contributing to information loss. One method that I will employ to examine this is Voyant Tools. Voyant Tools is an open-source website for the analysis of digital texts. The Voyant Tools software is used by scholars in many fields. Those working in the digital humanities use this software to engage in text analytics, and many have used it in situations involving communication studies (Sinclair & Rockwell, 2023).

Since my approach for analyzing the forensic pathology and forensic engineering reports lies at the intersection of scientific communication, math, and linguistics, I employ Voyant Tools to highlight textual instances’ peculiarity that could be entropic instances. The data visualizations produced by Voyant Tools are productive in this endeavor. These entropic instances are, I think, unpredictability inherent in the text having an effect on the readability index. The idea I would like to expand upon here is that of Shannon’s source coding theorem as it pertains to micro behaviors in a nonlinear dynamical system. In general, source coding is a theorem that Claude Shannon developed, otherwise known as the noiseless coding theorem (Shannon, 1959). This theorem is used to describe the nature of information loss when data is compressed in the entropic system Shannon articulated. Ideally, information compression would take place in a vacuum where the potential for data and information loss is otherwise mitigated; however, this is simply not the case. When compressing information, there will always be some information loss. It is the nature of this information loss for which Shannon's source coding theorem is built. It is important to note that Shannon's Source Code Theorem outlines limits of data compression in dealing with computational data storage. However, the idea that I would like to expand on here is the idea of compression of information or data regarding communication.

Terms like "information compression," while they have scientific underpinnings, also provide a useful framework for unpacking deeply conceptual ideas about the micro functions of a nonlinear chaotic dynamical system, such as human communication. Information compression is defined as reworking long strings of data and information into a more manageable, perhaps efficient, form. This concept of information compression can help us understand the encoding and decoding processes that work in these micro systems. While this dissertation is not attempting to compress language into bits of data or into binary, I will compress data from the forensic pathology and forensic engineering reports via Voyant Tools software. Though these visualizations and output will be examined in the subsequent chapters, I would like here to note here that the purpose of my compressing written communication in this way is to gather instances of what could be perceived as noise or interference, and highlighting and redefining such instances as entropy. My methodology for handling such communicative data is to first gather instances of individual peculiarities, which I understand to be forms of unpredictability. I will examine instances of such entropic elements through the data visualization. This method suggests a way by which we can measure individual entropies with regards to specific elements found in the qualitative coding analysis by seeing what data are outliers of the initial compression. Those data, possible instances of culture, or subject position, or noise, I argue, are indeed instances of entropy.

Each code that is found in the forensic pathology reports and the forensic engineering report in the subsequent chapter will be analyzed as, first, an individual artifact, then analyzed in socio-cultural and technical contexts. The data visuals produced will consist of a multitude of data points. Each datum will then be assigned an individual entropy by way of isolation and articulation. Psychologists Meng-Cheng Wang, Qiaowen Deng, Xiangyang Bi, Haosheng Ye, and Wendeng Yang, in their 2017 text, "Performance of the entropy as an index of classification accuracy in latent profile analysis: A Monte Carlo simulation study," utilize this type of method, though it should be noted that they employ this method to analyze behaviors in social and anthropological context regarding population dynamics. Second, each of those assigned entropies will be treated as individual elements in a nonlinear dynamical communicative system. This will provide some empirical insight into the nature of entropy and the role of entropy in these chaotic nonlinear dynamical systems.

Forensic Pathology and Scientific Communication

The aforementioned fields of forensic science are productive for analysis of communicative elements because of the necessity for different elements of communication. Forensic science combines elements of risk communication, scientific communication, technical communication, and medical communication. At any given stage of a criminal investigation, the articulation of these reports will differ based on context, medium, and audience. Each of these factors will impact the genre specific requirements and resulting piece of communication. In considering various factors that have an effect on a piece of communication, one can see that communicative processes are affected by noise, recast as entropy specifically. This dissertation does not focus on tangible, or feasible, ways one can mitigate entropy in a communication system; instead, it argues that these entropic instances warrant observation.

Communication in forensic pathology sits in the intersection of risk communication, scientific communication, technical communication, and even medical communication. Police communication, as a whole, is defined through the source and does encompass other important components, such as high uncertainty (Lee, 2014). In order to gain an accurate understanding of the needs of scientific communication about forensic pathology and forensic engineering, I will define the different fields of communication as well as some components present in most models of communication such as entropy, noise, encoding and decoding. In general, I tend to draw a distinction between scientific communication, technical communication, risk communication, and medical communication. I will also consider the root of these communication models as Shannon and Weaver's model of information theory. It is important to draw a distinction between the models of communication because the field will dictate what elements are present.

For this dissertation, communication is considered a four-component system in which there is a sender, a receiver, a message, and the atmosphere. The deficit model, though very common in scientific communication, requires dialogue in order for two-way communication to happen and thus make the actual communication more productive. I understand noise in a communication system to mean the external factors that cause issues with the encoding and decoding process between the sender and receiver. Entropy, on the other hand, is a measure of randomness in a communication system. The more randomness, or entropy, in a closed communication system, the more potential for issues with encoding and decoding. Shannon and Weaver's (1948) model of communication, which serves as a guide for analysis, is a mathematical explanation of human communication: described as the "transmission model of communication." One particular critique of this model is that it is linear, while human communication is not.

Additionally, Weaver and Shannon wanted to address three particular issues of communication with this model, as described by communication professor I.A.S. Buarqoub: the technical problem of accuracy of the message, the semantic problem of precision of language, and the effectiveness of decoding other messages received (Buarqoub, 2019). While the Transmission model has flaws when trying to apply it to written communication, this model offers a productive base for building other conceptual models. Scientific communication concerns itself with educating and informing, usually the public, about scientific discoveries, topics, and complex scientific issues. The science of science communication examines how exactly this happens. Scientific communication by virtue of its engagement with the public, necessitates or warrants a participatory element. Technical communication broadly concerns itself primarily with properly transmitting information, usually in professional contexts. Medical communication concerns itself with communication with the public about health and associated choices in addition to doctor patient communication. According to legal medicine scholars C.P. Campobasso and F. Introna, in their 2001 text "The forensic entomologist in the context of the forensic pathologist's role," the goal of articulating uncertainties in death investigations, regarding forensic pathology, is to preserve credibility in the eyes of the court, judge, and jury, and to mitigate the potential for the defense to call into question the validity of the rigor with which that investigation was carried out (Campobasso & Introna, 2001).

Trust, likewise, is central to understanding scientific communication. Andrea Retzbach and Michaela Maier, in their 2015 text, "Communicating scientific uncertainty: Media effects on public engagement with science," "aim to experimentally investigate how the presentation of scientific uncertainty in media reports on nanotechnology influences central elements of *Public Engagement with Science*, namely in the interest in science and technology, *belief* about science, and *trust* in scientists" (Retzbach & Mair, 2015). What this speaks to is credibility yet again, leading, in our case, to the doubled importance of trust in the forensic scientists and their processes. Forensic science, considered through scientific and technical communication, operates on a different level of interaction with the public, one that is two fold. One, forensic scientific communication interacts with the jury members, though indirectly because that is the job of the prosecutor. While the medical examiner or forensic scientist may be called to testify as a subject matter expert, there is still a level of trust needed in the forensic scientist. The second level of interaction occurs when the investigation has concluded, and the details are released to the public or made available in the public record.

Forensic science also indicates some limits of scientific communication. Retzbach and Maier go on to argue,"The term *public understanding of science* is often referred to as *public engagement with science"* due to the general public paying attention to scientific decisions being based on "controversial evidence" (Retzbach et al., 2016, pp. 639). It is valid, in the broader scientific communication community that public engagement is expected, it is wanted and necessary as well as invited. However, for forensic science, especially with cases dealing with death, these scientific communication processes are not expected, or wanted because that interaction with the public increases the chances that an investigation could be tainted. In the broader scientific communication community, the public's engagement with the scientific material or even a scientific artifact, is integral, it is necessary in order to facilitate and foster learning about science. However, forensic science has different goals, different objectives, all dealing primarily with law, methodological integrity, and objectivity. Let us consider the implications of communicating scientific uncertainty regarding forensic science. Broadly, scientific uncertainties may imply that the underlying science is invalid, even if that is not the case. Those working in forensic science have to maintain a balance when articulating uncertainties due to the nature of trials and investigations; the repercussions can be significant. Conceptual models of scientific communication, specifically my model of scientific communication that places entropy at the center, have a more accurate account for data loss and information loss in a communicative system.

Where scientific communication regarding forensic science diverges is in terms of intent or goals. Melvin A. Shiffman, in the edited 1999 book *Ethics in forensic science and medicine: guidelines for the forensic expert and the attorney,* states, “the attorney utilizes and depends upon the expert witness in many instances to establish various aspects of a legal matter” (Shiffman, 1999). This relates primarily to testimony of an expert witness, which in this case is the forensic pathologist or the medical examiner. It is within this stage that the otherwise closed communication system becomes open. This is where information and data loss due to entropy are apparent and have an immediate effect. Moreover, we can observe more directly the magnitude and nature of entropy at this stage. Shiffman goes on to state, “the honesty and integrity of the forensic expert is an uncontrolled parameter in the field of litigation. The individual expert testimony, extricate the facts, and come to opinions which are logical, truthful, and untainted by even a hint of bias. Dealing with those involved in the process of utilizing an expert should be above board and the forensic scientist must not be swayed to stretch the truth” (1999). There are a significant number of other factors that are outside of the communication system that have an effect on the amount of data and information loss.

While this dissertation proposes an entropic model of scientific communication at the level of public reports, courtroom elements do warrant mention, as they have an impact on scientific communication models in terms of which model would be the most appropriate to deploy in situations that account for human emotion and ethos more than a strict deficit model where one merely outlines a scientific matter.

Let us take a closer look into the actual role of the forensic scientists in this section, as I see their role as a type of opinion leader. "Physicians and forensic scientists whose professional endeavors bring them into the legal arena-voluntarily or unsolicited, happily or resigned-must come to realize that they are playing by a different set of rules, in an unfamiliar forum, and with people who may not show the respect and deference they are accustomed to in their own professional milieus" (Shiffman, 1999). The forensic pathologist is a medical doctor who can act as an opinion leader in a way, except what testimony they offer is not presented as an opinion, but a well founded scientific fact. This parallel is important because it demonstrates how much influence a forensic scientist has, though unlike the opinion leaders Paul Lazarsfeld and colleagues described in their two step flow communication model (Katz & Lazarsfeld, 2017). This particular type of opinion leader is buttressed by expectations of scientific method and has an audience that is amenable to that conversation.

Expertise is paramount in this situation. "The forensic expert is a person who, by reason of knowledge, education, training, skill, or experience, is capable of enlightening and assisting the fact finder (judge and jury) in resolving factual issues in a particular legal matter. In order to be accepted as an expert, the court must establish that an individual fits the criteria and qualifications of one who is capable in the specific area of expertise necessary" (Shiffman, 1999). The forensic expert sits as a communicative expert; they sit at the intersection of different communicative challenges and have to navigate and negotiate different communication models within not only a single setting, usually court, but also in one primary document: the report. Forensic reports provide the focus of the case studies in this chapter and a subsequent chapter.

The forensic pathology analysis reports, more commonly referred to as the autopsy, operate in specific ways. In addition to the facts presented, they can also offer opinion by virtue of their inherent ethos, as within the courtroom, the forensic scientist is able to offer alternate testimony outside of facts found in their pathological, or engineering investigation. "The forensic expert is an individual who, in matters of litigation, can explain to lay persons, in example, the court and jury, a complicated specialized subject, and make it readily understandable to the average non-medical individual. By doing so, the forensic expert expands and defines to the layperson scientific medical terms critical in adjudicating conflicting opinions" (Shiffman, 1999). In a trial or court setting, the forensic scientist will have the job of exploring either their findings or some other forensic subject matter that requires an ideally simple explanation given by a subject matter expert. Moreover, the forensic pathologist specifically has to explain the medical aspects of a case including diagnoses, autospies, varying or competing medical explanations. "An expert is usually used both by plaintiff and defense, to help the attorney understand and adequate evaluate issues and, more importantly, to impart these complex issues, their interpretations and an opinion to the trier of fact (judge and jury) in an objective, comprehensive, yet simple manner so as to be understandable by a "lay audience" (judge and/or jury)" (Shiffman, 1999).

Autopsy Overview

In reviewing this autopsy, I considered that the surrounding controversies might impact the pathology report. The controversy surrounding John Grant's execution was that his death was due to Grant aspirating on vomit during the injection, thus contributing to his death. It should be noted that the medical examiner did find that the cause of death was still the result of lethal injection and not aspirating (Shelton, 2021). This death, while still controversial to some, did not receive as much media attention as Floyd's death. That is not to suggest that there are no external socio-cultural factors that could have had an impact on the pathology report. I would however suggest that due to the smaller amount of media attention, the unpredictability of the text was not as high as that of Floyd's report. This is due to the target audience of Grant's report is the same as the intended audience whereas Floyd's report reached multiple, unintended audiences which heightened textual unpredictability, that resulted in the relatively low readability score having more of an impact, thus making Floyd's report have a slightly higher entropy than Grant's.

To that end, I found that George Floyd's autopsy report had a total of 579 total words, 320 unique words and word forms, with an average of 13.5 words per sentence.

John Grant's death, and by extension autopsy, was not surrounded by as much controversy, though its availability is connected to its role in national debates regarding the death penalty. Specifically, the article from the "Death Penalty Information Center" outlines the details of Grant's death. Grant was a death row inmate who died by lethal injection in October of 2021 (Death Penalty Information Center, 2022). According to Oklahoma state officials, the lethal injection was standard and without complications (Wilson, 2022). The associated death required an autopsy because it was a state sanctioned death by lethal injection. In Grant's case, the medical examiner was Jeremy Shelton M.D. (Wilson, 2022).

This contextual element seemed to show in the final results of the Voyant Tools analysis. Grant's autopsy has a total of 3,616 words, 1,159 unique words and word forms, and an average of 15.7 words per sentence (Sinclair & Rockwell, 2023). From the general summary of words, unique words, and total words used in both Floyd's report and Grant's report, it would appear that there is a significant document density difference. However, I am uncomfortable speculating about the cause of the discrepancies between documents.

There is not enough data to suggest that the turbulent and controversial contextual nature surrounding Floyd's death and subsequent pathology report was the result of such controversies. Rather, I would like to highlight that the readability index for both Floyd's report and Grant's report were similar. A readability index is how easy or difficult a text is to read. Floyd's readability index was 13.759 and Grant's readability index was 13.703. According to linguists Zamanian and Heydari (2012) in their text "Readability of Texts: State of the Art," a readability index that is considered good is around 60-70 . What can then be inferred is that both reports have a low or “bad” readability index. I attribute this to the level of complex medical terms and specialized jargon present in these reports. This word analysis includes articles and definite articles as well as measurements and medical adjectives. That is to say, there is nothing eliminated, or no words that can be eliminated as they could be perceived as noise or interference.

I would like to examine insights that can be derived from Floyd’s and Grant’s Cirrus word clouds. This image is below. The word cloud provides an overview of content and frequency of terms included in the reports (Sinclair & Rockwell, 2023).

Figure 2. George Floyd Word Cloud Produced Using Voyant Tools.

The two Word Clouds show striking differences in not only size, but also in the frequency of terms that appear. The difference in size is clearly the result of Floyd's autopsy report having only 579 total words and Grant's autopsy report having 3,616 words. The most frequently appearing word in Floyd's report was "injuries." "Injuries" appeared 10 times in his report, whereas "left" was the word that appeared most frequently in Grant's autopsy, 49 times (Shelton, 2021). In Floyd's autopsy report, the term "injury" peaks in the first segment of the report, then it does not appear any time thereafter. In Grant's article, the term "left" appears in nearly equal measure throughout the report. In Floyd's report, there is only one phrase in which the word "injuries" appears, that is, "injuries of the." In Grant's report, there are several phrases in which the word "left" appears: "left antecubital fossa venipuncture site", "left anterior descending coronary artery", "left fossa venipuncture", 'left anterior descending coronary" and "left thoracic musculature" (Shelton, 2021). There appears to be a difference in descriptive terms here. For Floyd's report the term "injury" is a productive descriptor; however, it is used in the most general sense.

In Grant's report, "left" appears in high frequency in medically significant descriptive phrases. I would like to highlight the readability index again here. Readability was relatively low for both reports. The question I have at this point is if the readability is low because of medical jargon or if it is low because of some underlying contextual structure of the report itself. I would say that regardless of the cause of readability score, it seems to gesture towards some type of interference. That is to say, between the readability scores being low and after examining some of the phrases in which the most commonly occurring words being used appears, this would suggest that there is a loss of information for the person receiving the information. In information theory, as discussed in previous chapters, loss of information in a communication system suggests noise or interference.

While initially, I thought of the instances of noise as perhaps a positive force, through my analysis I am finding that these instances of noise are counterproductive for the communicative system as a whole. That is, they contribute to the loss of information. Here, it is important to note that noise in this particular communication could also come from the unpredictability of a text. The heightened unpredictability of a scientific text increases the entropy. Within the context of the most frequently appearing words in Floyd's and Grant's autopsy report, the uncertainty, or entropy, seems to enter into the communicative system fairly early in the report and at a high frequency. The entropic element of the word "injuries" in Floyd's report could be due to the rather controversial context surrounding Floyd's death. That is to say, when the general public reads Floyd's autopsy report, there is an underlying context that adds a level of uncertainty due to the nature of his death and the associated feelings surrounding it.

Floyd and Grant TermBerries and Trends

To offer further context for Grant's autopsy, John Grant was a convicted felon who received the death sentence. This report details the cause of Grant's death as government sanctioned lethal injection. While there is some controversy surrounding this method of execution, the general population was not as invested in this autopsy report as they were with Floyd's. This is demonstrated by the amount of news coverage and internet search results. The search for news articles regarding the search terms "Floyd" or "George Floyd " yields 1,570 news articles on Google and over seven million general search results. For Grant, the search term "John Grant Autopsy" yields 596 news articles and a little over four million general search results. Floyd's autopsy report proved an official cause of death in which not only the judicial and legal system was interested but, the general population who had been following the news was interested.

Grant's low readability index score and the phrases in which the most frequently occurring word appears suggest that there is still a loss of information due to entropy in these communication systems. However, that loss of information comes from the uncertainty surrounding the technical, medical jargon. None of my previous analysis is to suggest that there is an overt bias in Floyd's report, or suggest that there is an intentional omission of technical jargon for malicious purposes. Instead, it could suggest information being modified to account for the deployment of information. That is to say, due to the surrounding nature and context of Floyd's death, it could be assumed that the medical examiner knew of the potential for this report to have a massive dissemination, and perhaps accounted for that factor. The textual anomalies and by extension instances of entropy, can be attributed to the reception and perception from the receiver's end.

I would like to move on to the second visualization, the "TermsBerry" (Sinclair & Rockwell, 2023). Floyd's and Grant's TermsBerry are the figures below.

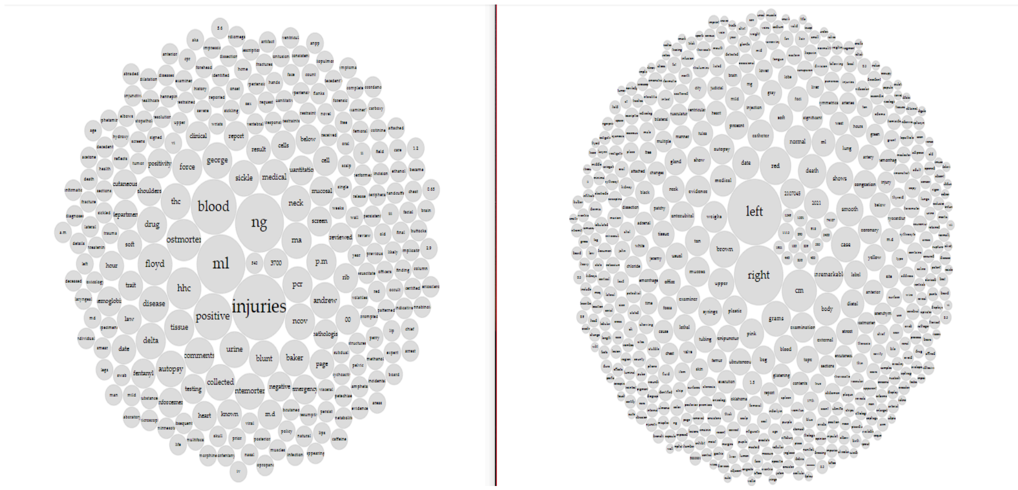

Figure 3. Floyd & Grant TermsBerry Produced Using Voyant Tools.

The TermsBerry is similar to the corpus word cloud in terms of scaling the frequency of most commonly used words. Where the TermsBerry and corpus word cloud differs is in terms of what is being conveyed. The TermsBerry shows not only the frequency of terms being used, it shows the context in which the terms co-occur (Sinclair & Rockwell, 2023). The TermsBerry demonstrates the relative proximities of the words being used. I want to highlight this particular visualization because it better contextualizes articles, definite articles, conjunctions, and other words that could be misinterpreted as noise, or even a type of interference. Previously, I briefly mentioned eliminating words that are noise. In police communication, these types of noisy words that muddle the final message conveyed are ones which some might seek to eliminate in an effort to gain some control of unpredictability in a communicative system. This would result in lowering the overall entropy in this communication system. An example of this is a standard in police report writing. In the police academy, as well as in my previous two police departments, the

Green Bay Police Department and the Sheboygan Police Department, it is a genre convention and even requirement to eliminate such words, as they are thought to contribute to information loss. I understand these types of words to be a type of entropy. That is, they contribute to uncertainty in a communication system on the level of adding grammatically necessary but contextually unnecessary information.

The next visualization that I would like to highlight is a line plot of the trends in each autopsy report which are in the figure below.

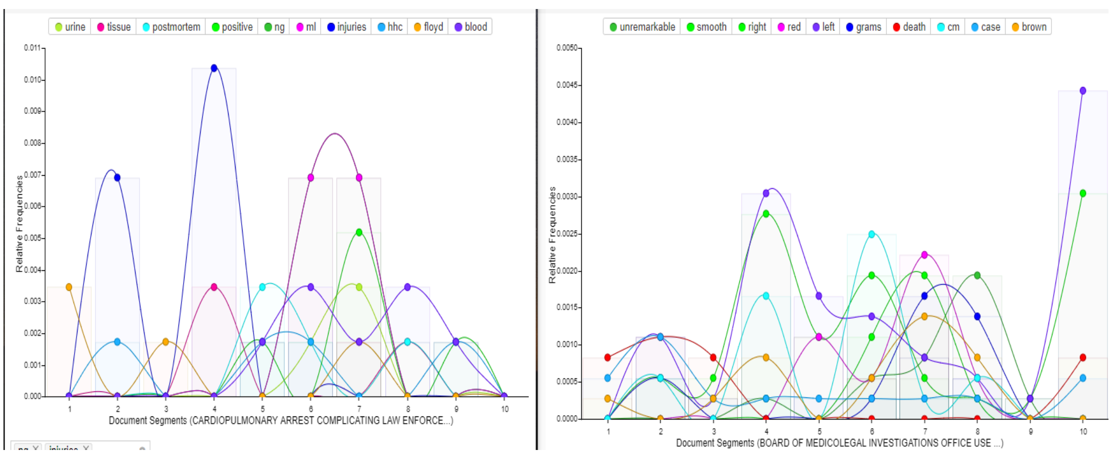

Figure 4. Floyd & Grant Trends Produced Using Voyant Tools.

The Trends is a visualization that shows the frequency in which terms appear throughout the document (Sinclair & Rockwell, 2023). The graphs in the figure above show not only the frequency of but also the distribution of terms across the document. The one on the left is a graph of Floyd’s word trends; the graph on the right is Grant's. Each point and line on the graph has a color that correlates with a term; the key for the color is located at the top of the graph. The x-axis is dedicated to the segments of the documents ranging from one to ten. The y-axis is the number of frequencies. The words included in the graph are limited to the top ten terms appearing in each document. It should be noted that the words included do not exclude units of measurements. The top ten words in Floyd's report are: injuries, urine, tissue, postmortem, positive, ng, ml, hhc, Floyd, and blood. The top ten terms in Grant's report are: unremarkable, smooth, right, red, left, grams, cm, case, and brown. Similar to the terms corpus, there is a difference in the descriptive words used in each.

It should be noted that some of these differences could be attributed to the writing style of the medical examiners themselves. As with any written piece of communication, the composer of said communication will write based on subject position, training, experience, and the moral economies they find themselves in. Not knowing the aforementioned elements for the respective medical examiners, I can only assume that their subject position, experiences, and moral economies are different. To that end, the contexts in which they performed the examinations and wrote the subsequent report differed wildly. It could also be, again, the socio-cultural context surrounding these deaths. That is to suggest that even those writing an "objective" scientific report, that is supposed to be as formulaic as a forensic pathology report, is still influenced by surrounding controversies. What I would like to highlight here is the distribution of terms across segments of each document. Floyd's distribution of terms tends to peak around the seventh, fourth and sixth segments of the documents, with a decline in the ending segments of the document. Grant's distribution of terms appears to be more even across segments of the documents.

It should be noted that “segments" are created by Voyant Tools as a way of dividing the document into equal parts. They correspond to the beginning, middle, and end of a document. Given that information, the graphs for Grant and Floyd’s autopsies show that the distribution of most commonly used terms vary. Given what is known about the readability index, one might assume that a more equal distribution of terms across a document would make the readability index higher. And a higher distribution of terms in the earlier segments in a document would suggest a lower readability due to an overload of information at the beginning of a document. However, the graphs do not seem to suggest this type of relationship between distribution across segments and the readability index score. The Trends graph suggests a different type of entropy that does not correlate with word choice, noise, or interference. Instead, the entropic element I see in these graphs is on the level of document structure and organization. Floyd’s distribution of terms across document segments seems to suggest a higher entropy than Grant’s because of the uneven distribution of terms across segments. The reason being is the underlying structure of the document in addition to the even or uneven distribution of words cross document segments add to a level or predictability. Since Floyd’s report has a relatively uneven distribution, that would then suggest a higher unpredictability towards the end of the document – and thus a somewhat higher entropy.

Rhetorical Situation(s)

The underlying structure has an effect on the predictability of a text. I want to consider, more in depth, how the rhetorical situation can also have an impact on that structure. In the text “Expert knowledge as a Condition of the Rhetorical Situation in Criminal Cases” (2017), Friis and Astrom consider the rhetorical situation as it relates to 150 court cases. Friis and Astrom assert that criminal situations must be reconstructed to include exigence (Friis & Astrom, 2017, pp.28). Both Floyd’s and Grant's cases were criminal, at least at one point in the process. However, within the genre of forensic pathology reports, the exigence comes well before the composition of the document. In fact, I would argue that the exigence in forensic pathology is the rhetorical context, not merely a predecessor. Floyd’s autopsy report is of particular interest in thinking about exigence and rhetorical situations. The family of George Floyd hired their own Medical Examiner to carry out a separate autopsy examination. This was done by Dr. Michael Baden and Dr. Allecia Wilson. They concluded that the cause of death was “traumatic asphyxia due to the compression of his neck and back during the restraint by police " (Baden & Wilson, 2020). Please note that I was unable to obtain a copy of this report; however, there is a summation of it located on the Minnesota Judicial Branch (mncourts.gov) website. This additional context adds to the consideration of the rhetorical situation because it is the court case itself that serves as a rhetorical activity (Friis & Astrom, 2017, pp.28). The rhetorical situation between the two versions of Floyd’s autopsy reports vary. However, each situation is dictated by the audience, in this case the judge, jury, defense attorneys, and prosecutors.

The autopsy reports act as rhetor, the performer, in the adversarial court setting. Whether or no that performance succeeds or fails is based upon the audience. It is difficult to say if the readability index contributed to Baker's official autopsy report had an impact on its failure without having seen Baden and Wilson's report. However, based on the very brief description of Floyd's death as it appears in their report suggests that it would be more accessible. Perhaps it's written in a more similar form that has a higher predictability for an audience of lay people outside of the medical and legal system. Perhaps, that higher predictability made for a higher readability index which made for that report succeeding in its appeal to that audience. This, of course, is all merely conjecture based on the limited information available regarding Baden and Wilson's report.

Connecting Genre and Unpredictability

Within these nonlinear, dynamical, communicative systems, I see data as indicators of entropy. Within this context, these individual data points are the grammatical leaks produced in a communicative system. These indicators of entropy can be graphemes or entire phrases. My explanation demonstrates different methods in topic modeling, data visualization, and how data from language can be measured. For Claude Shannon, the source of the information is the core of what information must be decoded (1964). This is why I think it is of particular importance to look at the microscopic elements for a communicative system in order to arrive at a specific model of communication for forensic pathology and forensic engineering.

Peter Manning in his classic 1988 text, *Symbolic Communication: Signifying Calls and the Police Response*, states the following, "police face a communication problem: how to anticipate, respond to, mediate, and filter rising citizen demand, with a controlled, calculated strategy" (Manning, 1988). It should be noted that while this text is not recent, speaking from my professional experience, police communication still faces the same issue. What's interesting here is there is a form of police communication that is more reactive in that its genre calls for the incident to happen and the resulting report "to anticipate, respond to, mediate[…]citizen demand" that is done in a way that is controlled; that is the police report, and its variation, the forensic reports. Manning (1988) states the following, "police forces are based on complex communication systems, and are dramatic, quasi judicial organizations structured to allocate and deploy officers across time and space" (Manning, 1988). At the tail end of police communication, reports are generated that are available to the public, and they are highly structured, per genre requirements. That does not suggest that there is no information loss in these communication systems; however, the information is so structured, the potential for information loss is minimized. Manning states the following, "the set of messages emitted by citizens, seen as a secure or a socially organized network, is characterized by high entropy" (Manning, 1998). High entropy correlates with an inherent disorganization that can stem from messages disseminated in a large social context by various actors.

This is due to the relatively unpredictable way some might decode the message as well as the lack of structure of a message.

On the other hand, highly organized communication that comes from a singular source, like the reports produced after a law enforcement event, are highly predictable, due to the restricted and explicit nature of the communication. Manning asserts that problems arise with how the participants are oriented to the message (Manning, 1988). The orientation to a message is integral for considering the role of entropy because it is a highly dynamic, situation dependent, factor. For Manning, at one level messages contain "bits" of information or "syntagms" that can be organized as to salience and connections made with bits of information in that message or another (Manning, 1988). In the chapter following, I will examine syntagms drawn from forensic engineering, while keeping in mind how genres also emerge from considerations of entropy.

The next visualization that I would like to examine is the "Bubblelines." Bubblelines shows the frequency as well as the repetition of terms present in a document (Sinclair & Rockwell, 2023).

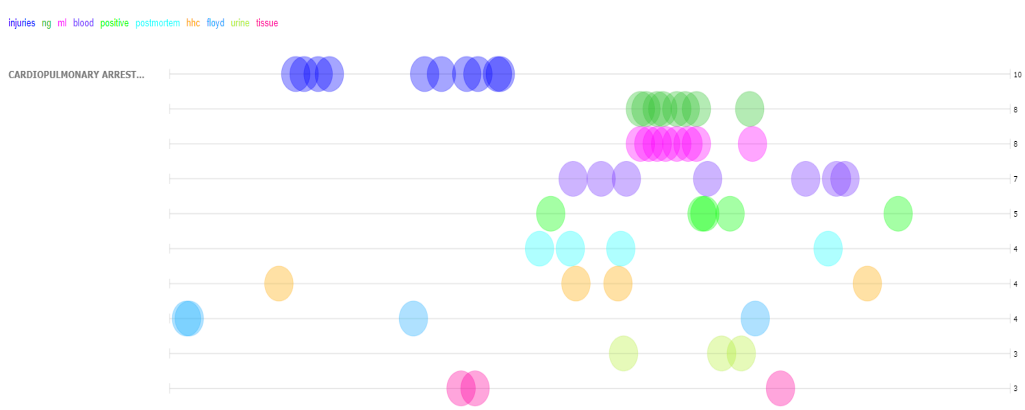

Figure 5. Floyd Bubblelines Produced Using Voyant Tools.

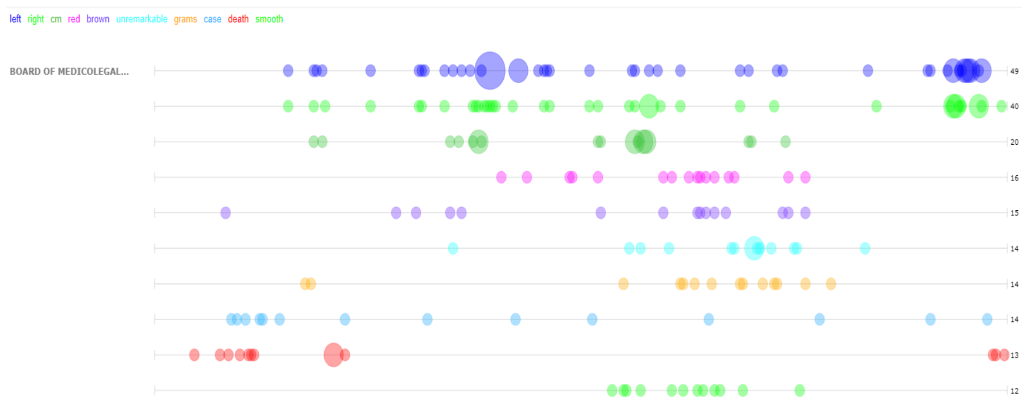

Figure 6. Grant Bubblelines Produced Using Voyant Tools.

In Bubblelines visualizations, each document is represented by its own line. Each of the top words are represented by a bubble of varying size and color. The size of the bubble correlates with how frequently it appears in the document. This tool, among the other visualizations offered by Voyant Tools, is useful in analyzing text entropy. What I would like to highlight with the Bubblelines is the context and correlations that it highlights. There are two aspects that make up the Bubblines visualizations, the first one being context, and the second one being correlations. Within Voyant Tools, context is an analysis that separates keywords into three categories: Left, Term, and Right. The category “left” is the contextual words appearing to the left of the key words. The category “Term” is for the keywords matching the default user-provided term query. “Right" is the contextual words appearing to the right of a keyword (Sinclair & Rockwell, 2023). The correlations aspect of the Bubblelines visualization I would like to highlight is the variation in frequency between Bubblelines. Floyd’s Bubblines vary in where and by how much the top word frequencies appear throughout the document. Grant's Bubblelines show a more steady and even distribution and frequency of words throughout the document. What this suggests is that an internal entropy is greater in Floyd's pathology report than Grant's. Context in Voyant Tools refers to the occurrence of each keyword with the ten surrounding terms to the left and to the right of the key term (Sinclair & Rockwell, 2023). Floyd and Grant's context tables are the two figures below.

Contexts | Bubblelines | Correlations ?

	Document	Left	Term ↑	Right
⊞	CARDI...	20; 9:25 a.m. PATHOLOGIST: ...	injuries	A. Cutaneous blunt force injuries of the forehead, face, and upper lip B. Mucosal injuries of the ...
⊞	CARDI...	Andrew M. Baker, M.D. FINAL ...	injuries	of the forehead, face, and upper lip B. Mucosal injuries of the lips C. Cutaneous blunt force inju...
⊞	CARDI...	who became unresponsive whi...	injuries	of the lips C. Cutaneous blunt force injuries of the shoulders, hands, elbows, and legs D. Patter...
⊞	CARDI...	enforcement officers; he receiv...	injuries	of the shoulders, hands, elbows, and legs D. Patterned contusions (in some areas abraded) of ...
⊞	CARDI...	the wrists, consistent with restr...	injuries	identified A. No facial, oral mucosal, or conjunctival petechiae B. No injuries of anterior muscle...
⊞	CARDI...	disease, multifocal, severe B. ...	injuries	of anterior muscles of neck or laryngeal structures C. No scalp soft tissue, skull, or brain injurie...
⊞	CARDI...	history of hypertension C. Left ...	injuries	D. No chest wall soft tissue injuries, rib fractures (other than a single rib fracture from CPR), ve...

Figure 7. Floyd Context Table Produced Using Voyant Tools.

Contexts | Bubblelines | Correlations ?

	Document	Left	Term ↑	Right
⊞	BOARD...	By Authority for Autopsy FINGERPRINT COMP...	left	antecubital fossae venipuncture sites demonstrate intraluminal catheter pla...
⊞	BOARD...	combined lung weight, 1390 grams) with edem...	left	ventricular hype1trophy (1.5 cm), right atrioventricular dilatation, and histol...
⊞	BOARD...	disease A. Mild cardiomegaly (440 grams) with...	left	anterior descending artery; 20-30% stenosis ofright coronary artery C. Aorti...
⊞	BOARD...	B. Atherosclerotic coronary artery disease: 70-8...	left	femur (6.5 cm in greatest dimension) VI. Non-lethal injuries: abrasion of rig...
⊞	BOARD...	Division, Tulsa, Oklahoma. Blue seal #1806609...	left	femoral vasculature on 10/28/2021 at 1922 hours and 1926 hours, respectiv...
⊞	BOARD...	very short length, and shows frontal balding. Th...	left	bulbar conjunctivae, and multiple petechial hemorrhages of the right and left...
⊞	BOARD...	white stubble in a beard and mustache distribllt...	left	bulbar and palpebral conjunctivae. The corneas are transparent. The pupils ...

Figure 8. Grant Context Table Produced Using Voyant Tools.

The Context tables isolate the top ten terms that appeared in the report. The Contexts appear in order, in the frequency in which they appear. In Floyd's report, "injuries" is the most frequent, appearing ten times. Some key contexts in Floyd's report regarding the keyword “injuries" are the appearance of the word in the first two segments of the document, then not appearing once throughout the rest of the document. The context in which the words appear still does not offer any socio-cultural insight into the mechanism of injury. For instance, “injuries” appears in the context “blunt force injuries" first, then “cutaneous blunt force injuries of the forehead, face and upper lip.” In Grant’s context, the word “left” is first as it appears to be the most frequent. “Left” appears frequently throughout the document and is relatively evenly distributed through the segments of the document, with an uptick toward the last segment of the document. Similar to Floyd’s report, the appearance of “left” does not provide socio-cultural clues or significance; however, unlike the use of “injuries” in Floyd’s, “left” is far more descriptive. Given that Grant’s document is more than twice as long as Floyd’s it would appear that the context for each of the top terms has a direct correlation with how much context is offered. Context adds a level of structural clarity that seems to, at least on the surface, mitigate unpredictability.

As discussed above, Grant's report contains all sections that are required as well as not required in autopsy reports. Such sections, for instance, were outlined by Wyatt and Wyatt (2011). Floyd’s autopsy report is far less detailed and does not have several sections listed in the genre- specific conventions of a forensic pathology report. These sections included: Opinions, preliminary cause of death, Jurisdiction of the medical examiner, and the specificities of the event leading to the death. Grant’s entire autopsy report adheres to textbook genre conventions outlined by the *Oxford Handbook of Forensic Medicine*. Floyd’s report has peculiarities in the articulations of the cause of death in the beginning. For instance, the report says the following “46-year-old male became unresponsive while being restrained by law enforcement officers; he received emergency medical care in the field and subsequently in the Hennepin HealthCare Emergency Department, could not be resuscitated” (Baker, 2020). It is genre convention to specifically and explicitly list a cause of death in addition to the opinion of the cause of death and rationale for such opinion. Floyd’s report does not do any of that.

As mentioned above there were other peculiarities in Floyd’s report in addition to the lack of sections present in autopsy reports. That is, there is a section that discusses the structure of Floyd’s blood cells that is longer than the description of death. This is odd because it adds nothing to the cause of death. In Grant's report, not only is a statement of an explicit cause of death listed in the beginning of “lethal injection,” it is later restored at the end of the report. That is then followed by a section titled “opinions” where the rationale for such findings are articulated. Not only is Grant’s Autopsy more textbook in terms of adhering to the prescribed genre conventions, it is also far more detailed than Floyd’s. While the reasons behind these peculiarities are speculative, it is undeniable that the differences are significant and noticeable. These oddities and differences between reports suggest that in a field where genre conventions are rarely deviated from, when it happens, it is likely due to external socio-cultural events. To further illustrate this point, the next chapter will examine a forensic engineering report that adheres to the strict genre conventions in the same way that Grant’s report does. Lastly, it should be noted that the following engineering report is embedded in a less extreme socio-cultural context.

Chapter 3: Analysis of A Forensic Engineering and Report.

Forensic engineers, even beyond the courtroom, handle similar situations. Randall Noon, in his text *Forensic engineering investigation* (2001) states, “forensic engineering is the application of engineering principles and methodologies to answer questions of fact. These questions of fact are usually associated with accidents, crimes, catastrophic events, degradation of property, and various types of failures” (Noon, 2001). That is to say, essentially a forensic engineer is tasked with assessing what was there before the collision or event, and the condition it was in prior to the event. Additionally, they have to assess what is present after the event, and in what condition it is in: hypothesizing plausible ways in which pre-event conditions can become the post-event conditions. They have to apply engineering knowledge and skill to relate the various facts and evidence into a cohesive scenario of how the event may have occurred, then go further to articulate it in a manner that is digestible to various audiences (Noon, 2001).

The assessment that is produced by a Forensic Engineer, as with all composers of a text, will be impacted by their subject portions. Such positioning suggests that each individual is embedded in a socio-cultural fabric that has an impact on encoding and decoding information. In the chapters preceding this, I suggested that Daston’s conception of a moral economy of science was fighting for understanding the subject positions and embeddedness of an individual working in forensic science and law enforcement. Carrier (2018) in his article, “Moral economy: What’s in a name” suggests that it is important to articulate a more precise definition of moral economies. Carrier describes a moral economy as a context for "economic activity and those that arise from the activity itself' (Carrier, 2018). What's interesting here is that both Carrier and Daston utilize "economies" as describing a system with shared norms (Daston, 1995). I would go as far to suggest that the way in which the word "economies" is conceptualized suggests a type of genre itself. When I think about a moral economy of police science, I think of a set of norms that are "affect saturated" (Daston, 1995, pp.4). That is to say a moral economy of police science suggests a genre specific set of norms that are impacted by surrounding values. Such values and genres are in a reciprocal relationship with each other.

Theoretical Underpinnings

Bearing in mind Ospanova's "synergistic theory of communication," I will shift focus to a specific forensic engineering report (Ospanova, 2013). Forensic engineering broadly refers to accident reconstruction. The text "Forensic engineering" by civil engineering professor Carper (2001) discusses different aspects of forensic engineering. The primary goal of forensic engineering reports is to detail the cause and mechanisms of the accident to be prepared in a report for legal testimony (Carper, 2001). Similar to the Medical Examiner (ME), the Forensic Engineer (FE) is expected to articulate their opinion of what occurred during the incident. The reason that an accident might require a reconstruction and by extension a forensic engineering report is because that incident resulted in a loss of life or lives, property damage, or the threat of litigation (Carper, 2001). The forensic engineering report that I analyzed took place in Florida: State v Norris 21-55302 CF. The report was prepared by Srinivas Kadiyala and Elliot Stern, both identified as Ph.D.s, in 2021.

The collision took place at 2:30 am on State Road 528 in Florida. Mrs. Norris was driving southbound on State Road 528 when she struck a pedestrian, Ms. Lucas. Ms. Lucas died as a result of the collision. Kadiyala and Stern gathered the following information for the report: homicide photos, scene photos, vehicle photos, autopsy photos, physical evidence, sworn interview of Michel Baker, sworn interview of Gary Horton, scene mapping, measurements, evidence markers, body cam footage, and images of the vehicle. The aforementioned sworn interviewees are not mentioned again through the report. The medical examiner does not state who these individuals are, however it is likely that these individuals are the names of the Police Officers who handled the initial crash scene. If cases like this go to court, sworn testimony is required of officers on scene, as their reports and testimonies are used to make judicial decisions. It should be noted that there are no sidewalks or crosswalks on this road in which Ms. Lucas was walking. Mrs. Norris said that she had not seen anyone walking, and it felt as if her "windshield exploded" (Kadiyala & Stern, 2021).

There are several major parts of this report. First, is the background section that outlines the basics of the incident that occurred. Second is the crash information and description. The third section is the crash dynamics analysis summary and conclusion. The pages following are dedicated to figures and diagrams of the collision and scene. I would like to reiterate that it is productive to view a written communication system in terms of order and disorder as it can offer insight into what hindered the full reception of a message. Of course, without being on the direct receiving end of these forensic reports, and receiving the information through my own subject position while having a background in these fields, it would appear that for these forensic reports, entropy is low. However, when a document is in the public domain for anyone to access, especially as they offer insight into an event such as a death or a fatal car accident, the unintended, secondary audience expands almost exponentially. It should be noted that this case was not particularly out of the ordinary. The name “Stave V. Norris" is given due to the State acting as and acting on behalf of the deceased victim. In cases like these, the state, or the prosecution, will act on behalf of the victim against the defendant. Norris is the defendant, or the person responsible for the crash (Suzanna Norris).

Similar to the pathology reports in Chapter two, I see entropy as a way to describe unpredictability in a communicative system. It should be noted that to properly calculate entropy in a communication system, one must have a set of near complete distribution of textual probabilities occurring with every single letter present (Ospanova, 2013). For example, Ospanova utilizes three definitions of entropy in order to begin calculating entropy in a communication system. First is physicists Clauisius’ definition which defines entropy as proportional to the amount of associated energy in the system that cannot be converted to work (Clausius, 1867). The second definition Ospanova utilizes is physicist Boltzmann’s which states entropy is a measure of disorder, randomness, and uniformity of molecular systems (Boltzmann, 1995). The final definition that Ospanova utilizes is

Shannon's. The definition of entropy is as follows: "a measure of information communication channel: entropy characterizes numerically the transmitted signal credibility and is used for calculating the information amount" (Shannon, 1948). In understanding these definitions of entropy, Ospanova asserts that language acts in a hierarchical manner. As such, it is necessary to define the information in these communication systems (Ospanova, 2013).

In such a definition, one has to consider letters, words, word combinations and other textual factors in order to assert the raw quantity of information (Ospanova, 2013). He goes on to state that quantifying information, down to the singular letter, offers a value equal to entropy in that system (Ospanova, 2013). Mathematicians Andreas Greven, Gerhard Keller, and Gerald Warnecke, in their edited collection *Entropy* (2003), state the following, "The concept of entropy arose in the physical sciences during the 19th century, in particular in thermodynamics and in the development of statistical physics" (Greven, Keller & Warnecke, 2003, p.1). Entropy is an important concept regarding the underlying mechanisms of scientific communication because a significant issue in any closed or open communication system is loss of information or data during articulation, dissemination, or reception of that information. Entropy is one factor that contributes to this loss. Entropy stems from probability theory and is a measure of randomness in a system. The higher the level of randomness or entropy, the more likely information will be lost or distorted, thus limiting the potentiality for a productive communicative outcome. Similar to the pathology reports in Chapter two, I see entropy as a way to describe unpredictability in a communicative system.

Unpredictability and Forensic Engineering Reports

The forensic engineering report has an inherent level of predictability, similar to other pieces of scientific and technical literature. The forensic engineering report that I am analyzing has a total of 3,238 words. Of those words, there are 1,038 unique word forms. The vocabulary density is 0.231. Vocabulary density is a measure of complexity in terms of how often certain types of words appear in a sentence. Voyant Tools note that a high vocabulary density would be 0.200 and higher (Sinclair & Rockwell, 2023). What this means is that this report has a high amount of complex words, and they are used in a lot of unique sentences. This factor alone would suggest a higher unpredictability due to the high likelihood of information loss. The readability index is 8.645. As mentioned in the previous chapter, a high readability index is 60 and above. Floyd's and Grant's forensic reports had a readability above 13; this is still very low. This forensic engineering report is even lower at 8.645. This suggests a high likelihood for entropic interference as a low readability level will impact how much information is accurately received. It was conceptualized by Shannon and Weaver that the measure of success in a communication system is partially a measure of information loss in the message conveyed and accurate reception of information by a participant in a communication system. The summation of the Voyant Tools analysis suggests with a high vocabulary density of 0.321, a low readability index of 8.645, and a high average of words per sentence being 19.4, that the likelihood of an accurate reception of information by a general audience is low. This, by extension, would suggest a high entropy in this particular communicative system.

Genre offers a framework that guides the reader through the report. These genre conventions rarely change. As a result, the reader (the primary audience) knows what to expect. A heightened predictability is impacted by the amount of context offered. In the previous chapter, Floyd’s report deviates from genre conventions which raises the unpredictability of that particular text. In opposition, Grant’s report offers far more context which results in less textual unpredictability due to the structure of the document. However, similar to Grant's report, added context requires added information; what this does is decrease the readability index due to the required jargon. Thus, on one level unpredictability due to textual elements is raised.

Let’s take a look at the Cirrus Word Cloud generated by this forensic engineering report.

Figure 9. State v Norris Word Cloud Produced Using Voyant Tools.

This word cloud contains 500 words. Here it appears that the top words appearing in this report are pedestrian, response, ft., collision, average, Impala, slide, side, mph., evidence, and analysis. The key difference between the most common words here as opposed to the most common words in Floyd's and Grant's pathology reports is the frequency of nouns, adjectives, and verbs. The pathology reports are of course more human centered, whereas the forensic engineering report is far more object and action centered. On the surface, one could assume that having a human centered inquiry as opposed to an object centered inquiry impacts entropy. It seems as if the human centered word choice of the pathology reports implies less entropy than the object and action centered words in the engineering report. This observation seems to suggest that there might be a link between how a participant relates to the text and the amount and accuracy of information received from the information. Even though each of these forensic reports have a low readability score, the pathology reports are a tad higher, possibly due to the participant being able to relate more to the human centered language used in those reports.

If we look at the terms, the figure below shows the top two terms, "pedestrian" and "ft." used in the engineering report as they relate to distribution, collocates, and phrases.

Figure 10. State v Norris Terms Table Produced Using Voyant Tools.

We can see that the correlation between those top terms and the terms in which they correlate, show a further removal of the human element. That is to say, the genre of forensic engineering reports warrant strict distancing of even human centered events such as a fatal car accident. When the relatable human element is removed from texts, it seems that information will be lost when being conveyed to the participants. This element increases entropy in a communication system. To further illustrate my point, I want to examine the TermsBerry for this forensic engineering report. The first image is the TermsBerry sorted according to distinct terms, and the second image is the TermsBerry sorted by top terms.

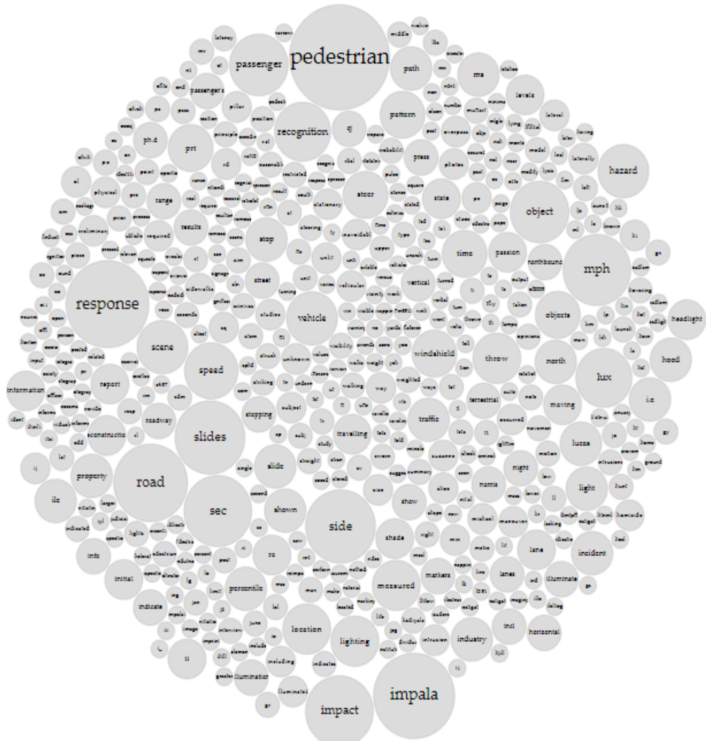

Figure 11. State v Norris Distinct TermsBerry Produced Using Voyant Tools.

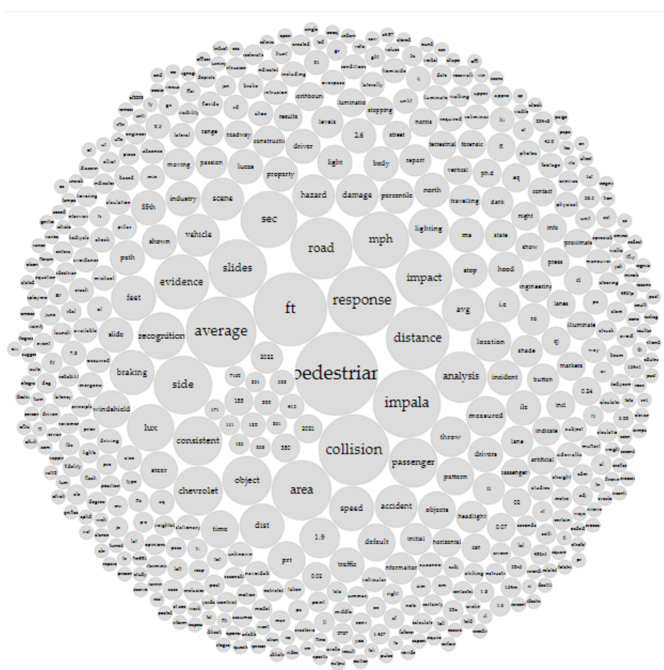

Figure 12. State v Norris Top Terms TermsBerry Produced Using Voyant Tools.

As a reminder, the TermsBerry is used to visualize how terms appear in relative proximity to each other in the document (Sinclair & Rockwell, 2023). For distinct terms, the highest frequency terms tend to spiral outward whereas the top terms appear clustered in the middle. These TermBerries help define the amount of key information in this report.

Using Shannon's formula, we could calculate text perfection. In the formula below, the key variable is "*P*" as it represents the relative probability of detecting any system unit and their magnitude (Ospanova, 2013).

$$H = -\sum_{i=1}^{N} p_i \log_2 p_i$$

Figure 13. Shannon's Formula 1963.

If we used the frequencies presented in the TermsBerry, we should be able to use that value for *P.* Such calculation would progress this text analysis closer to finding a numerical value for entropy within the forensic engineering document.

Genre and the Probabilistic Nature of Language

The Trends analysis in Voyant Tools shows a chart of relative frequencies across the report (Sinclair & Rockwell, 2023). The figure below has a color coded key at the top of the graph for the most frequently occurring terms. The y-axis shows the relative frequencies, and the x-axis shows the document segments.

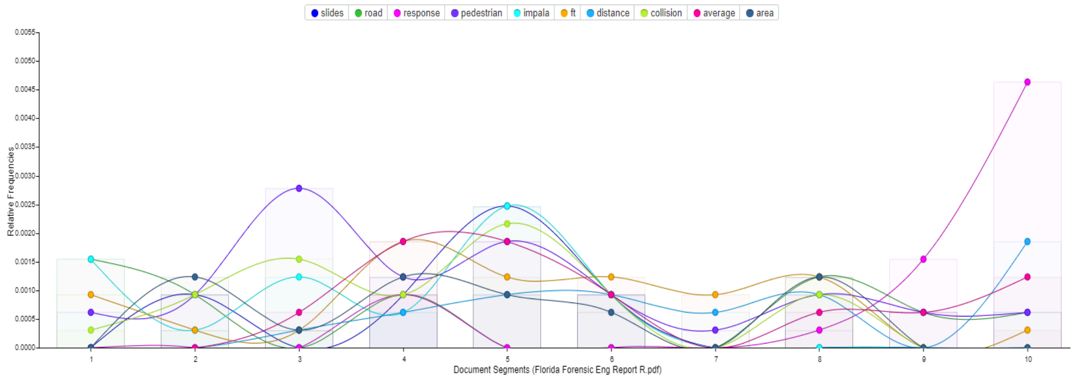

Figure 14. State v Norris Trends Graph Produced Using Voyant Tools.

It is clear from the image that the top terms are relatively evenly distributed throughout the document segments. As mentioned in the previous chapters, an even distribution of terms suggests a lower entropy resulting from the level of unpredictability of a text. That is, context contributes to the internal organization of the document, and by extension, speaks to the predictability of a document; the higher the predictability of a document, the lower the entropy. Regarding textual analysis, language entropy is probabilistic in nature. That is, it is highly dependent on an almost incomprehensible amount of factors. This is what makes it intrinsically nonlinear, dynamic, and chaotic. This is important to consider because when carrying out a textual or linguistic analysis numeral and visual calculations can only account for so much.

What's interesting in forensic engineering reports is the latter half of the report is dedicated to labeled diagrams of the accident itself. There is less need, then, to rely on words to tell a story in these types of reports. Miller discusses the idea of recurrence as it pertains to material tendencies in situational theory. She states the following “what is particularly important about rhetorical situations for a theory of genres is that they recur.[...] The existence of the recurrent provides insight into the human condition. The recurrent would lead to scientific generalizations” (Miller, 1984, pp. 156). The addition of a depiction of a material object in the engineering report adds to the primary audience’s understanding of the event/citation that had occurred.

This is a type of recurrence in which the reader is able to understand analogous situations which requires scientific generalizations. Miller notes that the material configurations of an object or event are unique from “moment to moment, and person to person” (Miller 1984). Unique forms of material configurations are perceptions, and as Miller notes, intersubjective phenomenon. The visual additions of the material word, for example, the collision, is reconstructed in a way due to the articulations of the perceptions of that event through those images. The articulation of those intersubjective phenomena are then almost rearticulated through the visulas generated by Voyant Tools. If one accepts genre working on a level of material, intersubjective, situation, then one should accept that there will be an impact on the underlying structure. This impact to the structure will, by extension, have an effect on the unpredictability of a text.

The Trends Graph illustrates the underlying dynamics of entropy in this system. The consistency of the frequency of words across segments of the document indicates a higher probability for a lower entropy. However, that lower structural entropy does not automatically indicate an overall lower entropy. The Context and Correlation analysis of the forensic engineering report are not particularly surprising considering what I have observed through the other analyses. The context analysis shows the term “pedestrian” as being a part of dense sentences, as the words to the left and to the right are fairly complex and unique. This speaks to the readability index as well as the vocabulary density. The correlations analysis, which shows the extent to which term frequencies are in sync, shows a positive significance (Sinclair & Rockwell, 2023). As a correlation value, the measure of significance is measured from .05 or less. This particular document shows a high significance for the top 1,038 words in the figure below.

Term 1	←	–	Term 2	Correlation...	Significanc...
collision			distance	0	1
fl			pedestrian	0	1
passenger's			pedestrian	0	1
area			distance	0	1
act			pedestrian	0	1
left			pedestrian	0	1
consistent			distance	0	1
approximat...			collision	0	1
7,8			distance	0	1
calculations			distance	0	1
111			distance	0	1
al			distance	0	1
calculated			distance	0	1
avoidance			impala	0.006074455	0.98671263
mph			response	0.008537901	0.98132473
1.9			road	-0.0091093...	0.9800749
certainty			response	0.011113856	0.97569144
max			response	0.011113856	0.97569144

Term 1	←	–	Term 2	Correlation...	Significanc...
collision			distance	0	1
fl			pedestrian	0	1
passenger's			pedestrian	0	1
area			distance	0	1
act			pedestrian	0	1
left			pedestrian	0	1
consistent			distance	0	1
approximat...			collision	0	1
7,8			distance	0	1
calculations			distance	0	1
111			distance	0	1
al			distance	0	1
calculated			distance	0	1
avoidance			impala	0.006074455	0.98671263
mph			response	0.008537901	0.98132473
1.9			road	-0.0091093...	0.9800749
certainty			response	0.011113856	0.97569144
max			response	0.011113856	0.97569144

Figure 15. State v Norris Correlations Produced Using Voyant Tools.

It should be noted that the measure of significance depends on the distribution of data throughout the segments of the report. The correlations are calculated by Pearson's Correlation coefficient (1928). This formula is illustrated below:

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum (x_i - \bar{x})^2 \sum (y_i - \bar{y})^2}}$$

r = correlation coefficient

x_i = values of the x-variable in a sample

$\bar{x}$ = mean of the values of the x-variable

y_i = values of the y-variable in a sample

$\bar{y}$ = mean of the values of the y-variable

Figure 16. Pearson Correlation Coefficient 1928.

I wanted to highlight this formula because it provides a way to quantify more textual elements in order to provide another variable which brings us closer to calculating entropy. Entropy within a text is difficult to pinpoint in terms of cause and magnitude. A textual analysis of a written communicative system offers insight into the complexities underpinning word choice and how such complexities impact the amount of information received from a message. In thinking about the associated numerical complexity of such information, it is productive to think about linguistic typification. Miller cites linguist M.A.K Halliday in discussing *types* of situations. Miller states “the apparently infinite number of different possibilities represents in reality a very much smaller number of general types of situations” (MIller, 1984, pp. 157). What is important here is that these situation types are the bases for meaning. The language expands as the socio-cultural context expands. This then increases the complexities of the information presented. A textual analysis using correlation coefficients could account for the semiotic variables that are impacted by the rhetorical situation.

Chapter 4: Models of Communication and the Argument for Unpredictability

Given the analysis of the forensic pathology reports and the forensic engineering reports, it is important that one understands the foundational communicative elements present in these reports. Regardless of the type of report, the goal is to convey a meaning and a message. That is to say, the rhetor must productively articulate meaning in order to communicate effectively. Communicative success refers to mitigating the amount of information that is lost through the communicative process, as philosopher Peter Pagin discusses in his text, "What is communicative success?" (2008) Further, Pagin argues for the "classical view" of communicative success. What is helpful in Pagin's text is that he delineates 'communicative success' from 'successful communication.' Pagin states the following, "first, I prefer to use the term 'communicative success' rather than 'successful communication', since it helps us focus on the question of success conditions, given background ideas of what communication *is,* whereas the term successful communication is more appropriate for inquiry into the nature of communication in general, including the issue of success" (Pagin, 2008). I understand the aforementioned passage to mean that communicative success shifts focus back towards the underlying mechanisms, or as Pagin articulated, "conditions," in which communication functions, rather than the results of a given piece of communication. What's interesting here is the inquiry into the underlying conditions or mechanisms of communication that allow for communicative success.

In the forensic pathology reports and the forensic engineering report, the surrounding socio-cultural context influences the communicative system. To clarify, I see the context in which these reports were written as an underlying condition or mechanism of communication. The way I understand the underlying mechanisms to behave is similar to what has been described as 'nonlinear' and 'dynamical' in chaotic systems, terms primarily in the fields of mathematics or physics. In order to examine these underlying mechanisms, I will employ methods discussed by mathematician András Kornai in his 2007 text *Mathematical Linguistics*. In thinking about how this can apply to the autopsy reports and the forensic engineering report, I see the uneven distribution, pertaining to Floyd's report, as being similar to a grammatical structure on a larger scale. The study of phrase structures in Chapters 2 and 3 illustrate my point. The use of Voyant Tools can be considered similar to the Context Free Grammar (CFG) developed by linguist Noam Chomsky in 1956. These CFG's buttress current computer languages, according to Kornai (2007). Formalizations of language into something computational allows for a more standardized approach to unpacking the language to find trends in a given system.

In looking at language in these police scientific and technical communication systems, I hoped to understand how entropy or textual unpredictability pertained to information loss in a system. From the examination of the forensic reports as well as the forensic engineering report, I now see that it is not as simplistic as a linear relationship between information loss and textual unpredictability. Instead it seems as if there is a complex and multifaceted relationship between the rhetor, their embeddedness in socio-cultural context, and genre expectations, which could include technical factors and the purpose for which the report was written. Linguist Edward Sapir in his 1921 text *Language: An introduction to the study of speech* stated that all grammars leak. That is, all communicative systems utilizing symbols and forms come with their own type and magnitude of leakiness. In that way, this dissertation studies the "leakiness" of commutative products produced by forensic science.

Theoretical Underpinnings

Ideally, given the manifestations of textual unpredictability in police scientific and technical communication systems, a new model of communication might be warranted. Police scientific and technical communication affords the opportunity to integrate different communication models. What the two forensic pathology reports and the forensic engineering report does is highlight instances of textual unpredictability. These instances of textual unpredictability take the form of uneven distribution, as illustrated in Floyd's report. All of these elements culminate in a low readability index. This is the type of entropy that should be considered in an articulation of a more specific model of police scientific communication. That is not to say that I will articulate an explicit model of police scientific and technical communication that I had previously hoped to do, but instead I will call for a rearticulation of current models to better accommodate textual unpredictability. Many of the constraints of introducing a new model of communication are similar to those of a model of scientific communication in general. Where my research diverges from traditional scientific communication is there is less of a focus outward to communicating with the public, or public understanding of science, to communication with other professionals with varying levels of familiarity with forensics.

As demonstrated by the forensic pathology reports and the forensic engineering report, intended audience is key in determining how well a message was articulated and to what extent that readability index is relevant. Where communicating with the public may become a part of this model of communication is when trials happen post investigation, and the written and verbal communication about the forensics must be explained to a jury of non-experts to reach a well-informed verdict. Where problems arise in any communication system is a disruption of the encoding of the message or the decoding of a message. This phenomenon is often the result of entropy in a system, or, as earlier scholars have argued, "noise" as a measure of randomness. Information theory, when regarding communication, suggests that information and communication by extension is inherently probabilistic, in terms of finding a way to measure communication and what is not said per se, but all the things that could be said.

Throughout this dissertation, I wanted to emphasize that there is an underlying assumption that the nature of a communicative system is nonlinear and dynamic, or chaotic, in nature, specifically in regards to forensic pathology reports and forensic engineering reports. Such reports were productive rhetorical artifacts because of their genre and structure. That is, they represent a textual artifact that demonstrates the unpredictability of everything that *can* be communicated, but also unpredictability of how and if the message will be received, as described by Daniel Chandler (2017). Considering many communication models operate on the assumption of a single goal or destination for communication, varying in size, then it could be appropriate to say that the communicative approach may be limited to that factor. It should be noted that even though the result of a communicative approach is a type of single destination network, this is not indicative of one source being the cause. Narrowing the scope of focus down to a singular aspect of entropy is productive in terms of framing genre, especially regarding police scientific and technical communication. This is why in the chapters preceding this one, I articulate textual unpredictability as a type of entropy.

Scientific, Technical, and Classical Communication Models

Since forensic pathology reports and forensic engineering reports are both scientific communication as well as technical communication, it is important to understand the intricacies of both forms of communication. Understanding this will highlight how the manifestations and magnitude of textual unpredictability in forensic reports modify conceptions of scientific communication and technical communication. Scientific communication, specifically the theory of science communication, is a dynamic and complex field that traverses many disciplines. While this field mainly concerns itself with public understanding of science, I explore the science of scientific communication as well as other models. I refer to communication scholars, such as Uma Narula, Carolyn Miller, Claude Shannon, Warren Weaver, Stephen Littlejohn, Karen Foss, Daniel Chandler, Bruce Lewenstein, Kathleen Hall Jamieson, Alan Gross, Baruch Fischoff, and

R.L. Heath in order to gain a comprehensive perspective on communication models. Additionally, in examining the aforementioned scholars, I work to bring scholars in policing communication into the conversation, such as Peter Manning (for his text "Symbolic Communication: Signifying Calls and the Police Response"); Keith Erickson, Richard Cheatham and Carrol Haggard (for their text "A survey of police communication training"); and Murray Lee (for his text "Logics of risk: police communications in an age of uncertainty"). I examine scientific communication models at its most microscopic level to understand the larger effects on the communication system broadly, and the impact that textual unpredictability has on that communication system.

The scope of focus is determined by what I see as two key problems. One problem is that there is no singular agreed upon model of police scientific communication, in part because it exists at the intersection of scientific and technical fields and societal exigencies. In such a position, it is the responsibility of those working in the field to respond to those social exigencies in a way that still adheres to technical genre conventions, while catering to the somewhat fractured, multifaceted audience. Second, there is a core question of genre, and where genres come from. Through examining the aforementioned models of communication, I began to argue that genre can come from entropy or vice versa. Within a communicative system that is nonlinear and dynamical in nature, otherwise known as "chaotic," entropy on the most microscopic level is present in the slightest, perhaps most minute, aspects of written communication. It is within those microscopic, distinctive, communicative features we see a type of entropic trend emerging. These instances of distinct entropy is what informs the genre of the written text, since the final written product needs to work around that communicative entropy that has an effect on the larger system.

Unpredictability and Communication Models

As stated in the previous chapters, entropy is a measure of disorder, or textual unpredictability in a system, with important implications for police communication and forensic science. The standard mathematical and scientific understanding of entropy is simply a measure of a system's thermal energy. Moreover, in science, entropy is a way of illustrating the second law of thermodynamics (Greven et. al, 2003). However, Weaver and Shannon’s work informed a definition and utilization of entropy to accommodate communicative systems. While they used it to discuss information theory specifically, I have built on their definition for scientific and technical communication as a whole. There are valuable insights and articulations that I can use in thinking about the role of textual unpredictability, or entropy, in a communication system, such as the second law of thermodynamics. This law is primarily referring to measuring the spontaneous and irreversible change in a system. Entropy is often conceptualized as the intuitive idea of disorder or uncertainty in a system, however, as I articulate in the previous chapters, entropy can take the form of textual unpredictability. Moreover, within the system, there is a seemingly natural tendency to move into that disorder or uncertainty then to unpredictability. The latter conceptualization is how I will approach the idea of entropy:

the general tendency of a system of scientific communication to change due to its nonlinear dynamical nature.

It is this change that warrants further study because it seems to happen on the microscopic level at the middle stages of the police and forensic communication system encoding and decoding processes. To mitigate, or minimize the broader effects of entropy, genre conventions have to be adjusted to accommodate both spontaneous and gradual shifts in a communicative system due to textual unpredictability. To understand this, it is important to highlight entropic instances or distinctive features in a communicative system which could be perceived as noise or interference. After highlighting such distinctive entropic features, the task, then, is to prove that it can qualify as entropy even if it has been defined as noise in the past. Whinin these examinations, it is also integral to articulate the magnitude and nature of the entropy to confidently speak to what effects it has on the system. “The system” in this case will be the written communication of forensic pathology reports and forensic engineering reports. Each scientific field has individual genre standards and conventions, being approached by people all coming from different subject positions. By virtue of the individual nature of technical and scientific fields and their prospective audiences, there is a need for different approaches to not only arrive at a model of scientific communication but also motivate detailed inquiries into each field's specific communicative elements.

While some scientific and technical fields have been researched in this respect, police scientific and technical communication warrant further inquiry into their communicative processes. The fields that require more communication research often sit at a multifield intersection with many different stakeholders approaching communication from different subject positions and often have a clear social importance. This dissertation draws attention to the field of forensic science. Whether the underlying mechanisms of scientific communication in the field of forensic science have been largely ignored as the result of non-interest or the result of a lack of apparent exigence is difficult to determine. I would argue that intrinsically the field of forensic science creates its own rhetorical exigency, specifically, due to the nature of the investigations present in this field. Given that forensic pathology and forensic engineering sit at the intersection between law, science, and communication, they can utilize various models of communication.

Risk and Linear Models of Communication

Most often, due to the exigent nature of law enforcement, risk communication and its associated models seem to be at the forefront of discussion. Risk communication, with specific regard to communication in forensic pathology and forensic engineering, requires its own particular model of scientific communication because of the peculiar nature of communication in this particular field. Risk communication could be considered linear, as it usually consists of a one-way process where a sender encodes a message and a receiver decodes the message, and I want to take some time to consider more classical models of risk communication, in the context of broader linear models of communication such as: Aristotle's model of communication; Lasswell's model of communication; the Shannon Weaver Model; and Berlo's S-M-C-R Model. A linear model of communication is one in which a sender transmits and encodes a message to a receiver who then decodes said message or information, as articulated in from Warren Weaver's Introduction to Claude Shannon's *The Mathematical Theory of Communication* (1998 [1964]). Aristotle's model of communication places the "speaker" at the center of the model. Communication consultant Uma Narula, in her text *Communication Models*, describes an Aristotelian model in that way.

This type of speaker-centered model of communication hinges on a target audience and modifies its rhetorical strategies for that audience. Historically, this model of communication has been utilized for public speaking. Here, I want to highlight this model because of its core linear nature in which we derive various, subsequent models of communication. In understanding the linear nature of the Aristotle model of communication, one might be able to understand how a system of this nature might foster an environment which could be seen as exacerbating noise and interference, or as I argue, entropy. Moving on then to Lasswell's model of communication. Lasswell's model of communication moves from communicator to message, medium, receiver, and ultimately effect (Narula, 2006).

Lasswell's model of communication is more of a function-based model of communication. That is to say, there is an emphasis on the *effect* of communication, rather than an emphasis on the speaker. Let us now consider interactive models of communication. Interactive models of communication usually include sender, receivers, sometimes referred to as participants, a message that is either verbal or nonverbal, and encoding and decoding. Briefly, encoding is a process in which signs and signifiers are created and transformed from something that our conscious minds can understand. Decoding is a process in which deconstructed signs and signifiers are translated into understandable thoughts. That said, the interactive models of communication might vary somewhat in these processes, however, the core process remains relatively the same. In these models, the sender(s) and receiver(s), otherwise referred to as participants, conjure meaning through the process of sending and receiving messages (Schramm, 1997).

Interactive Models Of Communication

Some facets of forensic pathology and forensic engineering reports mimic a type of interactive model of communication. The processes illustrated by interactive models of communication are typically not linear in the sense that it is not a "one way" model. Such models work by incorporating feedback from the receiver, making the process "two way" (Narula, 2006). Some have referred to this part of the model as the "feedback loop" (Narula, 2006). It is important to note that an integral feature of the feedback loop process is that roles between participants switch back and forth. To that end, dissimilar to Aristotelian models of communication, the message is not at the center of interactive models of communication; instead, the participants are the key facets. What's more, the interactive models of communication highlight the fact that there is not one message sent between participants, but multiple messages being sent, sometimes simultaneously.

What's interesting here is that there is an acknowledgement that "unintentional" messages are often sent as well. One could see these unintentional messages as a type of noise, or interference on a larger scale. And while, to some extent, it may be productive to view those unintentional messages as such, this dissertation argues that it is more productive to view such messages as entropy.

Understanding unintentional messages as "entropy" insead of noise, broadens our conceptual understanding of what is actually taking place in these systems. Further, entropy, or in the genre of forensic pathology and forensic engineering, textual unpredictability, being a measure of disorder and of uncertainty, requires the identification and isolation of variables mainly responsible for an increase in the system's overall entropy. Unintended messages could be such variables. One specific example of an interactive model of communication is the Osgood-Schramm model. The Osgood-Schramm model considers participants as combined decoder/encoder/interpreter units, passing messages back and forth (Narula, 2006).

This model is derived from the Shannon-Weaver model, which had been criticized as being too linear (Narula, 2006). Shannon and Weaver's 1964 text, *A Mathematical Model of Communication* articulates the model outlined above. The early versions of the Osgood-Sherman model account for a participant's interpretation of the message itself. That is, this model moves beyond considerations of context, signs, and signifiers, to "how" a message is interpreted. The early Schramm model places the participants (in the example, the encoder and decoder) at the center of the model, as described by Narula (Narula, 2006). What this does is highlight the reciprocal nature of communication where there participants, the encoder and decoder, switches respective places throughout the communicative processes. It should be noted that Schramm wanted to emphasize the subject position within these models, as the person's background, knowledge, and experience are elements which play a role in the articulations and interpretations of a message (Lasswell, 1948). The scope of Shramm's model is zoomed in on the interpersonal, and if we consider mass communication, the model becomes more complex. Through considering the Westley and Maclean Model of communication for mass communication contexts, we can see the role participant feedback plays in these systems on a larger scale.

The Westley and MacLean model of communication hinges on the idea that the communicative process does not begin when a participant begins to speak, but when their surroundings become a rhetorical exigence, as explained by Narula (Narula, 2006). As such, the participant then responds to their surroundings and a reciprocal relationship is thus created. The model continues when a message is received by a participant. This model is particularly productive for thinking about the mechanisms underpinning mass communication. If we consider the process in which mass communication platforms disseminate information, we see instances where the surrounding contexts create a rhetorical exigence in which a message is transmitted, then received, then decoded by passive participants (Narula, 2006). It should be noted, here the phrase "passive participants" suggests that the participants may not directly interact with the transmitter of the message after it has been received, but instead participates in the communication system by decoding a received message. Often, a hypothetical scenario that is cited is a newspaper article, either print or online, where the readers can respond to the publishing agency in some way, shape, or form (Narula, 2006). What this response does is create a feedback loop.

Let's say, X1, X2, X3, and X4 represent information, the "f" represents feedback, "A" and "B" represent clients, and "c" represents gatekeepers (Narula, 2006). A feedback loop can be dissected between reader B and the newspaper C, we see fBC. The other feedback loop is between newspaper C and client A which is the feedback line fCA. Lastly, there is a feedback loop represented by line fBA between the reader and the client (Narula, 2006). What is interesting about interactive models of communication is that unlike linear models of communication, interactive models of communication account for participation and the resulting feedback. Further, interactive models are productive in unpacking mass communication, as well as highly productive for looking at the mechanisms underpinning interpersonal communication.

Transactional Models Of Communication

Lastly, transactional models of communication focus less on the participants of the communication process itself, and more on the context in which the participants are communicating. This is the model of communication that forensic pathology and forensic engineering seem to mimic the most. The general goal of linear and interactive models of communication is to deliver data as decodable information. The goal for a transactional model of communication is to form and reinforce moral economies (as in Chapter 1), and to engage in discourses within those economies.

It is important to note the three broad contexts in which this model functions. First is the social context, where rules and norms of that system are learned and mimicked. Next is the relational context where the interpersonal factor is brought forth. That is to say, *how* one communicates is heavily dependent on one's subject factors and subjective, embodied, positions. Lastly, the cultural context where specific aspects of one's identity, those truly embodied interpersonal factors, are factored into the communicative processes (Lapum, 2020). Two key interactive models of communication are Barnlund's Transactional Model and Dance's Helical Model of communication. First, Barnlund's Transactional model of communication is a model that is a two-way process where the transmitter and receiver are actively participating in the communicative process, as described by Narula (Narula, 2006). In Barnlund's 2017 text, "A transactional model of communication," a dynamic transactional communication model is articulated.

Transactional models of communication are dynamic in nature, similar to police communication. There is an expected level of engagement and feedback from the transmitter and receiver that is informed by continual cues. Similar to interactive models of communication, the transmitter and receiver are active participants in this system. Barnlund's model of communication builds upon the core ideas of the transactional model of communication. Barnlund's models require four elements; the communicator, their communication skills, the context, and the message (Narula, 2006). This model accounts for the embodied, subject position, of the participants and focuses on what they bring to the communicative process. What is interesting here is that Barnlund's models of communication not only accounts for the communicative skill of the participant, but also the non-verbal cues during the actual communication. This model of communication firmly embeds itself within a physical, social, and cultural context that considers an individual's experiential background. It should be noted that Barnlund's model of communication emphasizes context and its role in informing the message.

Dance's Helical Model of communication views communication as a holistic, life long, continuous, process. This model is derived from Bois' Model of Semantic Reaction (1973). Dance was inspired by a helix in 1967 when trying to articulate the evolution of communication. Narula alludes to Du Bois, later in 1975, commandeering the foundation of this model to describe a more temporal element to communication and one's own situatedness in communicative landscapes (Narula, 2006). Dance's Helical model articulates distinct, key features in this particular model which highlight the more temporal elements. In this model, communication is thought to be cyclical in that it starts general and moves towards complexity. This model of communication hinges on the temporal in order to accommodate communicative complexity. Within this model, complexity increases as one's knowledge base increases. With the temporal element in this model of communication, it can be used to better understand the acquisition of knowledge throughout a communication cycle. This is important to note, as I would argue that this type of model of communication speaks to broader models of public engagement with science and public understanding of science.

Deficit Model of Scientific Communication

Forensic pathology and forensic engineering are similar to communications in other fields of science as they seek to fill knowledge gaps of the readers. Public understanding of science deals primarily with the transmission and articulation of scientific information. While it might be more of a conceptual framework, rather than a communication model, it buttresses broader communication models. For example, within Public Understanding of Science or Public Engagement with Science, the contextual model accounts for the knowledge differences, needs, and attitudes of the recipients of said communication, as described by science communication professor Bruce Lewenstein (Lewenstein, 2003). The contextual model places cultural context and interpersonal experience at the center.

What this does is places scientific information into a rhetorical context in which an individual can remain in their psychological schemas to properly decode the transmitted information. Within the participation model, stakeholders, scientists, policy makers, and the public, engage in discourses about pertinent subjects. In this model, public participation is key, as that participation is perceived as a type of "democratization of science," as indicated by Narula (Narula, 2006). While this model is popular among social scientists and humanists, the Deficit Model of communication is one of the more commonplace models. The Deficit Model of Scientific Communication, more specifically, the Knowledge Deficit model, assumes the public lacks scientifically relevant knowledge (Narula, 2006). While this model hinges on the assumption that the public is deficient in scientific knowledge, it provides exigence to create scientific literacy programs, placing pedagogy at the center. Whether understanding of such knowledge and engagement of such knowledge by the public is increased, that is out of my focus.

However, it is important to note that all of the aforementioned models of communication are built upon the singular idea that knowledge, information, and/or data needs to be articulated in some form, encoded to do so, decoded by a recipient regardless of noise and interference, and ultimately received. That said, this presents an interesting question about reducing, or perhaps mitigating, noise and interference. In other words, a question remains from these models: is it actually productive to try to mitigate or reduce what is being perceived as noise/interference? This dissertation argues for a reconsideration of communicative noise/interference as entropy in order to view them as important, contextual pieces of information sent and received with the message.

In *The Oxford Handbook of the Science of Science Communication*, the interdisciplinary team of Kathleen Hall Jamieson, Dan Kahan, and Dietram A. Scheufele, (2017) takes more of an empirical approach to understanding the science behind scientific communication. In this text, they create definitions that can be operationalized; they unpack the designing of messages. Additionally, they map the underpinning mechanisms of communication itself. The purpose of this text is to evaluate the effectiveness of scientific communication. A central theme in most of the chapters is that the amount of science that an audience member must accept as valid exceeds the amount that they can comprehend or verify for themselves. This is one of the major issues in the field that ought to be considered but has little movement towards a solution. Rhetoric scholar Alan

Gross, in the text “The Roles of Rhetoric in the Public Understanding of Science” (1994), suggests that rhetoric is a key facet in understanding public understanding of science. Gross states, “rhetoric has two roles in public understanding of science: theory capable of analyzing public understanding and activity capable of creating it” (Gross, 1994, p.3).

If we understand the social constructions of technology as one of the key theories for science and technology, then we can see the articulation of the surrounding constructions around technology, and by extension how science is rooted in a rhetorical context. That is to suggest that rhetoric is central in understanding the intersection of public understandings of science and theories of science and technology. Rhetoric plays an integral role in theories of scientific communication because scholars are able to address the rhetorical context. For instance, the Deficit Model in scientific communication accommodates facts and methods of science that are designed to fit the public’s needs and limitations (Gross, 1994, p.3). The Deficit Model of science communication is among the most commonly used. This framework often operates on the presupposition that there is a hostility towards scientific knowledge and scientific literacy because there is a lack of understanding about the field. It seems as if forensic reports could fit into this model of communication, but not in the text itself, instead in the articulations and explanations of that text in court.

Moreover, this creates a perceived rhetorical exigence in which experts are attempting to articulate complex scientific topics for an audience of non experts. What's lost in these instances of communication is productive articulations about the nature of science. While this model of scientific communication has its affordances, some might argue that its constraints are that experts are not successfully improving the dissemination and transfer of knowledge. Even though those working within this framework are attempting to close the knowledge gap, some are unsuccessful in doing so because they have failed to overcome either public uncertainty, the ways in which information is processed, or a flawed processing heuristic. For the Contextual Model of scientific communication, rhetoric also plays a key role. According to Gross (1994), "rhetoric provides an independent source of evidence to secure social scientific claims" (Gross, 1994, p.3). For forensics, this dissertation argues, rhetoric reinforces the moral economies of police communication.

The Contextual Model considers the rhetorical situation of the receiver of information more carefully. This is a model of communication that should be adopted into forensic pathology and forensic engineering reports. In this model, the communicator tries to consider the diverse needs of the receiver. The last more significant model of scientific and technical communication is the Participation Model. It is within this model information is mediated through an idealized democracy. In this framework for communication, the information is oriented towards the public, but the public then helps negotiate meaning. This model not only addresses the rhetorical situation, it confronts it in a way in which the constraints of scientific and technical communication can be mediated. Irwin, in 1994, proposed that a model similar to the Contextual Model focuses more on public understanding of science. Irwin called this model the Public-Relations Science Model (Irwin 1994). However, the scope of this model is too narrow to be truly productive for scientific communication for the purposes of this dissertation. This model would be very productive for forensic pathology and forensic engineering reports only if the investigations causing the reports are criminal in nature.

These three models all have their affordances and constraints. According to Gross, the Deficit Model does not accommodate two way communication. Gross states, "the deficit model is asymmetric, it depicts a one way model of communication...it does not try to persuade, it assumes the public is already persuaded of the value of science" (Gross, 1994, p.6). The issue with the Deficit Model is that it does not account for the subject positions of the public receiving the information. This is a key element that Gross would argue is something that should be considered. It is important to note here that the Deficit Model is the framework most commonly employed by scientists.

The Contextual Model is what Gross endorses as it is a model in which the rhetorical situation, as well as the subject position of the receiver of information, is considered in effectively communicating. This model, according to Gross, considers and communicates based on the interaction between science and the public. Unlike the Deficit Model, the Contextual Model illustrates a two-way model of communication. This model does not assume what the public does or does not know, instead it works to accommodate a rhetorical exigence. That is to say, it attempts to persuade the public. The Contextual Model, as a framework for scientific communication, hinges on a rhetorical reconstruction of scientific knowledge so that the public is able to understand complex scientific communication. The public and scientists in this model work to create a joint understanding of what is being communicated. In this model it is a negotiation as opposed to the Deficit Model of science communication.

The last significant model of scientific communication is the Participation Model in which the public plays a significant role in the dialogue with scientists about scientific research. In this model, the stakeholders become as much of an equal communicator as the scientists and researchers. Gross does not necessarily advocate for this model as opposed to the Contextual Model because this model relies on the *interest* of the public rather than the *understanding* of the public. This model can be problematic because the information that the public receives from popular sources can be misrepresented, oversimplified, taken out of context, not covering sample size, or presenting unfounded certainty (Gross, 1994, p.6). As Gross articulates, the main issue with this model is that it relies heavily on the public's understanding of complex scientific principles that may lead to a mistaken view of science and may isolate the actual science from the surrounding context that makes it meaningful. For Gross, the Contextual Model is the forerunner of scientific communication and would make a productive framework for scientific communication because it considers the rhetorical situation as well as addresses a rhetorical exigence. Even though forensic pathology reports and forensic engineering reports are not grounded in a participation model, there are elements of that model that fit into this form of police scientific and technical communication. The participation, however, comes at the end of the communication, rather than being present throughout. To that end, I would suggest that the broader socio-cultural context itself is an actor or participant in police scientific and technical communication.

The Science of Science Communication

Forensics could likewise benefit from increased attention in science communication. Baruch Fischhoff produced a relevant 2013 text that was a result of the May 2012 Sackler Colloquium on "The Science of Science Communication." This conference sought to gather scientists from several different fields to discuss different parts of scientific communication. In general, this text was the bringing together of scientists who research the biological and psychological aspects of communication with scientists whose research could facilitate that communication. There was clearly a balance of different types of scientists who could offer different perspectives. This included decision scientists who could interpret results; behavior scientists who could convey those results; and social scientists who could create the channels needed for communication. This was particularly important because the observations that they arrived at were approached from various perspectives. In general, the scientists came to a consensus about what the goal of scientific communication is, what scientific communication and those working in scientific communicators must do to reach that goal, and what some obstacles are in obtaining the desired results. In the conference proceedings, it was agreed that in order for scientific communication to fulfill the mission of effectively communicating, it must perform four interrelated tasks. The first task is to identify the science most relevant to the decisions that people face. The second task is to determine what people already know. The third task is to design communications to fill the critical gaps between what people know and need to know. The last task is then to evaluate the adequacy of those communications. Fischhoff notes to repeat the aforementioned steps as necessary.

To fulfill these steps, it is argued that there need to be different types of scientists as well as experts; this is for the purposes of maintaining a credible view that will address various aspects of the issue that might otherwise be missed if there was only one type of scientist proposing a solution. This text highlights an important element in police scientific and technical communication. That is it articulates the coming together of subject matter scientists, to get the facts right. This also includes decision scientists for the purposes of identifying the right facts, so that they are not missed or buried as well as social and behavioral scientists, who will formulate and evaluate communications. The last group consists of communication practitioners, they will create *trusted* channels among the parties. Fischhoff goes on to argue that it is the realization of the implications of scientific communication that requires effectively integrating it with the decision-making processes so that it will *inform* and not just disseminate information. The conference proceedings conclude with the argument that communications are adequate or effective if and/or when they reach people with the information that they need in a form that they can actually use. Forensics can benefit from similar attention from multidisciplinary groups of scientists and practitioners.

Similarly important is a view of police communication grounded in communication theory more broadly. Littlejohn and Foss's textbook *Theories of Human Communication* is essentially an analytic introduction to the field of communication theory. There is a breadth of information covered in this book; however, the main goal was to understand the underpinnings of each model of communication, not necessarily to propose a solution to a problem like Fischhoff's text. Littlejohn and Foss define communication theory as a body of theories that make up our understanding of the communication process. It is important to gather as many definitions of communication theory from as many sources as possible because it will indicate a larger purpose of the text as well as indicate from what perspective and in which theoretical framework they are operating. It is argued early in the text that an understanding of systematic theories of communication is an important step towards becoming a more competent and adaptive person (Littlejohn & Foss, 2013, p.4). Here they are gesturing towards the idea that a widening of perceptions will help us become flexible and adaptable in instances of communication regardless of which model of communication is being used.

Littlejohn and Foss then offer a rationale behind studying communication theory which is applicable to my study into police communication. They suggest that the study of communication theory provides us with a set of useful conceptual tools (Littlejohn & Foss, 2013, p.4). This book centers around the idea that communication is always present and always complex and as such, it is not productive to look for the *best* theory of communication but to look at a set of behaviors that are informed by and impacts communication as a whole. This book is organized around three domains of communication: general theories, thematic theories, and contextual theories. Part two covers three theoretical approaches that attempt to capture the communication process as a whole (Littlejohn & Foss, 2013, p.29). The models and theories of communication that are outlined in the text are as follows: those that fall under the category of general theories like systems theory and rules theory; those that fall under the category of thematic theories like theories of language, theories of meaning, theories of persuasion, and theories of information; and those that fall under contextual theories like theories of relations and perceptions, interpersonal theories, and theories of mass communication. When each theory or model of communication is presented, Littlejohn and Foss buttress them with corresponding human behaviors to place them within a context. They argue that the clusters of behaviors fall into categories or systems of communication that can be observed and studied. The purpose of this approach of putting behavior at the center of a communication theory or model is because a communication system suggests a lot about human behavior and vice versa. This can give us a pretty good set of tools to make predictions and inferences about behavior.

With regard to the broader category of police scientific communication and information theory, I would like to spend some time highlighting the general, yet significant passages that influenced my understanding of the relationship between scientific communication and information theory, as that relationship is integral to understanding police communication. To begin, Littlejohn and Foss state "in a communication system, the behavior is the smallest unit of analysis in the communications system; sequential interaction patterns- the set of acts that are linked to one another" (Littlejohn & Foss, 2013, p.39). This is particularly important because we must view scientific communication as a system, not just as the bringing together of disparate parts for the purposes of disseminating information. By viewing it as a communication system, we are able to view the underlying and seemingly disparate acts of communication within a given system as a part of the whole. When we approach it this way, we then are able to make tactful alterations to the communication model to effectively address different parts of the communication process, thereby influencing the system as a whole.

Moreover, there is a section in Littlejohn and Foss' text that focuses on information theory that is productive in the way I consider its role in police scientific and technical communication. Following are selected definitions of the parts that make up the interpersonal theory of information theory and not the mathematical information theory. Littlejohn and Foss state "Information transmission is not concerned with the meaning of the message but with the transmission and reception" (Littlejohn & Foss, 2013, p117). Moreover, the source of the message formulates a message consisting of signs to be transmitted. It is important to note here that the transmitter converts a message into a set of signals that are sent from a channel to a receiver. Following this, the receiver then converts a signal into a message (Littlejohn & Foss, 2013, p.118). This process is important to understand because this is the type of system that Fischhoff as well as those participating in the Science of Science Communication conference are unpacking and finding productive solutions to.

While the interpersonal version of information theory appropriates terms from its mathematical predecessor, such terms are defined in a different way. For example, consider the term noise. Within an interpersonal model, it means a disturbance in a channel that distorts or otherwise masks the signal. Another term that is used and redefined is 'code' or encoding. Within this model, this means that a message is the sequence of stimuli or signs that hit the receiver sequentially (Littlejohn & Foss, 2013, p.118). The term 'decoding' is also used in this version of information theory. It means the various predictable patterns are found, which makes decoding easier because there is less information, lower relative entropy, and redundancy (Littlejohn & Foss, 2013, p.119). Through outlining the interpersonal version of information theory, Littlejohn and Foss suggest that a problem of transmission is reconstructing the message accurately at its destination, which is why the coding and decoding steps of this model are one of the ones in which science communications spend the most energy addressing (Littlejohn & Foss, 2013, p.119). We see this in Fischhoff's conference proceedings. We also see in Fischhoff's text a gesturing towards the method of relying on redundancy on multiple levels to convey or remodify a given message to reach the goal of scientific communication.

Similar to Littlejohn and Foss' discussion on redundancy with regard to information theory, my aim is to view police communication through defining it as a compensated noise, as noise distorts, masks, or replaces symbols, redundancy allows the receiver to correct or fill in missing or distorted stimuli (Littlejohn & Foss, 2013, p.119). It is important to note that since information theory has its roots in math and physics, the goal was not to necessarily understand the meaning of a message. Littlejohn and Foss articulate it in this way, "to make information relevant to human communication, semantic information was developed: we know that information is a measure of uncertainty, we know that such information can be transmitted, on the semantic level we can concentrate on the communication of information, which reduces uncertainty.

Information conveyed by a message that reduces information is called semantic information. Semantic information is the amount of information in a message that is removed from the situation because it is transmitted from person to person" (Littlejohn & Foss, 2013, p.120).

Each of these communication fields are integral for communication in forensic pathology and forensic engineering. Regarding risk communication, for one, communication in both forensic pathology and forensic engineering articulates the findings of a particular forensic investigation. Risk communication deals with the aspects of communicating vital information in a timely and accurate manner to different audiences with varying levels of understanding about the topic at hand. These communications are particularly vital as they aim to inform people on what to do in high-risk situations. Within this context, forensic investigations warrant distribution of timely and accurate information to different audiences such as officers, detectives, medical examiners, judges, defense attorneys, prosecutors, and sometimes juries, in order to make an informed decision.

In regards to scientific communication, the composer of such documents must outline complex scientific information from accident reconstruction, medical examinations, and investigations to different audiences with different levels of understanding of the scientific principles in order to propose an evidence based decision. The articulations in forensics reports are of particular importance in the later stages of an investigation, or trial, because it is what scientifically proves a hypothesis for an investigation in conjunction with already collected evidence and statements. This works as a burden of proof in courts for prosecutors. These articulations are for different stakeholders which have a direct impact on the outcome of an investigation or trial. Technical communication offers a high-level theoretical framework for which to approach building a specific model of communication for forensic pathology and forensic engineering.

Medical communication plays a smaller, yet important, role in that it offers a framework for communication about forensics pathology in an investigation specifically. However, their written report and findings impact an investigation, and by extension, a trial with the same magnitude as the other components of investigation. The difficult part here is there is an added layer of complex communication that must take place in order to move an investigation along. Medical communication, while not at the forefront of a forensic engineering report, is important depending on the nature of the accident being investigated. If the accident results in a death or multiple deaths, then the articulation of those medical findings become integral for determining criminal charges. It should be noted that forensics pathology investigations are in the technical jurisdiction of the medical examiner after a body is transported from a crime scene.

At the core of every conceptual model of either risk communication or scientific communication, a consideration of decision making should be at the forefront. In discussions about this science of science communication, decision making, and by extension the reasoning and the sometimes flawed reasoning, heuristics that we use to process information are not necessarily addressed. This is one of the key factors that make a mathematical explanation of communication like information theory counterproductive. It does not account for these processing heuristics. In the 2018 article "Risk Communication Emergency Response Preparedness: Contextual Assessment of the Protective Action Decision Model," Robert L. Heath and colleagues propose a model of communication based on a decision-making model. In this model, decision making is at the center of the model and therefore every other element has already accounted for states the following, "protective action decision model (PADM), which links environmental and social cues, pre decision processes (attention, exposure, and comprehension), and risk decision perceptions (threat, alternative protective actions, and stakeholder norms) with protective action decision making" (Heath et.al 2018). What's significant here is that a PADM model builds on a general model like information there, however, it accounts for social and environmental factors while accounting for processing heuristics for decision making.

This model employs some of the productive aspects of the contextual model of communication that accounts for the actors in those systems of communication. What this does is allow for not only more productive communication, but also mitigate the potential for encoding and decoding errors in communication. While accounting for these factors may increase entropy, these factors can be reduced if one were able to isolate the contributing factors. Overall, using a protective action decision making model, or something similar, is not only embedded in a more specific model of science communication, but maybe prefaces it. PADM has affordances as well as constraints; however, the constraints are outweighed by the potential benefits of implementing this sub-model of risk communication into a scientific communication model.

As demonstrated above, scientific and technical communication has a multitude of moving parts and socio-cultural considerations. The aforementioned scientific and technical communication models however, share a common goal; that is, to ensure the successful transmission and reception of the message being communicated. Of course, many of the models discussed above are contingent upon the successful reception or decoding of information received. That is to say, the participants are a factor in these communication systems that I would say act as independent variables. The dependent variable in these communication systems are the reception and subsequent responses to the participant's actions or articulations. It should be noted that not every situation in which these communication systems operate allow for a dependent variable to respond to a participant. However, in the context of police scientific and technical communication, there are many situations in which the person acting as a messenger can adjust a message or the information being conveyed to a participant. To that end, I examine three written pieces of police scientific and technical communication.

The documents being examined in the chapters proceeding this one do not allow for the dependent variable to adjust the message conveyed, according to the specific situations. In the cases considered here, two pathology reports and one forensic engineering report, the audience is not able to engage directly with the sender of the message. To that end the composer of the message is unable to adjust the message regardless of the level of information received and understood by the audience. I would like to note here, for autopsy reports and forensic engineering reports, the primary audience are those in the legal system, forensic practitioners, and those involved in the law enforcement case. A secondary audience is the general public. These reports are open and accessible to the public, and therefore allow for anyone to receive and review the information contained in the report, given the submission of a formal request, in some cases. The removed and somewhat distant audience is an element that I see as an unavoidable type of entropy in communication systems. In the analyses preceding this, I examine the type of entropy that I now define as textual unpredictability. To that end, this form of entropy, otherwise known as textual unpredictability, can be defined and controlled. It is the type of entropy resulting from the messenger and the context in which it was conveyed.

Broad Goals of Communication

It should be noted that the goals of police scientific communication and medical, communication, risk communication, and police communication are different. As such, the communication models will differ slightly. There still has to be an element of the deficit model where the prosecutor and the forensic scientist are informing interested parties, witnesses, judges, juries, supervisors, etc. of the specificity of a crime or event. There also must be another element of that particular communication system that replaces the participation element. When participation has a role in the public understanding of science, science outreach and by extension scientific communication, it is integral to ensure the public's participation in most cases. Communication about engineering forensics, ballistic forensics, and forensics pathology requires that participation element, though its role is obscured. According to Robert Heath and colleagues, scientific communication exists on different varying levels, depending on what stage of the communication model is active: person-to-persons (P2P) scientific communication, person-to-organizations (P2O) scientific communication, organization-to-organizations (O2O) scientific communication, and organization-to-persons (O2P) (Heath et.al, 2018). In such, while forensic science employs traditional methods for scientific communication, there are elements from risk communication that are introduced into that otherwise closed communication system, including a need to address the element of participation.

The relationship between scientific communication, entropy, and forensics is not immediately apparent. However, the aforementioned elements connect and inform each other in integral ways. Scientific communication acts as an encompassing concept for entropy and forensics. We ought to consider the relationship between these elements as if it were an upside down pyramid where scientific communication is at the top and followed by entropy, followed by forensics. Moreover, scientific communication is conceptually buttressed by larger models of communication. While there are many possible models, there are four general elements that must be present: the sender, the message, receiver, and the atmosphere. Within and between these elements are entropy and noise, these two factors inform and reform information at every stage of the process. Claude Shannon in his text "A Mathematical Theory of Communication" (1948), once defined the "fundamental problem of communication" as the possibility, as exactly or approximately, reproducing at a certain point, "a message selected at another point" (1948).

Messages in a communication system likewise have an intrinsic equilibrium that maintains the equilibrium of an entire communication system. According to mathematicians Andreas Greven, Gerhard Keller, G. and Gerald Warnecke, “Equilibria are those microstates which are most likely to appear, i.e they have the largest number of corresponding microstates” (Greven, Keller & Warnecke, 2003, p.1). The microscopic elements of a communicative system are therefore an integral part of maintaining an equilibrium or relatively stable communication system. What the passage above suggests is where we can examine the stability or equilibrium of a system within the microstates. That is to suggest, by examining the more minute aspects of a communication system, the more productive view of the state of equilibrium we could potentially gather.

Nonlinear Dynamical Systems in Communication

Since measuring textual unpredictability in forensic reports is the key to understanding where, how, and to what magnitude there is change, it makes sense to at least examine the potential effects on the stability of the system. Regarding forensic pathology reports and forensic engineering reports, the stability of such communication systems depend on the distribution of terms. As we have seen from Geroge Floyd’s report, the uneven distribution of terms led to a textual unpredictability that decreases the readability index. In the forensic engineering report, the low readability index seems to be attributed to the use of complex jargon, another form of textual unpredictability. The way textual unpredictability manifests is a type of microstate. “There are two sides to the coin: one side is the description of *complexity* of the problem to specify a microstate satisfying a macroscopic constraint; the other problem of *coding* this information" (Greven, Keller & Warnecke, 2003). Understanding entropy as a measure of randomness and probability in a closed dynamical system is a narrow view of the subject matter. What we ought to further consider in this regard is complexity within these systems.

A microstate such as a grapheme in a communication system offers its own intrinsic complexity. Additionally, a phenome, being the smallest sound one can understand, is an example of a microstate which has a set of definite constraints that are otherwise immovable (Zhabinskaya, 2019). A "microstate" comes from statistical mechanics, and phonemes were described as such by Dina Zhabinskaya (2019) in her text, "Microstates of a Physical System and Accessible Microstates of a Physical System." This constraint, therefore, buttresses the resulting information that has to be processed and coded through a given communication model. To understand entropy as it connects to complexity on a given communication system allows one to consider what contains information coding and decoding, and by extension data and communication loss through a given model of communication. The underlying complexity of a dynamical communication system informs the resulting magnitude and nature of entropy, which then informs the overall stability of that nonlinear dynamical system as a whole.

Understanding what exactly constitutes a nonlinear dynamical system is key here, because I am adding an element, communication. Physicist S. Neil Rasband in his 2015 text *Chaotic dynamics of nonlinear systems* states the following, "chaotic dynamics is a consequence of mathematics itself and hence appears in physical systems [...] chaotic dynamics refers to deterministic development with chaotic outcome. Another way to say this is that from moment to moment the system is evolving in a deterministic way" (Rashban, 2015). While complexity, by its very nature, does not directly have an effect on the stability of a nonlinear dynamical system, it does inform the nature and magnitude of entropy. This, then, increases the chances that a communication system can become unstable. The question here is in regards to what exactly is causing entropy and if there is a way to reduce it. If we consider the underlying complexity of a communication system, then one can assume that one way to reduce or at least mitigate the chances of increased entropy is to reduce unnecessary complexity.

Understanding complexity as it functions in a nonlinear dynamical system is vital to understanding the tangential effects on entropy. It is productive for understating how textual unpredictability is a form of entropy in a police scientific and technical communication system. "These functions are increasing or decreasing with dynamics of a system […] is exactly the type of behavior that the entropy exhibits due to the second law of thermodynamics" (Rasband, 2015). What the passage above suggests is that the underlying mechanisms of a nonlinear dynamical system, entropy and complexity, work not only in conjunction with each other, but they are also in a reciprocal relationship with each other. By the very nature of this reciprocal relationship, not only is the overall stability of the system affected, but it is cyclical in that the stability or destabilizing of the system will increase complexity and entropy. If we consider this conceptual understanding of the effects of entropy and apply it to a communication system, then we can begin to understand the microscopic sources of information and data loss during the transmission and dissemination stages of communication.

Broadly, to accept this assertion, one has to accept the premise that a police communication system mirrors that of a system that is a nonlinear dynamical mathematical system. This is not just referring to police scientific and technical communication, but *all* genres of scientific and technical communication. Lasswell's (1948) Model of Communication could perhaps give us the basis for such a system. However, what I am proposing is a more specific model of scientific communication that builds from Lasswell's and Shannon and Weaver's model as it pertains to a mathematical explanation of communication. This then gives us an import for considering entropy, noise, and complexity in a communication system. With that being said, we ought to consider again the microscopic elements of entropy and complexity in communication.

Within these communication systems, complexity and by extension entropy will be present at almost every stage of the communication process. That is to suggest that between the encoding and decoding of information and data in a nonlinear dynamical communication system, entropy and complexity not only exist, but take many forms and magnitudes. What makes a communication system mirror a nonlinear complex dynamical mathematical system, such as one that would result in a fractal, is the fact that communication, even at its most basic level, is nonlinear due to the human, socio-cultural components. Moreover, the trajectory of communication, even at its most organized, is rarely, if ever, strictly linear. Another element to consider is the "dynamical" processes.

Yet again, the socio-cultural nature of human communication makes these systems dynamic at every stage of the information and data transference process and while there are many human elements that will have a significant effect on the “nonlinear” and “dynamical” processes of communication, my focus is in entropy, as that can account for factors such as human choice, flawed heuristic processes, word choice, syntax, and the medium in which communication is being articulated and disseminated, as well as content for such communication. All of the elements are a form of entropy in that each one increases the underlying probability of different outcomes of communication. Even when a system is stable, the probability of one outcome decreases because the randomness or entropy within that system also increases. By virtue of written communication being a human affair, this is what makes these communication systems mirror a nonlinear dynamical mathematical system. As Rasband explains the broader problem, “Whenever dynamical chaos is found, it is accompanied by nonlinearity. Nonlinearity in a system simply means that the measured values of the system properties of a system in a later state depend in a complicated way on the measured values in an earlier state” (Rasband, 1997, p.2). The “earlier state” in the forensic pathology reports would be the preliminary findings that are then articulated and organized in the report. For forensic engineering, the “early state” is the primary mathematical investigation and accident reconstruction.

While considering the nonlinear and dynamical aspects of a police communication, we must also bear in mind that these concepts are fundamentally mathematical in nature. Rasband states, “The approach to entropy in statistical physics developed its full strength in the framework of probability theory. It had a large impact on information, stochastic processes, statistical physics and dynamical systems” (Rasband, 1997, p.4). While one might critique my view of an inherently human process of communication as reductive, at its core, communication is, on some level, mathematical. These equations and mathematical explanations give us a way to understand the interactions of these elements on the overall communication processes. It should be noted that a colloquial term for nonlinear dynamical systems as it pertains to entropy is often referred to as "chaos" or chaos theory, or more commonly the butterfly effect. That is to suggest that the most microscopic change can have a significant impact on the outcome of communication. In the case of forensic pathology and forensic engineering we can see the microscopic factors are the word choice as well as the distribution of those words that impact the larger system.

There is an interesting idea that entropy in a complex dynamical system is irreversible (Rasband, 2015). I want to highlight this idea because if we begin with a more complex model of communication such as the one proposed by Oomkes (2013), the interactive perspective might give us a conceptual understanding of how we can try to reverse some properties of communication so that it can mirror the way entropy in a complex dynamical system can be reversed. Now, "reversed" is a bit of a misnomer for the concept I am considering. That may be accurate for a purely mathematical system, but for a communication system, the entropy itself would not necessarily be reversed, but would instead be reduced. Oomkes's (2013) model of communication allows us to see exactly where one might propose for an entropic reduction.

Entropy plays a significant role in probability theory due to the stochastic processes. Let us focus a little more on the aspect of probability as it pertains to nonlinear dynamical communication systems. Probability theory is an underlying concept that buttresses many models of communication theory, due to its broad and applicable nature. As Rasband explains, “the role of entropy as a concept in probability theory, namely, [is] in the analysis of the large-time behavior of stochastic processes and in the study of qualitative properties of models of statistical physics. Naturally, this requires us to think along the lines of the microscopic approach to entropy” (Rasband, 1997, p.9). This is how and why I consider the microscopic. The nature of human communication makes it a stochastic system; intrinsically, a stochastic system is a highly probabilistic system in which entropy is high, because probability is high. Similar to a true stochastic process or system, human communication can be measured statically, to an extent; however, it cannot be precisely measured, then predicted. This is important because if we understand and accept human communication as a stochastic process or system, then we also accept the premise that human communication can be statically measured. Given that, one could assume that within those statistical measurements, we can measure entropy but also observe the magnitude of and nature of that entropy. Here, by “nature” I am suggesting that entropy comes in many forms in a nonlinear dynamical communication system. One such form is noise or any other external factor that will interrupt the data transfer processes.

Chaos in Communication Systems

A stochastic process is one that implies an underlying organizational structure that allows for statistical measuring not dissimilar to the communicative system that we see in forensic science. "The fundamental role that entropy plays in the theory of stochastic processes shows up most clearly in the theory of large deviations, which tries to measure probabilities of rare (untypical) events on an exponential scale" (Rasband, 1997). What the above passage suggests is that entropy plays an integral role in processes that are stochastic, like communication. However, one might not immediately or directly measure the effects of entropy in a system like this until the dynamics cause the system to deviate enough to be considerable, as explored in previous chapters.

The term chaos as it is used in physics offers valuable insight into the true nonlinearity of the systems. According to Rasband, "the basic idea, briefly indicated here, is the following. Unpredictability of a deterministic dynamical system, which is caused by an extreme sensitivity to initial conditions, is noticed by an external observer because typical coded trajectories of the system are highly complex and resemble those produced by a random source with positive entropy" (Rasband, 1997). Chaos has a multitude of connotations and meaning, but the intrinsic meaning hints at a system that presents in a manner that is nonlinear and dynamical. A system like that of human communication illustrates the highest potential for behaving in a manner consistent with what could be thought of as chaos.

An entropic consideration of a police scientific communicative system is productive. Placing entropy at the center of a discussion about a nonlinear dynamical system like that of human communication helps one to see where information and data are being lost. Textual unpredictability in the forensic pathology reports and the forensic engineering reports highlight this phenomenon through the readability index, as seen earlier. Moreover, considering entropy as the core element in examining these loss considerations attributes data and information loss to such entropies. Understanding entropy as one of the core causes for data and information loss in a scientific communicative system leads us to figuring out how that loss could be mitigated, at least somewhat, on the microscopic scale. It is within these systems that we must also consider the fact that entropy and chaos work in opposition to an orderly structure. That is to suggest, chaos and entropy in a communicative system, whether it is closed or open, will seem as if it is seeking to work against order.

Key Models Of Communication

A forensic science communicative system in equilibrium will have a better chance at communicative success in terms of the encoding and decoding processes if entropy is reduced. It is important to note here that in referencing the inherent nature of entropy, I might refer to the seeming "chaotic" nature of the nonlinear, dynamic system. The term "chaos" as it relates to entropy does not necessarily mean disorganized per se. Economists Alfred Medio and Marji Lines, in their 2001 text, "Nonlinear dynamics : a primer," articulates this idea. I like to think of a communicative system as a double pendulum. That is to say, at first glance, the movement of a double pendulum may seem random or disorganized in a nonlinear dynamical system only because the system is sensitive to the initial conditions. The movement of chaotic systems is actually determined if we know enough of the initial condition. In scientific and technical communication systems, we know at least enough of the starting conditions to understand the resulting product. However, that is not to suggest that discussions of entropy are moot.

Instead, it suggests that in a nonlinear chaotic dynamical communicative system, conceptual aspects of entropy can be measured. Generally, such measurements come from a combination of textual and numerical analyses: inductive qualitative coding analysis, a manifest analysis, and a latent semantic analysis. What these analyses do is take three instances of scientific communication in forensic science and point to instances that could be entropy. Moreover, these analyses buttress the close reading and discussion of the results. To illustrate the nature and magnitude of unpredictability in this system, the case studies might suggest that this system, while chaotic in nature, is not necessarily random and is more deterministic. Moreover, in unpacking the underpinning of nonlinear dynamical communicative systems, a trend could appear in the data that shows the nature and magnitude of the entropic elements of a communicative system. Results from Voyant Tools analysis show that instances of entropy are indeed "true entropy" and are not elements of linguistic anomalies, or subject position biases, and results can characterize actual instances of entropy in these systems.

Chapter 5: Conclusion

Though the Voyant Tools textual analysis has yielded tentative insights, it was still productive. What I hoped to accomplish was a microscopic view into what factors have an effect of communication within a particular subset of police communication. It is important to understand one facet of the loss of information through the written communicative process, as that is integral to the overall investigative processes of forensic science reports. In the beginning, I set out to examine what I viewed as an integral facet of police scientific and technical communication. I set out to describe and attribute such loss of information to the unpredictability of a text through what I described as entropy. That particular form of entropy seemed to have a direct correlation on the readability index of the forensic science reports. Such an index is a measure of how digestible and comprehensible a text is. I found that a low readability index seemed to directly correlate to the level of unpredictability/entropy in a text. That is, the higher the entropy, the lower the readability index.

Initially, I thought that noise and interference in a communication system were forms of entropy. However, after conducting textual analysis, I found that entropy may not necessarily be noise or inference, but instead may speak more to the underlying disorder in a communication system that has an effect on noise. That is to say, I now view entropy as unpredictability. That type of entropy, unpredictability, has an effect on how well the system can handle interference which, by extension, affects how much information is lost, received, and comprehended, which is more of a direct measure of entropy. One form that this takes is the reception of the output of information in the form of a low readability index. It should be noted that this particular form of entropy does not seem to be directly caused by noise or interference, nor does it seem particularly productive, as I initially thought. Instead, this form of entropy seems counterproductive as it adds to information loss/disorder, and does not provide any socio-cultural contextual clues about the meaning underpinning a message. That said, I found that the underlying moral economies of those participating in the broader police and forensic communicative systems seemed to impact the document composition. In these systems of communication, it is important to acknowledge the moral economies as that will offer insight into the subject position of the composer of a written text, related to the genre of a forensic report as a whole. Following these insights, my proposal for an entropic model of forensic scientific and technical communication is now a little more detailed than the models of communication articulated in chapter four.

My proposed model of forensic scientific communication accounts for one type of entropy, textual unpredictability. First, there is a sender or a composer of information, similar to information theory. The sender is embedded in a moral economy of forensic science. That embeddedness contributes to the highly probabilistic socio-cultural context. This context includes various subject positions as well as other factors. The sender or composer of the piece of communication then decodes the information provided by the autopsy or by the accident being investigated. Those findings are then committed to paper as a report, the report being disseminated to the primary audience (the judge, medical examiners, investigators and other law enforcement personnel), then to those in the judicial system (the judge, jury, prosecutors, defense attorneys, and plaintiffs), each party wrapped in their own entropy/unpredictability bubble that is the subject position and the socio-cultural contexts, which informs how this message is then decoded by that audience. Additionally, this message is embedded in the genre: with readability index, structure, and vocabulary density, particularly relevant in dissemination to the general public, who are also in their own entropy bubbles, as well.

The aforementioned model suggests that much of forensic-driven communication is similar in style and genre conventions perhaps because of the interworking of a moral economy of police science. Despite this perceived stability, a probabilistic approach to understanding the role of unpredictability in police scientific and technical communication would be productive in understanding the effect on the communicative system in the form of the readability index. It is important to account for the probabilistic nature of language. These microscopic, entropic effects on a communication system lead to larger impacts on the communication system in terms of information encoded and decoded, then lead to more systemic communication. Also, bear in mind that in regards to entropy, there is a tendency for a closed communication system to tend toward disorder, but ultimately, this dynamical disorder will move towards, and eventually gain, systemic equilibrium. Police communication, as a whole, is still settling into a new equilibrium given the cases analyzed in this dissertation and many others. Following Thomas Kuhn, forensic science in police communication is not yet a "mature science" (Kuhn, 1997).

The unpredictability of a text is entropic in that it is impacted by information that is input and proceeds to impact the internal organization of a system. The higher the unpredictability, the higher the entropy. This has tangential effects on other elements in a communication system such as the readability index. The dissertation introduces the questions: what causes unpredictability in a text? Moreover, to what extent is a particular genre to blame for unpredictability? Understanding genre can point to the cause of certain textual peculiarities. My inquiry is insightful as it highlights the microscopic elements as entropic communicative instances.

It should be noted that a forensic science communicative system in equilibrium will have a better chance at communicative success. A highly organized communication that comes from a singular source, like the reports produced after a law enforcement event, are highly predictable, due to the restricted and explicit nature of the communication. At any given stage of a criminal investigation, the articulation of these reports will differ based on context, medium, and audience. Each of these factors will impact the genre-specific requirements and resulting piece of communication. Since my approach for analyzing the forensic pathology and forensic engineering reports lies at the intersection of scientific communication, math, and linguistics, I utilized Voyant Tools to highlight textual peculiarities that could be signs of unpredictability. Many of the constraints of introducing a new model of communication are similar to those of a model of scientific communication in general. Where my research diverged from traditional scientific communication is there was less of a focus outward to communicating with the public; instead, this dissertation has emphasized communication with other professionals with varying levels of familiarity with forensics.

Socio-Cultural Considerations

This is all to suggest that genre works on a microscopic level beyond semiotics. The rhetorical situations of the forensic science reports derives its exigence from the broader socio-cultural contexts. That exigence then provides the composer of the forensic report with a purpose. That purpose, along with an understanding of the communicative participants' intentions, are then articulated for a more public audience. The resulting articulations are written products that highlight broader social patterns (Miller, 1984). Scientific objectivity is a goal in composing forensic reports, however unlikely that is to achieve in full. It is essential to consider the subject position of the participant, and it is the embeddedness of the participant in a particular socio-cultural context that impacts the genre. The results of such can and do have an impact on the unpredictability of a text, and such unpredictability is, I argue, a form of entropy.

Moreover, there are implications for the readability index of a document which are informed by the broader socio-cultural contexts. Please note that there is research being done regarding the George Floyd incident, notably Christopher Odom in his text "Justice for George Floyd: Tipping Point?" and Sasheena Polk's text "I Can't Breathe…Again. Individual's Attitudes towards Police After The Death of George Floyd." Both of these texts offer valuable insight into what elements affect the rhetorical situation when the forensic pathology reports were written. Texts similar to the aforementioned ones are an integral part of the broader conversation. It is important to understand the socio-cultural context in which these forensic reports were embedded. That context will inform the choice of signs and signifiers. These signs will have an impact on how effectively or how ineffective a message was conveyed. In the chapters preceding this, I argued for textual unpredictability impacting the readability index, which is a measure of communicative success. The social context in which these reports are embedded have a direct impact on their composition and reception.

Rhetorical Situation and Human Subject Research

In thinking about the impact of the rhetorical situation on semiotic variables, I would like to highlight the following passage from Friis and Astrom, "when the speaker enters the situation, the speaker is faced with a (real or potential) *exigence* or *urgent i*ssue that can be changed through discourse" (Friis & Astrom, 2017, pp.30). As mentioned above, the socio-cultural context has an impact on the reception and composition of a forensic report. Even though these reports are in the sciences, they do not and cannot escape 'non-objective' elements occurring in the texts. I think it is important to keep the subjective and intersubjective elements in these scientific reports because both forensic engineering reports as well as forensic pathology reports are human-centered inquiries. It is important to not remove the human out of that entirely as it can offer more insight into how a death occurred. To that end, such research can come with its own challenges.

While the three forensic reports that I analyzed did not require IRB approval, since the subjects are deceased, I was able to freely access that information. I would like to highlight that information can be utilized without ethics board approval if there are no paywalls or hurdles to obtain that information. You can, and many people do, request subject-sensitive information from police departments; however, there is usually a fee as well as a form to fill out. Had I used that information, I would have had to gather approval for use of that rhetorical artifact.

I highlight this because Human Subject Research versus what is available to the public will impact, at least on some level, how information is received. While out of the scope of focus of this dissertation, it is important to also consider the element of Human Subject Research as it does have an effect on effectiveness of a communicative system. Schneider in his 2015 text " The censor's hand: the misregulation of human-subject research" highlights the moral tradition expected in the sciences and how that relates to Human Subject Research currently. Schneider emphasizes the importance of understanding that good research practices can mitigate the potential for misuse of information; however, there is still some risk to a subject (Schnider, 2015). However, since the subject of a forensic science report is already deceased at the time of inquiry, that "risk" is gone. I would like to point out that the expectations set forth by ethics boards and Human Subject Research are a part of the foundation of legitimate science. There has been some discussion that forensic science is 'junk science' and therefore not legitimate.

Junk Science and Further Research

I think it is important to have discussions scrutinizing scientific practices in these types of fields. Productive scrutiny is necessary to force paradigm shifts. I do think, however, conversations that are happening regarding forensic science being "junk science" warrant some critical inquiry to ensure that the subject matter is not being misrepresented. "Junk Science" (2022), written by Chris Fabricant, discusses this topic at some length. While valid points are made about specific investigative techniques in forensic science, there is an issue that occurs in his text because he is conflating one singular forensic technique – dental testing – with the whole of forensic science. To suggest that forensic science as a whole is "junk science" based on one singular technique that is not used in a lot of cases, is irresponsible in that it diminishes the ethos of the field. This is important when it comes to litigation and criminal proceedings. Forensic pathology is a medical examination done by a medical doctor; to say that it is not science is not accurate. Medical doctors offer their opinions all of the time in terms of, for instance, a diagnosis, they then buttress that opinion with scientific medical findings; pathologists do exactly the same. Moreover, forensic engineering relies on physics and math to paint a picture of what happened and what caused an accident; for him to suggest that the whole of forensic science junk science based on one admittedly flawed technique that is rarely employed is questionable. However, conversions similar to this are so rich and absolutely integral to these fields and the associated research. There are so many possible avenues for future research that are similar to Fabricant's text. My dissertation aimed to contribute a small part to these types of conversations that are rather tricky to research. It is important to further research these complex interactions, between seemingly disparate fields, to gather insight into forensic science communication, because it occurs so frequently, with high stakes.

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