1. Project Summary

The Graphic Narrative Accessibility: Encoding Images for Blind and Visually Impaired (and Sighted) Readers and Researchers project was funded by a Level II Digital Humanities Grant from the National Endowment for the Humanities (NEH). The project was principally carried out by the Vizling App team, primarily made up of researchers at Wichita State University and at Florida State University. This project developed a fully functioning prototype of the Vizling App for use by blind, low-vision, and fully-sighted readers of graphic narrative texts through a novel...
approach that combined haptics (vibratory feedback common on cell phones and tablets), visual
linguistics, and an updated version of XML. In a world increasingly dependent on multimodal
texts, especially in educational settings, it is important that blind and low vision readers are
afforded an equitable, accessible experience with the text that maximizes their agency in the
reading experience. The team’s work establishing protocols for rendering graphic narratives is
readily transferable to other multimodal texts. By creating and carefully testing a successful
prototype of the Vizling App, the project provides a novel tool for readers and teachers at all
levels that is both empowering for blind and low-vision readers and useful for the fully sighted.

The project successfully met all benchmarks and produced valuable data:

1) The free, functioning prototype of the Vizling App was developed, tested, and completed
and sent to Apple and Android for review and publication. Users will be able to easily
download the app on their preferred device and utilize the app’s features to engage with
the sample texts. The Vizling team worked with two low-vision artists to provide some of
these texts.

2) The prototype conveys information intuitively to the user in a completely novel way that
helps them understand things like page layout, preferred order of reading, and
transitions. Robust usability testing feedback confirmed both the effectiveness of the
approach and the potential for further development.

3) A key survey of potential users of the app produced 120 detailed responses concerning
the preferences and issues blind and low-vision readers encounter with multimodal texts.
Information from this survey directly informed the building of the app and will continue to
provide valuable information about blind and low-vision readers’ preferences moving
forward.

4) The team developed clear, transmissible processes for digitizing, archiving, and
rendering accessible graphic narratives for future inclusion on the app. These efforts
established protocols for coding and organizing the visual elements for use on the app;
working with voice actors to properly record the corresponding sound files; establishing a
database for the rendered texts that is searchable and researchable; and ultimately
created a system that is both superior to current attempts at making graphic narrative
fully accessible and less costly.

5) The app’s ability to collect data will encourage research into how readers read digital
graphic narratives.

6) The team conducted a series of presentations at national conferences and with entities
like the Minnesota Braille and Talking Book Library.

2. Project Origins and Goals

Dr. DeFrain’s graduate course on graphic novels, taught at Wichita State University in the spring
of 2018, had two key emphases: accessibility and visual linguistics. One of the graduate
students in that class, Aaron Rodriguez, shared DeFrain’s concern for how a class that relied so
heavily on visual and multimodal texts could be equitably taught to blind and low vision
students. What started as Rodriguez’ final project for the class quickly morphed into in-depth
discussion between DeFrain and Rodriguez about finding better ways to bridge current methods of remediation for helping blind and low-vision students with graphic narratives.

Returning to the idea of visual linguistics, an approach largely pioneered by Dr. Neil Cohn in his seminal book *The Visual Language of Comics: Introduction to the Structure and Cognition of Sequential Images*, DeFrain and Rodriguez set about creating a method whereby readers could understand preferred reading sequence for graphic narratives. Comics and graphic narratives are not always meant to be read from right to left and top to bottom, and even fully sighted readers often need to negotiate the preferred sequence. These works are sometimes referred to as “sequential art” because of the importance of reading order. In addition to sequence, understanding important aspects of page layout is key for a complete understanding of a graphic narrative text.

With an approach for understanding graphic narrative sequence in hand, DeFrain and Rodriguez then pioneered a unique use of haptic technology that relies on sustained finger-to-screen contact to lead the reader through a graphic narrative in the proper order.

2.1. Problems with current methods of accessibility for graphic narratives

The Americans with Disabilities Act of 1990 mandated that K-12 and college & university students be provided with equitable learning opportunities. For blind and low-vision students, this has typically been accommodated through Braille or audio versions of assigned texts, when accommodations were made at all. For simple text, having such a translation is a suitable substitution for the original or printed material. As our world has gotten more digital, text producers and readers have an increased appetite for multimodal texts that rely on the reader’s ability to comprehend the visual elements. This is where current methods fall short for most classroom usage. When Braille or audio versions address visual elements of a text, they must first translate those images into written/verbal descriptions. While this can be helpful in some instances, it completely robs the reader of any agency in interpreting the text.

Furthermore, current efforts at creating equitable versions of graphic narratives and multimodal texts remain woefully inconsistent. One example from a biology textbook meant to use a graphic narrative to show how a cell divides. For the fully sighted student, successive images relayed the dynamic cleaving of one cell into two, illustrating and labeling the ways the individual elements of the cell replicate and split into two new equal cells. For the blind and low-vision student, the converted text reads simply: “The cell divides.”

The cost of these current methods is also an issue for most schools and institutions. A survey conducted by the Vizling App team at the onset of this project revealed that schools across the country are spending as many as 100 person hours to create a single audio or Braille version of a single title. While these inferior accessible versions are re-used within institutions, there exists very little sharing of rendered texts across institutions, even within states.

2.2. Problems navigating *mise-en-page* and panel transitions in the classroom
Graphic narratives are increasingly common in K-12 and college classes. In nearly every instance, parsing the visual elements in graphic narratives and other multimodal texts is a key part of mastering important concepts and complex meanings. In a typical two-page spread of a graphic narrative, the *mise-en-page*, or physical arrangement of the page related to features such as panel distribution, size, and orientation, often conveys as much information as the written text. Translating that verbally or in Braille is a biased exercise, ultimately imposing the translator’s evaluation which can itself be mistranslated.

Complicating issues with *mise-en-page* translations is the fact that graphic narratives like comics also often rely on panel transitions that don’t always follow the typical Z-shaped reading pattern moving from left to right and top to bottom. While a fully sighted reader can often rely on context clues derived from their apprehension of the *mise-en-page*, or self-correct and approach their reading experience recursively, a blind or low-vision reader has to rely on the strictly linear Braille version or audio tract that makes no allowance for the importance of transitions between or across panels.

### 2.3 Problems searching graphic narratives

Finally, even with a dramatic rise in the number of graphic narratives published or republished digitally, searching these files is difficult. To help address that issue, Dr. John Walsh of Indiana University created a TEI (Text Encoding Initiative) called CBML (Comic Book Markup Language). CBML is a logical, XML-based coding system that allows users to tag elements of the graphic narrative text (specific images, for example, or characters, dates, styles, etc.) that can then be recalled and cross-referenced in corpus studies and for other Digital Humanities research and beyond. Even with Walsh’s contribution to this broader problem, there is no unifying database that allows users to easily and effectively search graphic novels for research and entertainment purposes. One aspect of the app’s development is meant to potentially fill that niche.

### 2.3. Project Parameters

As the ambition of this project was to develop a novel system of making graphic narratives more equitably accessible to blind and low-vision readers, it was crucial that our team solicited feedback and guidance from those readers. We likewise want our completed app prototype to work seamlessly with existing software, like VoiceOver, that blind and low-vision readers prefer. Our ambition all along has been that the beta version of our app be widely available for free to all users in the hopes of spurring further research and applications of the successful technology.

The app itself would employ a novel combination of haptics, visual linguistics, and CBML coding to create a space for blind and low-vision readers to interact with graphic narratives in more equitably accessible ways. On opening the app, readers would receive audio instructions that explained the concept, approach, and rules for engaging the unique panel to panel process. They would then be guided to one of the previously loaded graphic narratives. To “read” this narrative, readers would be instructed to rely on sustained contact with the screen. Once they touched the proper starting point for the narrative (in the case of the first narrative, they would
start in the upper left) the app would read back what’s called the global narrative for the first panel, describing the action and any dialogue in an audio-book format. After the first panel has been read, the reader then drags their finger (in this case straight to the right) into the next, correct panel. If they’ve traversed the screen in the proper order from panel to panel, the app will then read the next panel aloud. If they move to the incorrect panel, the reader receives two short haptic bursts meant to indicate the wrong direction has been attempted. Upon moving to the next correct panel the app will continue reading.

The completed prototype of the app will feature two other modes of reading: 1) a conventional audiobook version of the graphic narrative that provides an audio version of the narrative page by page, and 2) a free exploration mode that responds to reaching touching anywhere on the screen with an audio description of whatever is located in that spot. This mode may be of interest to even fully sighted readers accessing graphic narratives with text-heavy elements on their cell phones. In this instance, readers could touch a wordy speech balloon, which might be difficult to read on a small screen, and have that read to them instead of zooming in on the text. Of course, this mode also serves to help blind and low-visions understand page layout and spatial relationships through touch.

With these parameters in mind, the project had the following outcomes:

1. Solicit a survey of blind and low-vision readers to determine reader preferences and experiences with graphic narratives
2. Design and develop the graphics for the app prototype based in-part on feedback from the survey
3. Establish protocols for writing global narrative scripts of graphic narratives.
4. Scripting the project text and submitting it to Shocker Studios for voice actor recording
5. Develop functional specs, architecture, and database for app QA
6. Upload the recorded files and CBML data and create protocols for this process moving forward
7. Beta-testing with Envision to seek and incorporate feedback into the prototype development
8. Refine, finish, and release the free app for use on iOS and Android devices.

3. Project Team, Partners, Activities, & Participants

Upon receiving Level-II grant funding of $99,915, work on the project’s goals commenced on 9/1/2021. While our team primarily consisted of Dr. Darren DeFrain at Wichita State and Aaron Rodriguez, ABD at Florida State, we worked closely with the following on specific areas of development:

Vizling App Advisory Board – Our team met with our Advisory Board, constituted of nationally-recognized experts in accessibility, coding, graphic narratives, translation, and sound editing, to establish our prototype development process. The board’s insights and concerns were immediately helpful in establishing clear priorities and quality assurance criteria for the process.
T3 – Located in Wichita, Kansas, and affiliated with Wichita State University, T3 is an independent company specializing in web development since 1998. Working with Senior Solutions Architect, Haris Khan, DeFrain and Rodriguez began developing a wireframe of the proposed app at the onset of the grant period.

Wichita State University’s Ablah Libraries – Working in conjunction with Dean of the Ablah Libraries Kathy Downes and Ablah Technology Development Librarian, Samuel Willis, the team developed the functional specs, architecture, and database for the app.

Envision – Located in Wichita, Kansas, Envision is a non-profit whose mission is to improve the quality of life and provide inspiration and opportunity for people who are blind or visually impaired through employment, outreach, rehabilitation, education and research. Executive Director, Dr. Ron Schuchard, and Lead Accessibility Scientist Dr. Rakesh Babu consulted on a Qualtrics survey aimed at discerning blind and low-vision reading habits and preferences with graphic narratives and multimodal texts.

3.2.1. Surveying the community

The IRB-approved survey was disseminated to Envision’s contact list and through the National Federation for the Blind’s contact list, garnering 120 responses. Blind and low-vision individuals participated in the study by completing an online survey consisting of twenty-three open and ten closed questions. The closed questions focused on known areas of interest while the open questions allowed for unanticipated responses. A complete analysis of the survey data will be published in the *Journal of Blindness Innovation and Research* in 2023. Four findings stood out from this survey:

1. Providing equal access to materials requires that blind and low-vision readers be able to find multimodal materials, and blind and low-vision readers utilize digital resources instead of physical resources when searching for reading materials. When asked how often they use the internet and the library to find books, graphic narratives, videos, or news media, 69 participants reported that they used the internet daily to find media, while 22 participants reported that they used it weekly to find media, 14 participants reported that they use it monthly to find media, and 8 participants reported that they use it rarely to find media. When asked how often they go to the library to find books, graphic narratives, videos, or news media, 3 participants reported that they go to the library daily to find media, 2 participants reported that they go to the library weekly to find media, 11 participants responded that they go to the library monthly to find multimodal media, while 97 participants reported that they rarely go to the library to find new media. While few people visit the physical library to find reading materials, many participants reported using online library resources like BARD to find reading materials.

2. Accessible materials are difficult to find. There is an assumption that text-based materials, like books, are easy for blind and low-vision readers to access. However, this is not necessarily the case. 18 participants reported encountering books that are not accessible most of the time and 71 participants reported encountering books that are not accessible sometimes, as opposed to the 26 participants who reported rarely encountering books that are not accessible and the 3 participants who reported never encountering a book that was not accessible.
3. Accessible reading format preferences vary. When asked how they prefer to read text, 24 participants reported preferring braille, 68 participants reported preferring screen readers, 10 participants reported preferring audio translations, 16 participants reported another preference, and two participants didn’t respond to this question. The preferences of the 16 participants who reported another preference, reported preferring magnification and OCR scanning.

4. There is significant interest among blind and low-vision readers to read graphic narratives. 35 participants reported that they were interested in reading graphic narratives to a great extent. 35 participants reported that they were somewhat interested in reading graphic narratives. 28 participants reported that they had very little interest in reading graphic narratives. 16 participants reported not having interest in reading graphic narratives.

The information received through the survey and a smaller, informal survey conducted by Dr. Babu, directly shaped the interface design for the app. It was crucial for the team that every possible decision be guided by direct and specific feedback from the blind and low-vision community. For example, the initial feedback received from an informal survey conducted by Dr. Babu indicated the need for the app to work with VoiceOver, a commonly-used assistive device for blind and low-vision readers. This was an element the team had not considered prior to initial development on the prototype, and therefore had to pivot to accommodate this interface.

### 3.3.1. App Development

**Designing the interface** – The development of the alpha version of the app progressed as planned, with only relatively minor setbacks related to coding challenges and brief illnesses suffered by a few key team members. The interface was developed to work seamlessly with Apple’s VoiceOver, the preferred assistive technology for blind and low-vision iPhone users. A quick tutorial was also developed to help users understand the underlying principles of sustained touch and haptic response, and to guide users on how to get the most out of the app.

**Designing the graphics for the app** – T3 developed the app’s graphics using a high-contrast color scheme. Following feedback from early testers, the user interface of the main menu was paired-down to three buttons on each screen. This allowed for blind and low-vision users to navigate the menu easily and ensure that they would not get lost. The app currently displays JPG images.

**Developing the functional specs, architecture, and database for the app QA** – Although the project planned on using CBML on the backend to organize the data, the app was unable to access the information quickly enough. The CBML code was converted to an Excel spreadsheet, where files, accessibility text, and pixel coordinates were collated into JSON automatically. The beta version uses Azure database systems to manage data retrieved by the app. Individuals wishing to contribute to the database can upload materials to the Vizling Omeka website.

### 3.4.1. App Testing and Troubleshooting
A notable challenge the team encountered early on was in getting the app’s processes to work with Apple’s VoiceOver, a commonly used assistive app for blind and low-vision iPhone users. VoiceOver has its own hierarchies, which often ran counter to the hierarchies established by the app’s panel to panel mode. Our coding team was able to successfully navigate a solution that allows full compatibility with VoiceOver that in no way compromises our

Dr. Babu then also led the usability testing for our prototype June through August of 2022. The generally very favorable feedback led to further refining. Another graphic narrative, by low-vision-identifying artist Marieke Davis, was acquired, coded, and recorded for use on the app.

Many of the issues the testers encountered with the app pertained to the need for more audio cues. For example, testers could not tell what page they were on, so the development team added automatic page number audio cues. Each time the user navigates to a new page, where a page in a graphic narrative or navigation menu page, the app gives an audio cue. Additionally, the buttons to turn the page forward and backward were originally too small to locate reliably, so they were enlarged.

The final iteration of the app was completed in the fall and submitted to Apple and Android for release (application pending) for free at the app store.

3.1.4. Spurring and facilitating research into the Humanities

The app’s successful launch only hints at the potential to enhance and improve the scope of research into comics and other multimodal publications. As we generate more user data related to preferences blind and low-vision readers have for reading accessible materials, we can refine our processes and share out data that will lead to a better understanding of accessible text production. This data will be important in better understanding important distinctions related to how and why fully sighted and blind, low-vision readers approach graphic narratives and multimodal texts.

Now that a fully functioning version of the Vizling App is available for use on the app store, further research will be conducted into the feasibility of the app’s capacities for use with other multimodal texts such as maps, schematics, and digital projects like the NEH-funded Picturing Urban Renewal website, that has created a host of interactive maps and stories. Not only can our processes continue to be refined to make graphic narratives and multimodal materials more accessible for blind and low-vision readers, the underlying approach can potentially be applied to a broad range of texts and situations such as sheet music, museum displays, and live productions.

Since the team relied on translation theory to produce the necessary scripts for text conversions, it is also clear that the app offers opportunities for making graphic narrative texts accessible and available in other languages. As protocols for translation of these works are established, further research into the multilingual translation of graphic narratives is a given.

Combining the processes developed through this project with eye tracking technologies in the future will help gain further understanding of the visual hierarchies with dynamic (theater, dance, museum displays) and three-dimensional art such as sculpture, mosaics, and reliefs. The data from such undertakings could be brought back to the app in order to create parallel equitable access to these other texts using similar haptic and visual linguistic protocols.
Since the first major hurdles have been cleared in creating a fully functioning app, the team will now turn its attention to creating systems and software to make it easier for anyone to adapt their graphic narratives and multimodal media into content that can be read and used on the app. The need for this content creation software is evident by the coding necessary to render graphic narratives for the app. While our processes have been streamlined, having content creation software created will allow users the ability to quickly and efficiently render new texts for use on the app through a “drag and drop” approach. This will have the added benefit of generating exponential growth in content and data.

4. Project Outcomes

There were 10 core outcomes that resulted from this project:

1. A collection of data on reading preferences and habits of blind and low vision readers when reading graphic narratives and multimodal texts. Our team conducted an IRB-approved online survey of blind and low-vision readers seeking input on if and how they read graphic narratives, and what kinds of issues they encountered and assistive technology they relied on for reading. We worked with Envision and the National Federation for the Blind to help disseminate the survey and were elated to receive back over 140 responses that helped shape several key components of the project.

2. Established protocols for converting graphic narratives into global narrative scripts, panel-to-panel scripts, and sets of data necessary for XML tagging. The process for writing and coding the scripts from the original graphic narratives was progressively refined and articulated, meaning future conversions of texts should be streamlined for quicker and more accurate production.

3. Established protocols for recording scripts for upload. As with the scripts of the adaptations, protocols had to be established for recording, editing, and uploading the audio files for felicitous retrieval and access.

4. Designed interface and graphics for the app that reflect accessible best-practices and feedback from our survey. Many of the decisions for making graphic elements and command functions accessible can be counterintuitive for fully sighted designers. Such decisions were important for our project and crucially driven by feedback from potential users.

5. Developed a functional architecture and database for the app using Omeka through Ablah Libraries.

6. Conducted usability tests through Envision that led to specific refinements of the app interface. Once we had a usable beta-type version of the app, we worked with Dr. Rakesh Babu at Envision to conduct usability tests with blind and low-vision readers. Dr. Babu’s comprehensive report initially revealed compatibility issues with VoiceOver technology. Those issues were remedied and the resulting feedback was overwhelmingly promising in terms of both functionality and potential.

7. Completed a rendered version of a graphic narrative written and drawn by a self-identified low-vision artist for use on the app. The app actually has 3 free available, full-rendered narratives for users to read and interact with. One of these is a comic
version explaining the premise of the app. The other two were commissioned works by two self-identified low-vision comic artists; Marieke Davis from Arizona and Doug Knight from Toronto.

8. Submitted the app for release for free on iOS and Android devices. The final version of the app was submitted for review at the end of December 2022.

9. PIs gave several presentations locally, at a national conference, and met with relevant national agencies and entities. In addition to presenting at the international Comics Studies Conference in Lansing, Michigan; the Western History Conference and Digital Public Libraries Association virtual conferences both PIs presented their work regionally. At the Digital Public Libraries Association, in particular, the PIs were able to contribute to important, international discussions about how libraries might make graphic narratives and multimodal works accessible for the estimated 253 million blind readers worldwide. At the Minnesota Braille and Talking Book Library, PIs demonstrated the application and discussed digital distribution methods.

10. The completed fully-functional app has already received an award from the prestigious Paul K. Longmore Institute on Disability. In June, the team entered their app showing the work of Marieke Davis into a competition hosted by the Longmore Institute. The panel of judges, including MacArthur Fellow and Amazon Principle Accessibility Researcher, Joshua Miele, awarded our app the $1500 prize, which will be used to pay our voice actors and editors.

In addition to hitting these benchmarks, the team has connected with a SUNY-Albany team working on an NEH project called *Picturing Urban Renewal*. Our team consulted on the accessibility concerns related to their project and will be putting the advances we’ve made with this grant to use making their final project fully accessible.

5. Project Evaluation and Impact

Project success and impact was evaluated formally and informally at every stage of the project during the course of the grant with the bulk of improvements stemming from persistent testing by the PIs and broader team. The first substantial evaluation came from our usability testing with Dr. Rakesh Babu at Envision. The feedback from this report was overwhelmingly positive, with participants asked to rate and comment on 5 primary metrics:

1) **Reading Interface Operability**: Reading interface operability is concerned with getting the built-in reader to work reliably and receiving its feedback continually throughout the app-user interaction process.

2) **Reading Interface Learnability**: Reading interface learnability is concerned with accessing the user manual and learning different functions and gestures supported by the reading interface.

3) **Narrative Operability**: Narrative operability is concerned with playing the global narrative of a page or the narrative of a panel of that screen.

4) **Application Navigability**: Application navigability is concerned with moving in and out of the Chiasm module and moving between screens of this module.
5) Panel Structure Navigability: Panel structure navigability is concerned with communicating how panels within a screen are laid out, the logical order of accessing them, and how to move from one panel to the other.

While users pointed to issues with VoiceOver assistive technology compatibility, these concerns were mitigated through adapting the app’s coding to supersede VoiceOver’s hierarchies. The bulk of outstanding concerns were addressed through updates to the audio instructions and a training module built in for first time users. Dr. Babu’s report concluded with the following:

Results of this early investigation indicate that the version of Vizling_MVP tested was generally accessible on both the iPhone and the iPad platforms for users with severe vision loss. In the future, a full scale accessibility study involving a statistically significant sample of iPhone and iPad users with vision loss may be conducted to remove any technical or functional accessibility issues. The study discovered some design and some manual issues that may have contributed to its lower learnability and efficiency scores. Participants not only helped identify these issues, but also suggested remedial measures. Most of these suggestions seem to be appropriate and feasible on their face value that merit further investigation and validation. The transformative potential of Vizling in enabling access to multimedia content was not lost on participants. Based on this, it is reasonable to believe that it will be well received by the BVI community as an enabler of daily activities involving visual information processing (italics added for emphasis).

The PIs held weekly meetings with the coding team to assess issues and debug. For creative elements, such as the global narrative and panel-to-panel scripting and voice acting and recording, the PIs worked to both streamline the process and make the process easily repeatable for future content additions.

Informally, the app was shared out via an accessible comics competition hosted by the Paul K. Longmore Institute on Disability. The concept and usability of the app was verified by the team winning the $1500 competition.

Aspects of the project related to the development of the database again meant persistent in-house testing and debugging to both achieve satisfactory workflow and to create repeatable, easy-to-follow instructions.

6. Project Continuation and Long-Term Impact
Now that the important work of developing, testing, and launching the Vizling app has been successfully completed via the NEH grant funding, the project team plans to immediately turn their attention to developing the content creation software. One of the current problems facing the app is that content must be coded for inclusion on the app by the creators. Our ambition is to now create simple “drag & drop” will make it relatively easy for anyone to create accessible material for use on the app. During the entirety of the grant project, the team was mindful of this next step and has taken pains to develop systems and protocols to facilitate this next step. The coding team at T3 has also been developing the app with this knowledge in mind. We plan to develop a grant proposal for level III NEH funding to facilitate the development of the software.
The software, like the app, will be available for free for most users to help facilitate accessibility and further research into the Humanities.