Furnished with digital cameras and other handheld devices, many people now find media-rich content creation to be an inexpensive, everyday activity. In addition, ever-greater Internet accessibility and bandwidth let us post digital records of events on YouTube or turn them into podcasts in seconds. These technologies inevitably play a role in requirements engineering. As a consequence, agreed requirements are likely to come from information content transformed across and among myriad originating and intermediary representations. Not all such transformations preserve content and meaning, and some are irreversible. For example, translation transformations don’t operate satisfactorily in a backward direction, which presents problems for subsequent traceability.

Traceability in Jeopardy
Software engineering needs traceability to aid requirements understanding, help manage requirements change, and demonstrate requirements satisfaction. A traceability process usually involves an engineer creating links between fragments of natural-language text, supposedly interrelated, to show each requirement’s development path, from original source material to eventual system components.

When digital multimedia artifacts enter the requirements record, we encounter new challenges with traceability. The basis on which we establish traceability links depends on how the media types involved interact, and as a consequence, the nature of any relationships between elements might not be obvious from a syntactic or semantic perspective. Furthermore, we might have trouble precisely pinning down the links’ exact sources and sinks. So, problems already known to traceability practice become compounded as engineers begin to use the latest technologies to explore and communicate their understanding of a project’s requirements.

Figure 1 illustrates a simple example of using media in requirements engineering. The figure shows media that might be featured during a workplace interaction in which engineers are in the early stages of determining requirements. Data captured for the record come from both digital video and audio recording and from traditional print media. The “Interview” sidebar shows part of the dialogue that might be exchanged during this interaction.

Understanding Media
In creating any representation with which to communicate, an engineer chooses—often unconsciously—some particular system of signs to work with. Sign systems are essentially abstract media made concrete or reified as some rendered representation or notation. Written and spoken natural language, sounds proper to their domain, and moving images are all examples used in requirements elicitation (Figure 1, first column).

Once, all these sign systems and their many sophisticated derivatives were associated with particular physical media—that is, their vectors or carriers. Written natural language and its structured forms, such as a novel or biography, became synonymous with “print” or “book”; animations and
visual narrative were, and often remain, simply “cartoon,” “film,” or “video,” each a term derived from a physical carrier. We can now find all these types of communication, including animated representations, in combination because their physical carriers are no longer disparate. A single, virtual digital medium can replace a multiplicity of simple and composite physical media. Whether a text with embedded pictures and speech is in a cloud of machines or on a simple memory stick is irrelevant, so long as it’s available in known formats. This is increasingly the case with the requirements record (Figure 1, second column).

The apparent ease with which we can now create and manipulate multiple abstract sign systems opens the way for their more prevalent use in requirements engineering as old and new media are created, combined, and changed. This looks like a win-win situation until we examine its implications more closely.

**A Lot Said, a Lot Captured, a Lot Lost**

The fourth column in Figure 1 shows the artifacts constituting the requirements documentation, all now finalized normally in specific digital formats. The two uppermost documents use natural language in different ways—first, in its original “primary” and unstructured form as interview excerpts and then as use case descriptions structured via a “secondary” modeling system. The bottom document, the use case diagram, employs what we might call a “tertiary” modeling system using graphical forms to represent aspects of the secondary system via a defined set of notational signs. In this case, we give natural language this primary status because it’s the basis for the others and provides a way to interpret the data as a last resort. This view is based on a theoretical position from the Moscow Tartu school of semiotics. In cases where UML class diagrams depict initial design decisions, as per the fifth column in the figure, the primary modeling system itself changes from natural language to some object-oriented programming language—

![Figure 1. Transfers between media in requirements. We can use multiple media, held in a variety of physical and digital forms, to elicit, record, and document requirements. The process involves many and varied transformations of these media, all of which can affect the final outcome and the quality of traceability.](image-url)
Traceability and Multimedia

Media incur costs. If we insist on attempting to capture absolutely everything in our projects, we should establish an approach that distinguishes between those media fragments that are worth keeping ready-to-hand and those that we can archive just for a full record. We need to be selective when creating a media-enhanced record for traceability purposes because it can be challenging enough to get the simplest of text-based traceability in place. Here are a couple of places to start.

Focus on the Media Translations

Translations between media aren’t necessarily bidirectional and, as such, can cause permanent discontinuities in the traceability record. For our example interview (see the “Interview” sidebar), if we create a textual description of the background control-room activities on the video, then a significant difference will likely exist between the information content in these two artifacts. A media translation from video to text involves unavoidable information loss and is therefore one-directional. Recreating the particulars and atmosphere in the control room would stretch even the most accomplished writers’ abilities.

Focus on Media Mergers and Amalgamations

When separate traceability paths merge as we form a new artifact, the ability to untangle the original sources’ contributions can be challenging. This is complicated further when the new artifact has amalgamated previously distinct and different media. In our example, if we recorded on video and noted the exchange, a storyboard of the issue-resolution process might initially feature a telephone call. Learning later that the word “call” in fact just means to appeal in some way to yet another colleague would require correction. Accounting for changes such as this, which we must propagate from an original source as a new understanding emerges, can be problematic. Attempting to trace back the provenance of this putative telephone call would demand juxtaposing the gesture in the video, the recording of the spoken word, and the simultaneously written interview note.

References


Olliy Gotel is an assistant professor of computer science at Pace University in New York City. Contact her at ogotel@pace.edu.

Stephen Morris is an honorary senior visiting research fellow in the Department of Computing at City University London. Contact him at sjm@sai.city.ac.uk.

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