Artful Trust of Digital Systems

John Roeder
University of British Columbia School of Music

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[1] In my usual capacity as a music theorist, I analyze compositions and explain how they work, so that students and audiences can appreciate them better. I specialize in recent art music, much of which is written, controlled, and performed with computers.

Whenever I consider a particular piece of music, I am exercising trust. For example, when I listen to something that is purported to be a symphony of Beethoven, I am trusting that the performers are accurately executing instructions that that composer himself wrote down according to unwritten conventions that he assumed, and playing on instruments that match the ones he specified. I trust those instructions have not been altered in a way that affects the essence of the work. If my trust is misplaced, then anything I say about what the work means, about the composer's style, or about their role in the history of music is suspect. Hearing the symphony might be a pleasant experience, but I can't connect it definitely to my culture and heritage, and whatever I think about the music may not be relevant to someone else who listens to a more trustworthy instance of it.

For music being created digitally today, issues of trust are even more pressing. Imagine the following scenario. [2] A century from now, a musicologist researching music of our time discovers [2a] a silver disk. The scholar recognizes it as an ancient and obsolete medium for storing digitally encoded information. Fortunately enough is known about this medium that, at great cost, she is able to read the digits on the disk, and determine that they group into four logical groups of information, or files. One of these [2b] seems to match the arrangement of bits

in a pattern common around the year 2000, the portable document format. When this information is decoded, it shows a musical score and some text indicating that the disk files contain instructions for performing a work for a bassoon and digital equipment that listens and responds to the bassoon's sounds. [2c] Another file matches an ancient but known digital representation of audio recordings. The other two files [2d] do not match any currently known format, but the PDF says they are control information for a particular type of computer and a musical synthesizer. What the musicologist can do with this information is a function of the trust she places in various assumptions. [2e] How does she know she is reading the files correctly? On what basis can she be assured that all these files are what they purport to be? That they have not been tampered with, or are simply a hoax? What does she need to know about these files to be able to perform the composition, and what confidence can she have that such a performance matches the composer's intentions? Generalizing this example, how can we place enough trust in digital representations of music to understand its history and cultural significance? If musicians in the future can't trust the musical documents today's composers are producing, then today's music has no future and future music will have no history.

These questions naturally resonate with the concerns of classic diplomatics. That body of theory analyzes the concept of trustworthiness into genuineness and authenticity. A record is genuine if it is legitimate, that is, created by the right person, and if it is truthful. A record is authentic if it has the physical and intellectual form typical of its purported time and place of creation. Classic diplomatics avers that if a record can be proven authentic, one can infer that it is also genuine. Therefore classic diplomatic analysis of physical documents focuses solely on authenticity.

The InterPARES research has proven that for digital records, trustworthiness is a much more

nuanced concept. [3] It distinguished the following aspects:

[3a] **Reliability** is the trustworthiness of a record as a statement of fact. It is the responsibility of the author of the record and depends on the record's completeness, accuracy, and the controls on the process of its creation.

[3b] **Accuracy** is a concept that deals not with the form of the record, but with its actual content. It is the degree to which the data in the record are precise, correct, truthful, and free of error or distortion. It depends upon the competence of the author and the controls on the process by which data are recorded and transmitted between persons, systems or applications, or stored or migrated when the hardware or software is upgraded or replaced.

[3c] **Authenticity** involves a trust that a record is what it purports to be and has not been tampered with or otherwise corrupted. Thus, it is the trustworthiness of the record as a record. To ensure authenticity, one must establish and maintain two distinct characteristics of the record, identity and integrity.

[4] **Identity** refers to the attributes of a record that characterize it as unique, and that distinguish it from other records. Those attributes are metadata that should be inextricably associated with the record. [4a] They include the names of the persons concurring in its formation; the matter or action in which it participates; its date(s) of creation and transmission; the expression of its archival bond; and an indication of any attachment(s).

[5] **Integrity** refers to the wholeness and soundness of a record. A record has integrity if it is intact and uncorrupted, that is, if the message that it is meant to communicate in order to achieve its purpose is unaltered. This may be so even if some of record's physical integrity is compromised, provided that the articulation of its content and its required elements of form are not changed. [5a] Certain metadata can provide evidence for a record's integrity. They include: name(s) of handling persons over time; the name of the person responsible for keeping the record; indication of annotations; indication of technical changes.

[6] InterPARES also clarifies a confusion that is sometimes made in the management of the digital documents. The word authentication is sometimes conflated with authenticity. The concepts are related, but not synonymous. Authentication is a means of declaring the

authenticity of a record at one point in time -- possibly without regard to other evidence of its identity and integrity. In digital transactions, authentication protocols often involve a **digital signature**, which is somewhat of a misnomer. It is functionally equivalent to a medieval seal, not a signature. Seals were a means of verifying the origin of the record and the fact that it was intact, and they also made the record indisputable and incontestable, that is, had the quality of non-repudiation. The analogy is not perfect, because the medieval seal was a physical shape that was associated with a specific person and did not vary from record to record, while the digital signature is a mathematical expression that is associated with a specific person but varies from record to record. [In both cases, nonrepudiation only obtains if one is certain the seal/signature has not been stolen.]

[7] Through this analysis it became evident that trustworthiness, including all the components I have discussed, is a product of designs and processes that must be in place before records are created. These participate in two conceptually distinct but interrelated systems corresponding to the making and keeping of records, which were modeled in great detail by InterPARES researchers. [7a] A**Trusted Record-making System** is a set of rules governing the making of records, and a set of tools and mechanisms used to implement these rules. In order to generate reliable and accurate records, every record-making system should include in its design record-identity metadata schemes, business and documentary procedures integrated in a workflow structure linked to classification and file plan, records-forms specifications, and record-making access privileges. [7b] Complementarily, a **Trusted Record-keeping System** is a set of rules governing the keeping of records, and a set of tools and mechanisms used to implement these rules. Every recordkeeping system should include in its design integrity metadata schemes, a classification scheme and filing plan, a linked retention schedule, a

registration system, a retrieval system, recordkeeping access privileges, and procedures for maintaining authentic records.

[8] With the theoretical knowledge of digital records gained from case studies of records and proto-records in business, government, and information-management systems, InterPARES researchers developed a set of requirements for trusting records before and after they are transferred to a preserver.

[9] Now, in the second phase of InterPARES, as we studied various sorts of creators, it became evident that concept of trustworthiness was applied to other digital documents besides legal and business records. For the most part, creators' conceptions of trustworthiness conform to the various senses of the terms exposed in the theoretical literature of their discipline. But they do so in informal and overlapping ways, such that the aspects of trustworthiness that seemed relatively clear and distinct in traditional record systems were entangled. Artists, scientists and bureaucrats have different ideas about the documents they create and reference, what needs to be kept, and the features that are essential. Terms that have a fairly precise meaning to the archival profession have very different, even contradictory meanings to these creators. I will summarize some of these nuances, in the hopes that it will assist archivists to communicate with creators outside of traditional record-management contexts. My information comes from an examination of the theoretical literature of the arts and sciences, and from InterPARES's specific case studies of scientists' and artists' document-making and keeping practices.

[10] Aspects of trust in science all relate to its basic mission, which is to discover and describe objective truths about the world. To fulfill this mission scientists do set aside information for future action and reference, [10a] but they call it "data", not "records." And they rarely use the word "authentic", so closely associated with records in archival science, to modify

"data". We encountered it in only a weak sense in one case study, where the scientists regarded data as "authentic" if there was no indication that they differed from the data recorded by the experimental instruments. Also, as in other fields, "authenticity" is sometimes conflated with "authentication". But scientists use other words that connote the stronger degrees of trust they place in data.

[10b] Scientists call data "reliable" if they were collected by a person who has professional credentials using procedures, instrumentation, transmission and recording devices that function as designed. [10c] Data are only "accurate", however, to the extent that they truly represent the physical phenomena being observed, within the capability of the instruments.

[10d] In the geospatial research community, trustworthiness is conceived in terms of "data quality". This includes various sorts of accuracy [positional accuracy, thematic accuracy, temporal accuracy, semantic accuracy], consistency, completeness, and lineage. Some of these aspects clearly correlate with accuracy and reliability of traditional records. [10e] Data "lineage" is especially interesting. This is information about the chain of transmission, starting from the moment the data were originally recorded, that brought them to the user. In other words it is a kind of integrity metadata.

Thus, although scientists use different terminology, their conceptions of trust approximate those in business and legal systems that also deal with objective fact. One important dimension of trust, though, is more perhaps apparent in science than in traditional record systems. This dimension is nicely theorized by contemporary archival diplomatics, which asserts that a record's identity depends upon its context, defined as the framework in which the action of the record takes place. [10f] Context is crucial to the trustworthiness of scientific data – and other documents, too, as we shall soon see. If information about the technological context no longer

exists—if we do not know how data were measured, how it was measured, and how accurately and precisely—scientists cannot trust the data, in the sense that they will not use it to characterize the world. Indeed vast quantities of data collected in the last thirty years are untrustworthy for exactly this reason, that information about their technological context was not kept. This may be the major issue for preserving scientific records. While a simple listing of static attributes that evidence the identity of an electronic record may be sufficient to ensure its authentic preservation, understanding the record and making it persistent require actionable metadata that specify its contexts and the actions or procedures that the record may support into the future.

[11] Let us now turn to InterPARES examination of the arts: its theoretical literature, and several close studies of practicing artists. Art is of course a very different enterprise from science and business, and we found similarities but also some striking and informative differences in their conceptions of trustworthiness.

Of course artists produce records as byproducts of their art-making activities—contracts, correspondence, notes, and so forth. These may be important to preserve. [11a] But artists are much more concerned with preserving their final products – their art works-- not just the evidence that they produced them. [11b] They intend their artwork not merely as an attestation of a past act, but as the vehicle of a communication between them and their present or future audiences.

Even though an artwork is not a record, artists care about some of the same properties of trustworthiness that records can have. [11c] They care that the work's message is clearly from them, and that the message has not been corrupted. Indeed the word "authenticity" itself often appears in discussions of art to signify these qualities, but its senses do not parse so neatly into

the dimensions I have discussed for more traditional records. [11d] In particular the notions of reliability and accuracy become entangled with integrity.

[12] Sometimes these connotations recall those of science. [12a] For instance, in photography, "authentic" is used by some to mean how accurately the image depicts truth. Some artists believe that such authenticity can be achieved through specific procedures, just as "reliability" of a record is achieved.

Most commonly, though, authenticity is a more subjective quality. [12b] On the most general level, it is used to denote the degree to which an artwork manifests the essence of its creator. Artists thus understand "authentic" simply to mean "mine".

Most of them understand such authenticity to result from their personal control over the creation and organization of their objects, and of their marking the identity of those objects with metadata, such as a signature and date. [12c] In the case where an artwork is "singular" – a physical object, like a painting – the word "authentic" thus means "original." Whether or not it is marked, the identity and integrity of a singular artwork may be established by a complete and reliable record of what happened to it after it left the artist's hands, analogous to the "lineage" of scientific datasets. In the lack of such a record, experts are called upon to "authenticate" objects as products of an artist.

[12d] But the concept of trustworthiness is more complicated for "multiple" art works that can exist at more than one place at a time. Examples include novels, photographs, music, plays, dances, and films. No instance of such a work is an "original" in the sense I have just used. Certainly, though, the identification of each instance with its creator is still considered important. For example, in literature, printmaking, and photography the link involves a "master" object that

is approved by the creator, from which are produced all objects that are "authentic" instances of the work.

But artists apply the word "authenticity" to such "multiple" works in ways that are more like archivists' concepts of "reliability" and "accuracy". For instance, some of these artworks, like music and plays, are experiences that are produced by performance. Performance is an execution of instructions, specified by the author, using instruments specified by the author. In the same category falls some minimalist art, which can be assembled anywhere, anytime from mass-produced materials according to the artist's instructions. These instructions may be enabling or instructive records, in the senses Luciana Duranti has just described. In one sense, "authenticity" still involves the link between the creator and the instructions and instruments. But musicians and actors also speak of "authentic performance", "a performance that reproduces all that is constitutive of the work's individuality". A performance is relatively authentic to the degree that the performer executes the instructions accurately and according to historical convention, and to the degree that the instruments match what the creator specified. While the creator is alive, she is able to "authenticate" performances, but that becomes problematic after her death, as we saw, for instances with the dances choreographed by Martha Graham. Indeed, there is controversy about whether such performance authenticity is possible or desirable, and it can be confusing to archivists, who think about authenticity as an absolute property.

Nevertheless it is understandable that an artist will disavow responsibility for a purported instance of her work that incorrectly realizes her instructions, even if the instructions have been preserved with all the formal elements that guarantee their diplomatic authenticity, because their reliability has been compromised. For many artists, "correctness" does not require complete

accuracy, but an authentic instance of the work should completely and accurate convey the expressive message of the original.

Especially in our rapidly changing digital environment, unreliability can arise not only from inaccurate human performers, but also through technological change. This aspect of trustworthiness is highly dependent on the technological context of the enabling and instructive records. [12e] Thus often "authenticity" is conceived as the "serviceability" of the digital components of an art-displaying system, that is, their capacity to function as expected in the hardware that is used to generate the final product. In other words, authenticity is conflated with reliability. This resonates with the importance of technological context that I mentioned in connection with science.

The artworks most sensitive to technological change are those that are "interactive", that is, their content varies within certain bounds, according to input from performers or audiences. There are two reasons for this sensitivity. Interface devices are usually custom-designed, or go quickly obsolete. Also, the interactions are often not explicit in the instructions for the piece; rather, they are implied in the code provided for the digital devices. Thus, even when interactive features of the works are grounded on fixed instructions and instruments whose identity and integrity can, in theory, be preserved just like other digital records, these entities will not enable "authentic performance" in the future, because they are tied to specific technical platforms and standards that change rapidly.

[13] A good example of this sensitivity, and of its implications for trustworthiness, is the composition for bassoon and interactive electronics I mentioned earlier. [13a] Three of the digital files on the disk are enabling or instructive documents needed to perform the piece. [13b]

Each was designed for a particular technology: [13c] the musical score for the bassoon, [13d] some control software for a particular computer, and [13e] some data specifying musical sounds for a particular synthesizer. A hundred years in the future, bassoons may be around, but certainly not these particular computers and synthesizers, which are almost extinct already. Even if the files have sufficient identity and integrity metadata that we can trust that they encode the composer's intent, they cannot be used to produce an authentic performance – indeed, probably not any performance at all, unless they have been written or annotated in such a way to permit migration to another technological platform. This migration is complicated greatly unless the whole range of interactions possible are explicitly specified, not simply implied in the code. And the composer must give also some explicit way to determine whether any particular instance is authentic, for the single recording cannot document all the possibilities. Otherwise the functionality of the digital files, that is, their reliability in the sense of their capability to convey the message the composer intended is compromised, and, with it, their trustworthiness.

To sum up, I have highlighted two contributions of InterPARES studies of the arts to the notions of trust in digital systems. First, I hope that our conceptual analysis, which attempts to carve out semantic boundaries and make clear distinctions among similarly named concepts, will promote better communication among all interested parties. For example, our case studies tell archivists that when they talk to artists about preservation, they need to be aware how artists think differently about what needs preserving, and about what "authenticity" means.

But returning to more everyday concerns, it not hard to see that exactly the same issues of trustworthiness that we encounter in scientific and artistic systems arise, *mutatis mutandis*, to any transactions that are constituted interactively by enabling documents on changeable technology. In our purchases with online sales systems, in our legal transactions with online government

services, we treat transient displays as if they were records. But we cannot preserve those experiences; we can only preserve the ability to reconstitute them. These ephemeral records are like music. To preserve them, we need to exercise trust that is mindful of the arts – we might say, artful trust-- not only trust in the identity and integrity of the underlying data and instructions, but also trust that their functionality is preserved across technological change. And I hope such comparisons and analysis of record-keeping in various disciplines will improve the possibilities for preserving our entire heritage.