CHAPTER

4

"Are Facts Not Flowers?": Facticity and Genetic Information

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Are facts not flowers?
and flowers facts?

—William Carlos Williams

Ever since Locke (1690/1998) introduced the notion of the *fact* in 1690, mediated human communication has revolved around facticity—the claim that a given datum or narrative does or does not refer to empirical reality. Distinctions between fact and fiction, fact and opinion, fact and falsehood, and fact and error are important for legal, economic, and often social treatment of information and those who produce it. Genres became distinguished along these lines so that journalism and history, for example, are presented as factual, whereas fiction is not. Adherence to specific practices and procedures for the production of fact are the core of professionalism in law, journalism, and science. Institutions with the capacity to "certify" data and narratives as factual have developed, always associated with governance and power.

Facticity has long been a subject of communication research in areas as diverse as studies of news production, sense making, the social construction of reality, and persuasion. Because technological change alters the practices by which facts are produced and the institutions by which they are certified, with each innovation in information and communication technologies new questions about the nature of facticity and its production arise and old ones must be revisited. The printing technologies of Locke's time presented a challenge to facticity because print publications offered the possibility of immediacy but did not guarantee it. As a result, "with the beginnings of the report of recent events came the problem of proving the truth of that report" (Davis, 1983, p. 70), a difficulty repeated on a different time scale with the telegraph (Headrick, 1990) and, today, the internet. In the same vein, the electrification of communication technologies in the late 19th and early 20th centuries made possible new forms of mass media and, consequently, genre shifts that led Robert Park to comment in 1940 on the rise of a "specious present."

Since that time, commodification of the fact (Lyotard, 1984), the increasing ease with which seeming facts can be manipulated (Enzensberger, 1974; McLuhan, 1968; Zavarzadeh, 1976), and growing sophistication regarding the interaction between facticity and power (Foucault, 1972) have made facticity a matter of focal interest. With meta-technologies, the expansion of the degrees of freedom with which information can be processed undermines facticity because the number of steps in the causal chain through which facts are produced has multiplied, interactions between facticity at different levels of granularity must be taken into account, and there is a proliferation of facts in a Lockean sense that must be taken into account in the formation of meaning. Just as the scale, scope, and ubiquity of human communication has been transformed in the digital environment, so the problems of producing, evaluating, and sustaining facticity have become more complex.

Genetic information of course differs from the facts of human communication because it is a set of instructions—like a computer program—rather than an assertion, but the effects of both types of facts we now know vary according to the receiver, context, and environment in which meaning, or form, is made. Genetic information raises issues of facticity at three levels: First order issues arise when determining the facts of genetic information itself, including questions of identification, quantity, and effect. The institutions that certify genetic information in various ways both demand facticity and constrain the ways in which representations can be undertaken, producing second order issues. Discourse about genetic information in society at large, often with persuasive intent, raises third order facticity issues in familiar genre form.

As with the facts of human communication, the facticity of genetic information matters because it has economic, social, and cultural implications. There are political implications as well because transfers of genetic information led to a radical restructuring of the global division of labor and control over it following the "Columbian Explosion" (Crosby, 1972, 1994), and practices based on misrepresentations of genetic information can result in environmental and/or health disasters. Today's ability to alter the genetic makeup of people—to change the facts, so to speak—contributes to the sense that we are entering the "posthuman" era so much discussed by analysts of the effects of digital information technologies (see e.g., Dewdney, 1998; Hayles, 1999). Both types of meta-technologies—biotechnology and digital information technologies—affect confidence in a fixed empirical reality and/or our ability to perceive it, habits and norms of fact production, the nature of the institutions that certify facticity, and the possibility of asserting property rights in facts.

The "semiotization" of nature (Hoffmeyer, 1997) began in the early 20th century when biologists began to explore the ways in which organisms perceive and act on their environments in ways describable as communicative, and it was extended when the discovery of DNA suggested it was possible to understand biochemical processes in the same way. There are of course limits to the extent to which metaphors can legitimately be transferred in either direction (see Ritchie's examination of this problem in chap. 2, this volume). Looking at the facts of genetic information and of human communication through a common lens, however, makes it possible to learn from the history and sociology of one type of meta-technology ideas that can usefully be applied to the other. Wildman (chap. 3, this volume) examines one such communicative feature—the role of conditional expectations. This chapter explores another, suggesting a typology of types of facticity evident in the analysis of genetic information that can be applied to the study of human communication.

The problem of facticity does not exhaust the ways in which biotechnology is intertwined with the sociology of knowledge. Development of the field has disturbed historical distinctions between types of scientific specialization; created new relationships among government, industry, and academia (Benson & Shaw, 1992; Hadwiger, 1982; Kloppenburg, 1988; Lazonick, 1991; Wiegele, 1991); and provoked new theories about the development of disciplines and their life cycles (Latour, 1988; Vernon, 1990). Indeed, the methodological revolution after the 1880s that led not only to contemporary biotechnology, but also to the use of research-directed experiments across the social and physical sciences, was driven at least in part by the very desire to raise respect for the field of biology (Harwood, 1993; Pearton, 1984). The sociology of knowledge has been useful in the diffusion of knowledge needed to use the products of biotechnology (McCorkle, 1989). The requirements—or alleged requirements—for knowledge building in biotechnology has led to changes in the law and government institutions (Kloppenburg & Kleinman, 1988; Pearton, 1984). Lievrouw (chap. 6, this volume), Murdock (chap. 9, this volume), and May (chap. 5, this volume) address some of these matters further.

THE GENE AS FICTION VERSUS GENETIC INFORMATION AS FACT

Few concepts in the history of the physical sciences have been as problematic as that of the gene (Goonatilake, 1991; Nelkin & Lindee, 1995). It is paradoxical that while the gene began as a linguistic fiction and continues to be so, it functions in popular culture as a secular equivalent of religious truth in ways that have remained remarkably consistent since the early 20th century. Although genetic information is constantly mutable and mutating, in popular culture the gene is treated as incapable of deception and as the locus of authenticity.

The term *gene* was coined by Danish geneticist Wilhelm Johannsen in 1909 to describe a presumed cellular entity capable of producing a particular trait. The notion was inspired by German physiologist and geneticist Hugo DeVries, who used the word “pangenes”—itself derived from Darwin’s concept of “pangenesis”—to refer to the origins of biological variation. For the first generation of experimental geneticists in the early 20th century a gene was, in practice, a physical trait such as wing shape or eye color which seemed to derive from a substrate of hereditary material, the actual constitution and functioning of which were at the time unknown. More recently, increasing knowledge about the gene as a molecular entity has clarified its physical form but complicated its biological meaning, not in small part because it can be described concurrently in morphological, physiological, genetical, and molecular terms (Bent et al., 1987).

The confusions are two, both deriving from one of the most ancient of philosophical problems—the difficulty of understanding the relationship between the intangible and tangible. First, in the popular imagination, the physical material in which genetic information is embedded—DNA—is often equated with the information embedded within the DNA itself. This is akin to mistaking the physical object of a book for the information contained within it. Second, the distinction between the genotype (the genetic information of which an organism is comprised) and phenotype (the manifestation of that genetic information in the material world) is often conflated. The phenotype results from interactions of the genotype with particular environments. Indeed, within any one species there may be thousands of the genetically variable populations derived from differential responses to environmental conditions known as landraces. Although it is tempting to think of the genotype as an ideal Platonic form, it is more accurately described as a potential for a myriad of possible forms out of which one will be selected by the environment and the history of an individual within it. There are important implications of this difference in the social world: It is one reason that, for example, genetic testing in the workplace should not be grounds for excluding certain workers from particular jobs because there is no way to know whether a genotype will be expressed phenotypically in any particular individual and/or context. There is in reality no single normal genotype, but rather an entire spectrum of genotypes should be considered normal (Suzuki & Knudtson, 1989). It is the genotype that is the genetic information discussed here.

Because of these two confusions, the word "gene" no longer has meaning for molecular biologists. "But," note Hubbard and Wald (1993), "since genes remain very much a part of the science of genetics, as well as of the culture at large, experiments with DNA get communicated in the language of genes" (p. 43). The result is ambiguity. Although DNA, the genotype, and the phenotype are so intertwined that it is not always clear which is being discussed, the actual complexity of genetic information often gets translated—both within the scientific community and without—into a machine-like metaphor that emphasizes the ability of humans to control it (Haraway, 1976; Nelkin & Lindee, 1995; Woodward, 1994). Even when there is no such confusion regarding genetic information, however, there are first order, second order, and third order facticity issues.

GENETIC INFORMATION AND FIRST ORDER FACTICITY

First order facticity issues involve the identification and description of information. They fall into two categories: "natural" falsification and human falsification. The themes are familiar because first order facticity issues of genetic information deal with two relationships: between sign and referent, and between stability and change.

Natural Influences on the Facticity of Genetic Information

The facticity of genetic information can be affected in natural ways through environmental influence, the presence of empty seed husks, or of nonsense, decay, genetic drift, and masking. This type of facticity issue has importance in the marketplace because buyers want to know what they are getting. In addition, in some cultures and/or periods of cultural history, the purity of species has been a moral issue (Harwood, 1993; Wiegele, 1991).

Environmental Influence. The genotype/phenotype relationship inevitably leads to a situation in which what one thought was a genetic fact may not be so. Efforts to prevent the phenotype from wandering too far from the genotype are essentially hopeless, although those responsible for maintaining genebanks put a great deal of effort into trying to maintain purity for purposes of quality control. However, manipulating the environmental factors that influence the phenotype can be a biotechnology technique in itself. Following a classic 1927 demonstration of artificial mutation by x-rays, Germans and Russians tried to target—or intentionally induce—particular types of mutation (Fleming, 1968) and following WWII, the Japanese successfully used radioactivity to create genetically mutated organisms for commercial use such as industrial fermentation (Krimsky, 1991). The meaning of human communication of course also differs significantly from context to context. Thus the focus in recent research has been on reception practices rather than content alone (see e.g., Liebes & Katz, 1999).

Decay. Genetic information can be "archived" in genebanks, but without regeneration (e.g., planting and reharvesting seeds or inducing reproduction in animals), the information held decays over time. Each type of genetic information has its own lifespan—wheat must be reproduced every 3 years, alfalfa every 10, and potatoes yearly. Long-term storage holds seeds for 50 to 100 years, but this requires moisture-controlled conditions at temperatures below freezing (at the highly sophisticated genebank in Ft. Collins, Colorado, many seeds lie in liquid nitrogen at –273 degrees F to minimize decay). Only a small proportion of the world's genebanks have such facilities. Some of the world's most important archives of genetic information, such as the Vavilov collection in Russia, hold seeds at room temperature ("Needed," 1994; Strobel, 1993). Even regeneration does not prevent decay, however, for it never exactly replicates the genetic information involved because of genetic drift and alterations in the phenotype (Konopka & Hanson, 1985). Some "falsification" also results because people automatically choose the best plants in every regrowing cycle, gradually adapting the original genetic composition to the new environment and favoring certain characteristics over others even when not for survival value (Leeuwis, 1993).

Thus just as there is the problem of conservation for the materials of human communication, whether in paper or electronic form, so it is difficult to conserve genetic information. Just as with human communication, where errors are seemingly inevitable with most modes of copying, each time there is a reproduction of genetic information the process itself introduces error. In human communication, the problem of decay has gotten worse with each technological innovation—whereas symbols chiseled into stone thousands of years ago remain legible, electronic storage media must be refreshed every couple of years. Recently software that was developed to study the evolution of biological organisms has been applied to the analysis of changes in texts that result from error occurring during copying, leading to new interpretations of Chaucer (Brainard, 1998).

Empty Seed Husks. The effort to quantify genetic information can founder when what is expected to be a physical embodiment of genetic information does not actually include that information, as when a seed husk is empty. In the case of seeds, the problem of distinguishing between seeds and seed-like structures is frequent enough that it is of keen interest to those in agriculture who are, for example, concerned about such matters as yield in seeds per acre. Estimating the number of seeds is also important to managers of genebanks because it determines whether material can go into long-term storage without first being reproduced, distribution policy, the number of seeds available for testing, how much space is required for storage, and the date the next generation must be produced. In some cases, a purity analysis is needed simply for counting purposes. One procedure developed to cope with this problem is to divide the total weight of seeds by the estimated mean seed weight as established by the International Seed Testing Association (ISTA) to get what is considered to be a reliable figure for the actual number of seeds (Konopka & Hanson, 1985).

Similar problems arise in the struggle to develop research methods that are both valid and reliable for the study of human communication. Formulaic techniques are also used here to address those problems.

Nonsense. In human cultures, nonsense fulfills the function of play. Some genetic information is described as nonsense—"junk DNA"—because it is not yet understood scientifically (Krimsky, 1991; Nelkin & Lindee, 1995). In the case of genetic information, such material actually marks the bounds of human knowledge and is not a matter of facticity at all. Indeed, many of the most important evolutionary features do not arise as adaptations, but as biological, social, or cultural cooption of structural byproducts—"spandrels"—thrown off from adaptive change for new purposes. Many even believe that reading and writing evolved in this way (Gould, 1997).

Change of Referent. In human communication, a vast amount of effort has been devoted to explicit discussion of the relations between signs and referents—definitions. In many cases there is more than one definition for a word or phrase, but when that happens each referent is separately identified in comprehensive dictionaries. Such an accomplishment is many years away with genetic information or may never be possible. Identical sequences of genes at different points on the genome can have different biological meanings, and the same genes can have different effects in different organisms from the same species because of the complexity of interactions among genes, and between genes and the environment.

Genetic Drift. Neither genotype nor phenotype remains stable over time as a result of genetic drift, the natural introduction of changes in genetic information in the form of mutation. This is a difficulty for intellectual property rights in the same way that asserting those rights in constantly changing digital texts is problematic. It also presents a problem for economists, who define goods as stable in form across time and space. It was for just this reason that the U.S. Department of Agriculture resisted the patenting of sexually reproducing plants for many years. Although the Plant Patent Act of 1930 did mark a significant change in the ability to patent asexually reproducing plants, it took several decades before those that sexually reproduce became patentable because the degree of genetic drift of such plants is higher. When they did, with the Plant Variety Protection Act of 1970, it was not because of a belief that sexually reproducing plants were any more genetically stable than they had been, but because the PTO stopped requiring precise descriptions of specific individual examples of the genes for which a patent was sought in favor of requiring only a description of population parameters (Bent et al., 1987; Kloppenburg, 1988; Krimsky, 1991).

The parallel in human communication would be natural changes in meaning that can, over time, lead readers or viewers to misinterpret a text created in an earlier era. In some cases, knowledge is lost altogether. Interestingly, the very act of translating tactic knowledge held by individuals into codified knowledge available to all can lead to a loss of knowledge.

Masking. One of the earliest features of genetic information of which scientists became aware was the ability of dominant information to "mask" recessive genes that may not make their appearance in the phenotype for several generations. The masking of recessive genetic information may be considered a form of falsification in the sense that the presence of certain information is hidden. The parallel in human communication would be misrepresentation through selective presentation of information.

Human Influences on the Facticity of Genetic Information

Deliberately or not, people can falsify genetic information through manipulations of the genetic information (adulteration) or representations of it (misrepresentation). Because of the ancient link between political power and control over fundamental resources such as food, which are reliant on genetic information resources, unofficial genetic information has also often carried the connotation of unacceptable falsity.

Adulteration. Interactions among the handling of germplasm, natural differences between samples of biological material, and environmental degradation create multiple opportunities for adulteration. Blending opportunities arise at multiple points of the distribution process: on the farm, at the point of delivery to traders, during transport, in the course of consolidating small batches into larger ones, during milling or other processing, and in packaging (Thorbecke, 1992).

The difference between deliberate adulteration of grain and grain blending is one of degree. For example, it has long been accepted practice to combine grain from different truckloads of widely varying quality as a receiving practice during periods when high volumes of grain are being transported. For this reason, blending is both the stimulus to regulatory interventions and a factor that confounds regulatory success. The ease with which genetic material of differing qualities and characteristics can be blended and the dispersal of opportunities to do so is among the concerns on both sides of the debate over genetically modified (GM) foods discussed by Murdock (chap. 9, this volume) and Priest and Ten Eyck (chap. 7, this volume). Consumers claim they can never know whether they are getting GM foods, and the agriculture and food processing industries insist that, irrespective of labeling and any efforts at containment, no single entity can control what happens to the material it produces once it enters the distribution chain.

Overgeneralization and statistical aggregation offer equivalent opportunities for "adulteration" of the facts of human communication that can similarly be intentional or not. The opportunity for such adulteration of the facts has even been exploited in recent years by the statistical technique of "perturbing" individual detail systematically to protect the privacy of individuals reported upon in a sample ("Privacy," 1991). Adulteration in human communication also occurs when misinformation and information are combined.

Misrepresentation. As with the treatment of facticity in language, where rules of legal evidence and the illegality of libel, perjury, and fraud attempt to restrict deliberate falsification of information through misrepresentation, a great deal of law and regulation has developed in the effort to prevent falsification of genetic information through misrepresentation. As early as the 4th century BCE in Greece, special laws governed trade in grain in ways that went beyond laws applied to other types of commodities, and there were special magistrates to administer those laws—whereas misrepresentation in the course of trading in metals, textiles, or oil was punished by fines or imprisonment, misrepresentation of the genetic information of grain was punishable by death. In China, Confucian morality is said to have grown out of Confucius' experience in management of a public granary in his youth (Spitz, 1983). With the elongation of the marketing chain, opportunities for misrepresentation of genetic information by distributors and traders also multiply. As a result, numerous rules establishing standards for distinguishing among grades of grain, measurement, grain handling, and labeling have been put into place. In the mid-19th century, it was an offense in Britain to sell any "killed or dyed" seeds with intent to defraud, for example, and many U.S. states legally require seeds to be "true to name" (Kloppenburg, 1988). Misinformation, disinformation, deception, and fraud are the obvious equivalents in human communication.

Unofficial Genetic Information. Over the long course of human history, households have saved seeds from 1 year's crop to sow for the next even when those in power controlled the storage and distribution of grains. In flush times, political entities had little or no interest in control over such genetic information because it was for personal use only. In times of scarcity, however, governments were interested in collecting these hoards as a form of taxation that transferred control over genetic information from producers to nonproducers (Spitz, 1983). During the 19th century, however, governments became aggressively involved in collecting and distributing genetic material (both plant and animal) in the effort to improve the quality of what was produced in the private sector. At the same time, the processing, distribution, and marketing of materials such as seeds took on an industrial form (Duncan, 1989; Martinson & Campbell, 1980). As a result, by the late 19th century, farmers in many places could buy seed from either the government or private vendors. During this period government-distributed seed was considered to be the more valuable based on the perception that the government was less likely to misrepresent the genetic information and was motivated to distribute only high-quality seed. Government seed was cleaner, unlikely to be old, and free of grit and weed seeds. The government also kept raising its standards for seeds, instituting testing procedures for germination, cleanliness, and other features in 1886 (Kloppenburg, 1988). Ultimately this translated into an equation of unofficial genetic information with falsity (Tarrant, 1992; Thorbecke, 1992).

Here there is a parallel with libel law. The notion that truth is a defense was an innovation of the United States in colonial times; up until that point, and in some places still, merely disagreeing with official versions of the facts of the nature of government activity was or is treated as libelous. In such circumstances, government information is factual and all else is treated as false. Interestingly, just as struggles over the nature of facticity in reportage and public debate has been an organizing goal for civil society, so struggles for control over grain have been significant in the development of civil society historically (Benson & Shaw, 1992). Contention over the accuracy, validity, and utility of unofficial information lies at the basis of debates over the procedures of objective, *The New York Times*-style journalism and new journalism because the latter insists on utilizing and treating as important fact information that comes from unofficial sources.

GENETIC INFORMATION AND SECOND ORDER FACTICITY ISSUES

Second order facticity issues appear when genetic information is inserted into institutional frameworks such as those of the Patent Office, genebanks (genetic information archives), and labeling requirements. Such issues are deeply intertwined with those of standard-setting (Hill, 1990).

Patent Office

French rose breeders led a lobby for patent protections just like those of inventors of machines in the late 19th century (Mooney, 1988), but moral, conceptual, and logistical barriers stood in their way. Resistance began to fall in 1922, when Germany accepted a process patent on a bacterium, and a meeting of plant lawyers in London began to explore the possibility of protection for plant varieties (Crucible Group, 1994). This possibility became reality in the 1930s, when the U.S. Plant Patent Act allowed for the assertion of intellectual property rights in asexually reproducing plants and the Paris Union for global patent rights was amended to include flowers and flour under patentable material. From that point on, one type of genetic information after another became subject to patent, with Germany again being the first to permit process patents for the breeding of animals. The U.S. Plant Variety Protection Act of 1970 made it possible to own patents on sexually reproducing plants, and in 1980 the U.S. Supreme Court accepted the patenting of microorganisms in the landmark case *Diamond v Chakrabarty*. In 1987, the U.S. Patent Office began to consider patents on animals, and in 1992, the first patent over an entire species was granted in the United States—a practice Boyle (1996) equated with granting Ford the patent on the car. In 1993, the U.S. government applied for patent rights over human cell lines of the citizens of several countries in the developing world, and harmonization of patent laws across nation-states became a requirement for participating in the global trading system.

The U.S. Patent and Trademark Office (PTO) has justified its changing position over time on the patentability of genetically engineered plants, seeds, and tissue culture as responses to the growing descriptive ability of molecular biologists and geneticists. A patent office “certifies” the facticity of genetic information when it assigns property rights upon demonstration of its uniqueness, accomplished through narrative. The raw materials with which biotechnology works are usually so complex and highly integrated before human intervention that it is not possible to describe constituent elements precisely. Thus, developments for which patents are sought are more likely to be described in functional or informational than in structural terms. All that is required is convincing a patent office that information supplied by the inventor sufficiently alters the nature of the genotype to be distinguishable as something new (Bent et al., 1987). Replacing descriptions of specific exemplars with population parameters, as discussed earlier, is one approach for doing so. Providing descriptions that are loose or vague—often making it possible for one genetic invention to receive several different patents—is another. With the growth in knowledge about genetic information, descriptive ability has risen, accelerating in turn the commodification of genetic information and an increase in the incentives to continue to develop such knowledge.

Some of what is presented to the Patent Office as unique, however, is not. Unlike the standard utility patent statute, beginning with the Plant Patent Act of 1930, utility was not required to patent genetic information, only novelty and uniqueness. The question of relative superiority to existing varieties was also considered irrelevant. Thus, the number of named species protected by patent has proliferated even though these species often bring nothing new to either economic utility or crop performance at any stage of production, processing, or distribution. The result is that a high percentage of patents go to pseudo (false) varieties. In the mid-1980s, 62% of varieties protected by the Plant Variety Protection Office were accounted for by five crops only, almost all pseudovarieties. The Federal Seed Act of 1939 provision making it illegal to use synonyms for a single variety has not prevented this type of falsification: It only requires that patent applications include a demonstration that some research had been undertaken to develop the item for which a patent is sought.

Although seed company executives claim that farmers cannot tell that competing brands are virtually identical, this is not the case. A 1980 study demonstrated that Illinois farmers were well aware they were being forced to choose among 253 different selections of the same species of corn (Kloppenburg, 1988). Serious conflict has thus arisen between farmers and the seed industry because of the rising costs associated with creation of pseudovarieties. Those in agriculture have sought certification programs separate from those of the Patent Office to cut through falsification of genetic information descriptions, but the seed industry opposes the move.

Intellectual property rights do not play the same role in certification of facticity that patents do for genetic information because of course copyright does not require facticity. The one intellectual property rights issue that applies to both is patent “stacking” (English Nature, 2002). In the digital environment, sensitivity to the use of material owned by one entity in the production of further content has gone up. Stacking—linking several patents together to produce one item—has not yet been proposed as a way to cope with this in the copyright domain. In this period of extension and experimentation with intellectual property rights, however, that would be an interesting addition to laws dealing with compilations, collections, and derivative works. The multiplicity of patents involved in information technologies is a stacking problem that has long plagued those who try to enforce antitrust (competition) law.

Genebanks

The first order problem of decay becomes the second order problem of conservation when genetic information is archived in genebanks. *In situ* genebanks—"crop reservations" (Frankel, 1988)—preserve environments within which particular genetic information thrives so that it can be maintained on site in its natural context. Most genebanks are *ex situ*, off site, in scientific laboratories and botanical gardens.

The problem of decay requires high standards of quality control in genebanks for maintenance of their credibility. As far as possible, the genetic integrity of each individual accession is maintained, meaning that environmental influences on phenotypes must be controlled (Konopka & Hanson, 1985). Bibliographic data that justify inclusion of particular samples in the collection vary from genebank to genebank. They can include detail on breeding landmarks and special genetic characteristics, and always include data regarding the viability of seeds and regeneration and distribution instructions. Setting the standards for each type of data is a process of continuous negotiation between breeders and curators. It is the responsibility of curators to determine and standardize the threshold values for the number of seeds per sample in store and the regeneration standards that must be used to ensure that seeds remain viable, bearing in mind breeding systems, patterns of variability, and individual seed yield. Genetic information from different regeneration cycles is never mixed; information from different accessions of the same species are kept as separate samples, often in different locations to protect the distinction between them. Inaccurately classifying genetic information, a lack of fit between archival categories and empirical realities, differences in terminology from genebank to genebank, and active misrepresentation of genetic information to ensure its inclusion in genebanks are all potential sources of falsification during the process of translating genetic information into archival form.

Archiving, too, builds knowledge architectures when it effectively distinguishes between what will be accepted as fact and what will not. When the Chief Archivist of the United States (head of the National Archives and Records Administration) decides which U.S. government records are worth keeping for historical purposes, he or she determines the official view of U.S. history. George W. Bush has recently drawn dramatic attention to the political importance of this ability of archives to build knowledge architectures with an executive order making it much easier for presidents to forbid access to their papers as part of the mélange of policies putting in place changes in access to and use of information since the events of 9-11. In a related way, indexing fulfills a socially structural function via its determinations of knowledge architecture.

Most of the second order facticity issues in the world of social information deal with knowledge architectures. Some of these are textual: Compiling facts in dictionaries and encyclopedias makes them both official and available. Disputes over what should and should not be included provide interesting insights into social divisions. Eric Partridge, the lexicographer who seminally built dictionaries of slang, spent a life battling for acceptance of study of the language of those at the bottom, on the periphery, and in resistance.

Knowledge architectures are also built conceptually through the design of frameworks that are then used to guide institutional, economic, and legal behaviors. The classification system for industries and products used for purposes of economic analysis provides an interesting example; the long-standing Standard Industrial Classification (SIC) codes ultimately strayed so far from empirical realities that they are no longer in use. Although in 1997 a new conceptual framework, the North American Industrial Classification System (NAICS), came into use, analysts are still trying to figure out just how to make distinctions among industries and products within the information sector because, as they say, they can't quite figure out just what is being bought and what is being sold.

Institutions also have a knowledge architecture function because the very proceduralization of fact production within institutions has this effect. Analysts of journalism have discussed this in their analysis of the ways in which events become reportable facts when they pass internal institutional barriers—a license gets granted, for example, or someone graduates. This linkage of institutions with knowledge further supports the value of official versus unofficial fact.

Labels

Labeling has been an issue in the marketing of germplasm for a long time. One of the first pieces of business when the American Seed Trade Association (ASTA) was formed in 1883 was to agree to print disclaimers of performance on seed packages and a mutual acknowledgment that it was easy to market the same seeds under different names.

Among the several biotechnology issues currently the subject of intense debate is the labeling of those foods that include plants or animals that are genetically modified organisms (GMOs). There are "how to" and "whether or not" questions, both involving facticity. Standard-setting organizations (SSOs)—often the same groups that certify industrial technologies (Clark & Juma, 1991)—require adherence to specific types of descriptive terms. Although labeling developed over time as a cultural practice, today it is explicitly used as a form of information policy (Magat & Viscusi, 1992). Ratings systems and software filters are labeling systems applied to human communication.

Whether or Not. The National Food Processors' Association claims that two thirds of what is available in grocery stores has been modified. Along with numerous other groups, it is thus pursuing labeling as a way to warn people of potential health hazards. At minimum, selective and voluntary labeling is the best and most efficient way to diffuse perceptions of imposed risk (Douthitt, 1995). Almost all of the food with GMOs being produced comes from the United States, Canada, and Argentina, however, where labeling is not required.

Undeniably, meeting proposed EU standards or those being suggested for the United States would be logistically difficult because of the practice of mixing agricultural products from different fields and farms. Labeling also adds significant costs to processing and distribution and, it is claimed, reduces scale efficiencies (Miller & Huttner, 1995). Critics also maintain the law tries to draw distinctions between foods that are not chemically distinct. Even advocates of labeling are not clear on where to draw the line: Should a pizza be labeled if it contains cheese made with biotechnology produced rennet (60%–80% of current cheese; Thompson, 1997)? Chickens raised on feed from biotechnology engineered corn? Food from plants that are genetically engineered, but have no new genes or gene products in the edible parts?

We are beginning to see evidence of health effects in GM foods. As such evidence grows, so of course will public concern. The issue is currently on hold in light of world affairs, but it could easily trigger a trade war between the United States and Europe.

"How To." It would seem that the use of labels would reflect a commitment to facticity, but Wilkinson (1987) points out that labels instead often conceal rather than reveal essential facts because they fragment whole foods into constituent ingredients that often hold little or no meaning for consumers. Doing so reinforces the image of the food processing industry as the supplier of nutrients as opposed to food—a redefinition that in turn opens up new markets for biotechnology products in the form of "non-conventional" foods or elements of balanced diets. Although eating food is sensual and laden with cultural practice and meaning, deciding on a diet is conceptual and ridden with rules. This definitional shift is of importance from the perspective of facticity because it substitutes one set of referents for another.

The FDA's approach is that a food derived from a new plant variety must be labeled as such if it differs from its traditional counterpart to the degree that the common or usual name no longer applies to the new food, or if a safety or usage issue exists to which consumers must be alerted. Labeling must be both accurate and material. Because there is no evidence that biotechnologically modified foods systematically or significantly differ from other foods in ways related to either nomenclature or safety, there is no need to label, although there would be a reason to do so if the nutritional content changed (Miller & Huttner, 1995). The EU has approved rules requiring the labeling of any foods containing .9% material derived from genetically engineered organisms (GMOs) not previously approved, although they must be approved by the European Parliament and the 15 member states before they go into effect. These rules are extremely complicated—if the corn oil used in a particular mayonnaise is even 1% derived from GMO corn, it gets a label, but if an egg is raised by a hen on nothing but GM feedcorn, it does not get a label. Alternatively, a "no biotechnology" type label would protect those foods that had been monitored throughout the production and monitoring chain, but would leave most foods unlabeled (Thompson, 1997).

GENETIC INFORMATION AND THIRD ORDER FACTICITY ISSUES

Although first order issues derive from efforts to empirically capture genetic information, and second order issues from the institutionalization of genetic information, third order issues appear in the course of reportage and persuasion regarding either the viability of biotechnology for investment purposes or its health and environmental risks. As with digital information technologies, there are both utopian and dystopian views. Third order distortions of the facticity of genetic information are rife because of media willingness to follow often wild speculation in both directions. The politicization of biotechnology has taken place with little knowledge about actual perceptions of its risks (Douthitt, 1995; Siddhanti, 1991). The construction of narrative texts involves facticity problems that are cumulative, including those of the first, second, and third orders.

Investment

Although Rifkin's (1998) book describes the 21st century as the era of biotechnology, the same was said at the beginning of the 20th when it was believed that the new technologies would bring an end to hunger. German use of biotechnology to produce cattle fodder during World War I led to dreams that people ultimately would be able to convert the evening newspaper into sugar so rapidly that the protein produced could be consumed the next morning at breakfast (Bud, 1993). The most recent “geneticization” of the public mind via media campaigns in the 1970s generated investment confidence and public support for the then-blossoming industry. Genetics was once again seen as the next big wave of technological progress, and by the close of the decade the media were a captive audience for biotechnology. Each new scientific advance became a media event designed to capture investment confidence and public support, and market expectations and social benefits were often overstated (Krimsky, 1991).

A number of forces contributed to the nature of media coverage. There were economic pressures from advertisers because the food industry has provided almost 20% of advertising dollars for the media since the 1960s (Mamiya, 1992), and pharmaceutical advertising has become increasingly important. There was political pressure because trade in agricultural products was significant for the U.S. budget (Mayer, 1986). Information subsidies from trade groups, the organization of newsbeats, and a lack of scientific training on the part of most scientists (Kitzinger & Reilly, 1997, intclib.ask for cite; Wiegele, 1991) make it easier for news media to be more pro-biotechnology than critical. Meanwhile the public interest aspects of news about the food, agriculture, chemical, and pharmaceutical industries were more difficult to discern and typically receive relatively little coverage (Oliveira, 1992).

Risk

The media do of course pick up on stories with high drama, such as claims that because of biotechnology, the ground will freeze, harmful bacteria will run rampant, plant and animal species will mutate beyond recognition, and cancer will spread. Popular awareness of risks from biotechnology was stimulated by two novels—Michael Crichton’s (1969) *Andromeda Strain* and Kurt Vonnegut’s (1963) *Cat’s Cradle*. Scientific concern over biotechnology had a prehistory in Vietnam-era concerns over the military purposes to which research and development (R&D) in general were being devoted. Biologists, chemists, and physicians were in particular disturbed about chemical and biological warfare and the use of Green Beret medical teams for political purposes in Vietnam. It was clear that technologies developed for counterinsurgency abroad had immediate domestic implications as well (Krimsky, 1982). In the 1970s, a group of scientists frustrated by the National Institute of Health’s (NIH’s) reluctance to closely examine release of genetically modified organisms into the environment began to publicize the issue, letting the public know that scientists were polarized regarding the safety of biotechnology. By the late 1970s, national environmental groups such as Friends of the

Earth, the Environmental Defense Fund, and the Sierra Club were involved in litigation over risk assessment procedures and related matters.

High drama was introduced into the debate by Jeremy Rifkin's use of a variety of media techniques, including confrontation. In 1977, he led a group of supporters in an invasion of a meeting of the National Academy of Sciences devoted to rDNA science and policy and disrupted it with guerrilla theater. Other tactics followed, generating media coverage that began to be successful as first Cambridge, Massachusetts, and then dozens of other states and municipalities passed laws prohibiting rDNA experimentation when it requires physical or biological containment. Congress was ultimately moved to hold hearings (Krimsky, 1991). There was a similar reaction to genetic engineering in Europe by the mid-1980s, and even more concern on that continent than in the United States over genetically modified (GM) foods by the mid-1990s (Gottweis, 1995). Rifkin's books (1984, 1998) have been critiqued for being scientifically unsound, but he continues to stimulate public debate about important issues.

Meanwhile biotechnology risk has become increasingly politicized. Experimental release of genetically engineered organisms (GEOs) is taking place in developing countries, sometimes unknowingly and without approval ("Bugged," 1994), and sometimes, as has been the case with storage of hazardous waste, a deliberate choice on the part of impoverished and marginalized communities to earn cash by doing so. The United States has accused the EU of increasing perceptions of risk by the very slowness of its legal response. Research on GM crops is now demonstrating risk beyond those of unintended release, such as an increase in the demand of such crops for water, freak and/or non-bearing crops, the danger that super-resistant bugs or weeds will develop, and greater sensitivity to UV-B rays (Benson & Shaw, 1992; Ehrlich et al., 1993). Some interbreeding with other plants has been found (Lean, 2003) as well as real environmental costs when insects or animals reliant on a particular food source cannot tolerate genetically modified plants—the Monarch butterfly was the first casualty of this kind. Interestingly, although some foods such as the bioengineered tomato have caused a lot of controversy, other transgenic foods have not. The medical industry accounts for 90% of the products of genetic engineering but it is food that generates about 90% of the controversy (Thompson, 1997).

ORDERS OF FACTICITY IN HUMAN COMMUNICATION

The distinctions among first, second, and third order types of facticity brought to our attention by the study of genetic information can enrich understanding of facticity in human communication in two ways. It provides a way to conceptually bundle issues that have been addressed in different literatures so their similarities and relationships can be seen: First order issues are raised by research methods, second order issues by knowledge architectures, and third order issues by narrative production. It also provides a way to conceptually unbundle issues that have been grouped together in discussions of facticity so that the unique characteristics of each—and their relationships with each other—may be more clearly seen.