

Development of Prototype Digital Interpretative Touchscreens at Worcester Historical Museum

An Interactive Qualifying Project Report submitted to the Faculty of WORCESTER POLYTECHNIC INSTITUTE in partial fulfillment of the requirements for the Degree of Bachelor of Science

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The Worcester Historical Museum



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ABSTRACT

In an effort to revamp the Fuller Gallery at Worcester Historical Museum (WHM), a previous IQP was tasked with investigating the use of digital technology at WHM. The previous IQP group recommended WHM to further evaluate an open source exhibit software called Open Exhibits. Our original mission was to develop prototype digital interpretative touchscreens using Open Exhibits for integration into the redesigned gallery. After evaluating Open Exhibits and concluding that the platform required a long learning curve for museum staff and a great investment in hardware and design services, our mission shifted to designing and building a custom, multi-functional, multi-media database, which could retrieve and display artifacts, animation, audio files, video clips and interpretative text. In addition, we created an outline for an educational mini-game with a proof-of-concept demonstration. The game created an opportunity for audience to engage more deeply with the digital interpretative content. We recommend that WHM with the further develop and use of the exhibit database and mini-game we created, perhaps expanding and improving upon them with future IQP groups, and that they reserve Open Exhibits for a potential renovation of the gallery.

ACKNOWLEDGEMENTS

We would like to thank William Wallace and Vanessa Bumpus at the WHM for sponsoring this project, and the guidance they gave us. We would also like to thank Robyn Conroy, Elena Olivieri, Jesse Heinzen, John Llewellyn, Charlotte Haller and Laura Robinson for assisting us during this project. Lastly, we would like to thank Professor Joseph Cullon for advising us, and providing us with help and guidance.

EXECUTIVE SUMMARY

The Fuller Gallery at the Worcester Historical Museum is home to a twenty-year old exhibit on Worcester's industrial history entitled "In their Shirtsleeves." The installation is outdated, featuring cluttered artifacts, timelines, and interpretative text all competing for attention. There is little apparent connection drawn between the artifacts, and since this is a traditional exhibit, there is limited interaction between the artifacts, their interpretative apparatus and the audience. With the help of digital technology, the information of several of the artifacts can be displayed on one touch-screen, which also can capture the movement they once had with animations. Additionally, themes can be drawn between items in the exhibit by connecting them through the usage of digital technology. In addition, digital technology can perform other functions that traditional installations cannot. For example, the galleries can become interactive with the audience creating moving maps, sliding timelines, and playing educational mini-games. In an effort to illustrate the strengths and limitations of digital technology, we were tasked with analyzing and developing prototype in-gallery touch-screen applications for WHM.

Based upon the recommendation of a previous IQP, we initially intended to work with the open source museum software platform Open Exhibits (OE). We began with an evaluation of OE, using three criteria:

Availability – the extent of information on the internet to aid programming in OE and the vibrancy of user forums among the community of practice to offer assistance, help or feedback;

Accessibility – the extent that the museum can develop and maintain exhibits in the software itself and the hardware/software needed to use OE; and

Cost and Satisfaction – the extent to which previous users of the software thought that investment of time and money into OE was cost effective and produced exceptional enhancement to gallery experience.

We concluded that, even though OE is powerful, aesthetically pleasing, and can perform several functions which would enhance the experience of the gallery, the limitations of the OE was too great at this point. These limitation included complexity of programming; cost of hardware; investment in design services; and obstacles to easy in-house maintenance and expansion.

Recognizing that WHM desire a more user-friendly system that would expand and grow with available resources, we created our own software, which featured functions that we thought would be useful for the Fuller Gallery. Our own software, Augmented Exhibit (AE), is a web-based database, which can retrieve and display information, images, and videos of artifacts, historical events, and people. AE can function as a “default exhibit”, which allows for touch areas, called “tiles”, to contain information such as title, date, image, text and videos, as well as an interactive map, where the “tiles” have a map pin in the center, and “timeline exhibits”, where the “tiles” are historical events on a timeline-grid. AE allows for cross-connection between these “exhibits”, and for connection between artifacts, by automatically creating links between different “tiles”.

We also made a prototype of an educational mini-game, Rat Trap, to work within the AE environment. The game is built around the Clark’s Jillson 1856 patent for an improved mouse trap and allows the audience, especially younger audience, to interact with the exhibit while learning about it. Because of the limitations of this project, we could not develop a complete game and instead created a outline of the game with detailed instructions.

Our recommendations for the Worcester Historical Museum to pursue, are as following:

- To not use Open Exhibits for the current exhibits, since it is a large investment, but to consider it in the future if a complete and ambitious renovation of the gallery is to be made.
- Augmented Exhibit can be used as it is now, as a temporary piece of digital technology, or can be improved upon by a future IQP group or a freelance developer and used as a complete digital technology for the gallery. This would require basic programming knowledge.
- The educational mini-game, Rat Trap: The Game can be completed by a future IQP group and used as an interactive supplement to the gallery. This requires experience in game development.

CHAPTER 1: INTRODUCTION

Problem Outline

The Worcester Historical Museum (WHM) is undertaking a thorough redesign of their Fuller Gallery of Worcester's Industrial History. The current installation, entitled "In their Shirtsleeves," is now over twenty years old and its design principles reflect its age. The gallery space is crowded with artifacts. The walls are covered with text and images. An elevated timeline near the ceiling competes with guard rail interpretative panels for attention and often reiterates information. Some artifacts have extensive interpretation, while other items are simply identified by name and date. While the individual pieces are all fascinating, a visitor can sometimes have difficulty getting a sense of the big story as the pieces -- artifacts, images, timeline and text -- compete for attention. The result can be an overwhelming, cluttered and disconnected experience.

In hopes of elevating the interpretation of fascinating artifacts, their history and importance to Worcester, the nation and the world, digital technology can be used. Digital technology can be used to show one entire artifact, delivering detailed descriptions of each part, and develop a deep background, all at the visitor's own choosing. To relieve the crowded atmosphere, where artifacts, images and descriptions compete for space, digital technology can be used to let the visitors pick and choose which artifacts to read about. Some of the gallery's most fascinating and significant pieces are machine tools that sit silently, but digital touchscreens can bring them to life, incorporating elements like animation or historical video. The same screens can provide audio of machine shops or factories to increase visitors' sensory engagement. Additionally, these touch-screen can incorporate interactive maps, that show where

industrial output in Worcester took place or where it ended up. With digital technology, the traditional static gallery can be made to move.

One area that a digital augmentation can be used to enhance the exhibit is in its timeline. There is a very interesting and developed timeline encircling the room, but because it is far back on the top of the wall, as well as competing for attention with the signs on the railing, it is easily overlooked. By utilizing digital technology, we can bring the timeline closer to the viewer where it can be noticed more easily by the audience, who can then navigate it on their own. In this way, the artifact within the exhibit can be tied to a central narrative, which is easily accessible to the audience. This allows for an enriched experience, bringing the historical relevance of Worcester to the front of the audience's experience.

Thus, by using touch-screen digital technology, the gallery can be utilized to a higher potential, than with traditional galleries. The items can move, more depth to the information can be given, connection between different artifacts can easily be made, relevant pieces can be elevated and the audience can interact with all of this to their own choosing. This makes for a strong audience-focused exhibition, which would enrich the individual's own experience.

Mission Statement

In an attempt to address the challenges of the current gallery space and to explore the potential of digital interpretive panels, our mission is to: **Develop prototype touch-screen applications, as a means to illustrate the strengths and limitations of digital technology, as well as to lay a foundation for the future application of digital technology at WHM.**

We have attempted to achieve this by researching what sort of applications are viable, and the strengths and weaknesses of these. We have also developed a set of test exhibitions, including an augmented exhibit, a timeline, an interactive map, and a mini-game. For this we

have built an original database, which is paired with these applications, to retrieve and display information on artifacts, people, events, and locations.

Background

Before spending time redesigning the exhibit, we researched what makes a successful exhibit in the first place (Marty, 2008). First looking through popular exhibits, we found that most displays put together recently are simple, clean, and clutter free. For example, the Museum of the City of New York, where digital technology is used to design a clean and aesthetically pleasing gallery (Roberts, 2016).

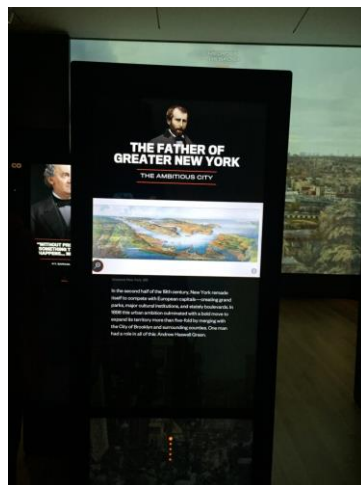


Image 1. Example of a touch-screen at the “New York at its Core” Exhibit at the Museum of the City of New York

Since this would require a major overhaul of the exhibit, we instead focused on another feature that made exhibits popular. Interactivity was by far what engaged museum goers, for a variety of reasons (Zaharias, et al., 2013). Touch-screen panels allow patrons to interact with portions of the exhibit, sometimes even triggering the exhibit to do something corresponding to what was touched. Secondly, it allowed younger patrons to have an interface between the artifact and themselves, providing insight that they would not have imagined. Finally, it allows a greater

amount of information to be available at the exhibit itself without causing clutter or confusion, and for the patron to choose how deep they want to pursue this information. This is an issue in traditional exhibits in that too little information can lead to confusion or flat out boredom, and too much information can become overwhelming. Digital interactive displays solve this problem by letting the patron control the amount of information that should be displayed, depending on their own interest, by a range of different mediums (Correia, 2010).

In 2015-2016, a previous IQP team initiated an exploration of museum technology and suitable software platforms for digital interpretation (Marry, et al., 2016). Specifically, they surveyed several available systems for personal device apps, touchscreen kiosks, mobile system to extend the museum experience beyond the walls of 30 Elm Street. They looked into both open source and commercial software options. After the broad survey, they focused upon three different platforms to evaluate through trial. These included a stationary touch-screen application (Open Exhibits), a mobile application (OnCell), and a mobile service which focuses on historical experiences beyond the gallery (TAP). To test the full potential of these three systems, the team developed expanded interpretive materials for three artifacts: a replica of Morgan Construction Company's Flying Shears, a parlor model from Worcester Organ Company and a corset from Royal Worcester Corsets. They then experimented with building out the digital exhibits in the three systems, evaluating the potential and limitations of each as they went along. They concluded that Open Exhibits had great potentials, but would need extensive work before the museum could utilize it. OnCell was, they concluded, very limited in its potential and customizability. Lastly, TAP, though easy to use and more powerful than OnCell, was outdated, and no support existed for the application. Based upon their recommendations,

WHM asked that further investigation of Open Exhibits and similar touchscreen technologies be undertaken.

We have undertaken the project of further exploring Open Exhibits and determining its suitability for the WHM. Open Exhibits is an open source software collection, which lets museums share experience and visuals for digital exhibitions. It runs best on touch-screens, and utilizes Gesture Markup Language (GML) and Creative Markup Language (CML), which require professional experience to operate. In addition, Open Exhibits lets the museums that belong to its community utilize Omeka, which is standardized database software, which lets museums easily convert stored information to digital technology. The gallery can then be displayed on stationary screens inside the gallery, and visitors can interact with the exhibition.

(cite Open Exhibits about page)

CHAPTER 2: EVALUATING OPEN EXHIBITS

Methodology

We evaluated the suitability of Open Exhibits (OE) as a software package for developing in gallery digital exhibits for WHM. Our assessment involved building within and programming with open source software; examining documentation and activity within user forums; and evaluating OE installations at other museums through interviews and research. Our evaluative criteria included:

Availability – the extent of information on the internet to aid programming in OE and the vibrancy of user forums among the community of practice to offer assistance, help or feedback;

Accessibility – the extent that the museum can develop and maintain exhibits in the software itself and the hardware/software would be needed to use OE; and

Cost and Satisfaction – the extent to which previous users of the software thought that investment of time and money into OE was cost effective and produced exceptional enhancement to gallery experience.

Platform Description

OE is an open-source software collection designed to aid museums in the production, display, and sharing of digital exhibits primary on touchscreen platforms from tablets to tables and walls. Launched in 2010 with support from the National Science Foundation, OE is powered by Gestureworks and essentially operates as a set of “building blocks” - templates, components and utilities – that can be arranged in various ways to create digital displays. This system has been specially conceived to develop multi-user interactives on large table sized touch-screen panels. Ideum, a hardware and software company specializing in large format touchscreens for

informal educational settings, is the primary developer and sponsor of OE. Ideum is also the developer behind Gestureworks, the authoring framework powering OE, and Tangible Engine, an object recognition system for large touch-screen panels. OE has been used in a variety of museums to engage audiences and given the software's emphasis on multi-user panels, touchscreens operating OE have frequently been centerpieces in gallery exhibits.



Image 2. Multi-user interactive recreation of the ancient Inca City of Cusco on an 84” multi-touch table in the Inca Roads Exhibit at the Smithsonian’s National Museum of the American Indian Museum

Since its launch, OE has steadily expanded its capabilities to include full 3D support. Further in 2014, it began work with the Roy Rosenzweig Center for History and New Media at George Mason University, so the two partners might join the display capabilities of OE with RRCHNM’s Omeka, an open source web platform for the digital management and display of museum collections. In 2016, the two released Omeka Everywhere, which allowed Omeka content to be display in an OE collection viewer.

Although OE is billed an open source system supported by a community of users, there are several obstacles that limit its accessibility and prevent easy development of applications. While it is easy to download the software and to experiment in its code, the documentation is very simple, only detailing what each function does but not how to build a large application, and

the forums' content is dated. Activity in the forums has also sharply declined since 2015, spiking only briefly with the release of Omeka Everywhere. After working with the free version, we realized that, though this version offers many useful functions for digital technology in an exhibit, there is a very steep learning curve for new users, even users experienced and adept at programming. The limited nature of the documentation and the difficulty of customizing OE led to the conclusion that OE has limited availability as an out of the box product.

Current Installations

Curious about our experience, we contacted other museums who have worked with OE. These contacts confirmed our doubts about OE's accessibility. For example, the Minnesota History Center's 2015 Suburbia exhibit included an OE digital timeline of aerial photographs showing the growth of suburbs around the Twin Cities' major shopping malls between 1937 and the present. When asked about their experience developing the application in OE, Jesse Heinzen, the Multimedia Director at the Minnesota Historical Society, said that Ideum, the creators of OE, managed the software and application development through their creative services consultancy. He noted that the museum paid about \$20,000 for software development, another \$20,000 for the 75" Ideum touch table display, \$3,000 for a custom table base for the display, and \$7,000 in Museum staff hours. He was very enthusiastic about the end result, noting that after the Suburbia exhibit closed in 2016 the touchscreen was moved to a permanent exhibit, "Then Now Wow" (Heinzen email communication, 01/20/1017).



Image 3. Digital timeline of aerial photographs showing the growth of suburbs around the Twin Cities’ major shopping malls between 1937 and the present, at the Minnesota History Center.

Following up with other museum professionals listed as “Partners & Advisors” on OE’s website, we discovered similar results. John Llewellyn, Senior Exhibit Developer at the Museum of Science and Industry in Chicago, participated in “paper prototyping” with OE, but never followed up to collaborate on an exhibit in OE. He noted that his museum does not produce digital interactives but rather contracts out programming (Llewellyn, email communication, 01/27/17). Another partner, Catherine Baudoin of the Maxwell Museum of Anthropology, worked with OE on an interactive exhibit on the WW II Photography of John Collier, Jr. Rather than undertake the project of coding in OE she contracted with Ideum Creative Services on the interactive exhibit.



Image 4. The World War Photography of John Collier at the Maxwell Museum of Anthropology

Deeper research revealed this to be a trend. Although OE sought to create a “growing community of practice” as an open source system, it seems the community is small and composed of mostly contract professionals, including the creative team at Ideum, OE’s creators. The creative consultancy at Ideum have partnered with the Sullivan Brother’s Iowa Veterans Museum, National Museum of the American Indian, Museum of Contemporary Naïve Art, the Crystal Bridges Museum, Milwaukee Public Museum, Mount Vernon and others. The results have been consistently visually engaging but the costs were also very steep.

Conclusions

From this evaluation, we concluded that OE would not be ideal WHM to use at this time. If in the future, the museum might consider investing in massive multi-touch technology but they would likely be better served by starting small. Among the specific limitations of OE for the Industrial Gallery at this time are:

- Difficulty of use for non-Gestureworks developers, making the promise of open-source availability unfulfilled;
- Necessity and expense of contracting out services;

- Size and cost of multi-touch tables would overtake the space in the Fuller Gallery; and
- Challenging of updating the content of displays once programmed and deployed.

Given these limitations, the team realized that it might be best that the museum start small.

Rather than move immediately to incorporate the largest and most costly multi-touch, multi-user touch panel system into the Fuller Gallery, we decided, while consulting with WHM, that we would begin to initiate research into software which could utilize smaller touch-panels deployed across various parts of the gallery. These small panels could accomplish similar levels of interpretative immersion by focusing on specific artifacts, machine tools, buildings and lived experiences from Worcester's Industrial History. The gallery will need a system that will allow them to add and built content as the exhibit matures, evolving with user experience. This system would ideally incorporate the storage of all interpretative materials in a database, their retrieval upon command on to touch panels, and an aesthetic user interface and content style to inspire museum patrons to probe the history and meaning of Worcester industrial experience more deeply.

CHAPTER 3: PROGRAMMING A CUSTOM TOUCH-SCREEN EXHIBIT PLATFORM

Features and Criteria

After determining that the limitations of Open Exhibits to **our** particular project were too great, with the approval of the Worcester Historical Museum, we began to investigate other methods of achieving our goal. In order to make this system as accessible as possible, we came to the conclusion that web-based applications would be best for future development and ease of use. We brain-stormed ideas on uses of web-based applications, went over them with the Worcester Historical Museum, and developed prototypes of an augmented exhibit, a timeline, an interactive map and a mini-game as proof of concepts for digital technology.

When deciding on what alternative to Open Exhibits to use, as digital technology for the Fuller Gallery, we attempted to find some software which could perform some certain actions, that would, we think, enhance the gallery. We were looking for a system which could sort and store data, so for example something that integrates Omeka, or some other database driven storage system. We were also looking for something that would allow the artifacts to be animated, or have relevant images “attached,” and would allow the audience to read about related objects, if they so want. We also wanted to be able to design, more specifically, a timeline, an interactive map, and a game.

After some research, we decided that the best way to achieve a customizable, affordable, and easily maintained software for the museum was to build it ourselves. We could create a prototype, which hopefully inspires, and conceptualizes the power of digital technology in the Fuller Gallery. This prototype can then be used as it is, perhaps be improved by another IQP group or a professional developer, on small touch-screen surfaces. We decided to create Augmented Exhibit (AE), which would function as a digital exhibit, timeline, and interactive

map in one database system. We also decided to create a prototype of a game, which is a powerful tool in letting the audience, especially young children, learn while interacting with the artifacts of the exhibit.

Augmented Exhibit

The Augmented Exhibit (AE) needed to allow users to touch certain parts of a screen to allow them to further investigate the topics they are interested in. In order to make the current and future development as simple and accessible as possible, we went with a web based application due to the almost indefinite backwards compatibility with newer web browsers (newer versions of web browsers strive to not break existing web sites) and the availability of professionals in the field. To this end, we chose the Django web framework (<https://www.djangoproject.com/>) which uses the Python programming language (<https://www.python.org/>) to create database driven web applications. Both the programming language and the framework are widely used with many professionals having experience in one or both. This will allow for future development of our prototype by either other project teams or contracted professionals.

The AE is a web page which can be accessed from any device which has an internet connection to the server, where “exhibits” are displayed. Our AE is based upon the idea of “tiles;” these are objects that can contain text, dates, images, and videos. These “tiles” are touch zones that have information assigned to them which they can retrieve and display in a pop-up when tapped. When an “exhibit” is created, initially its type is chosen. The default type provides a full screen image over which “tiles” can be placed to make certain areas of the image interactive. These “tiles” can optionally be set to display their attached image and/or title. A “map” type can also be chosen which displays the “tiles” as map pins. A full screen image is still

displayed behind the pins, which ideally would be a map. The third and final type is a “timeline” type. In this display mode, the “tiles” are laid out as circles with their respective images covering the area of the circle. The “timeline” is a grid based system where the vertical axis is the month and the horizontal axis is the year. Each “tile” is laid out at its proper location.



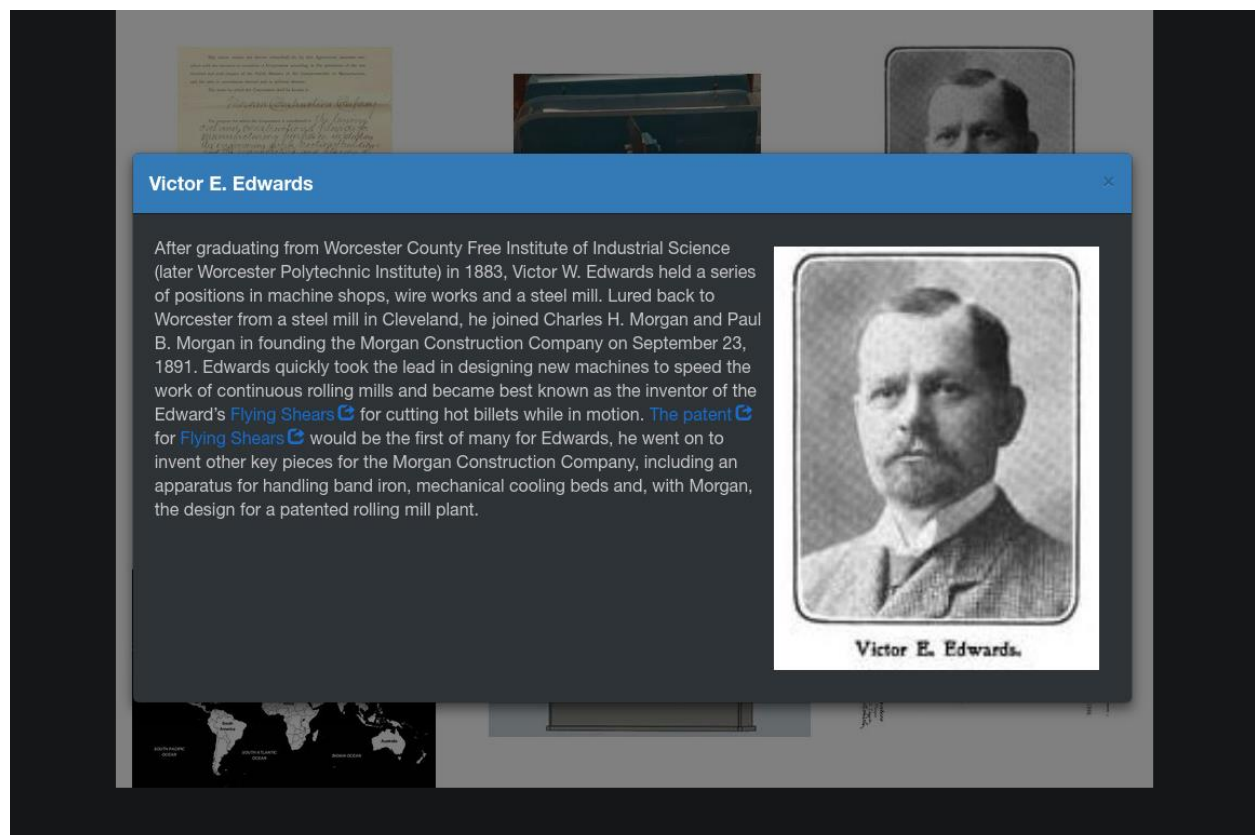
Image 5. Example map exhibit demonstrating locations of the Morgan Steel Company

The information stored in a “tile” is stored separately from the position of the “tile”. This allows “tiles” to be placed in multiple “exhibits”, sharing the same information base between each instance. “Tiles” can also point to other “exhibits” and display those those in pop-ups to create even more nested flexibility.

Our Augmented Exhibit is powerful in that it allows for cross-over between the different types of “exhibits.” A “tile” can be created which can then be re-used in a timeline, or a “exhibit tile” can link to an already existing “exhibit.” Additionally, a special type of exhibit can be

created called a “timeline set,” in which several timelines can be run in parallel, allowing for comparisons between different historical narratives.

Another useful feature of the AE is that it allows for hyperlinking between “tiles.” For example if one “tile” mentions the title of another “tile,” the text is automatically hyperlinked, and upon selecting the hyperlink, the “tile” corresponding to the link pops up. This allows for great flexibility, and since the “tiles” are easily edited, our software has little problem with any future renovations. A major problem with OE is that when completed, the digital technology cannot be changed without contacting the contracted company and working on redesign. AE though, only needs to edit the existing “exhibit”, or the web page can be changed to a new “exhibit”. This is both easy and practical, as well as cheap, no professional skill needed to create the basic structure of an “exhibit.” Small changes to the look and feel can also be accomplished with basic HTML and CSS skills, both of which are widely available from freelancers, hobbyists, and professionals.



The image shows a screenshot of a digital exhibit interface. A blue header bar at the top of the tile reads "Victor E. Edwards" with a close button (X) on the right. Below the header is a text block containing a biography of Victor E. Edwards, mentioning his education at Worcester County Free Institute of Industrial Science (later Worcester Polytechnic Institute) in 1883, his work in machine shops, wire works, and a steel mill, and his role in founding the Morgan Construction Company in 1891. It highlights his invention of the Flying Shears for cutting hot billets while in motion. To the right of the text is a black and white portrait of Victor E. Edwards, a man with a mustache, wearing a suit and tie. The portrait is framed and has the name "Victor E. Edwards." printed below it. The background of the exhibit is dark and features several other "tiles" or images, including a document, a photograph of a machine, and a world map.

Image 6. Hyperlinking example: tapping on “Flying Shears” or “The patent” will pop-up the information for the user

How to use Augmented Exhibit

In the home page, existing “exhibits” are listed. To view or edit these existing “exhibits”, tap the “view” (eye) or “edit” (pencil) icon next to the name of the “exhibit.” To create a new contribution, there is a button in the upper right hand corner which will pop-up a simple form that can be filled out.

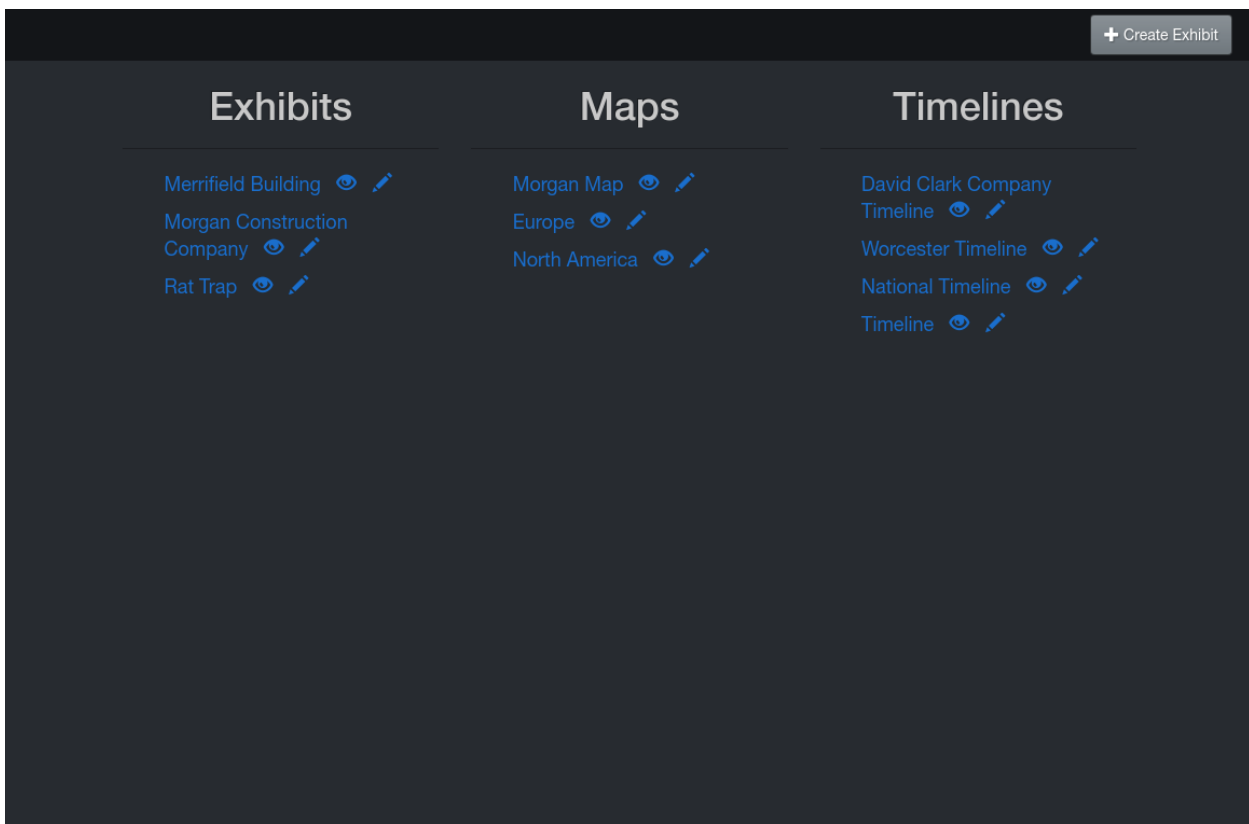


Image 7. Home page where exhibits can be created, viewed, and edited

For a “default exhibit,” on the top of the screen there is the edit bar, here one can choose to add a “tile” or an “exhibit tile.” For normal “tiles”, the edit screen pops up, and one can choose between already existing “tiles” or create a new “tile.” If creating a new “tile” is selected, a title, image and text must be provided. Additionally, one can select to show the image and/or

title of the “tile.” In the description field, a video file can be inserted by selecting “Tools->Insert YouTube Link” and entering the YouTube url of the video. When the “tile” information is done, press done, after which the “tile” appears on the background image, and the “tile” can be dragged around. Then, if need be, the “tile” can be resized by dragging the lower right corner, or its bottom and right sides.

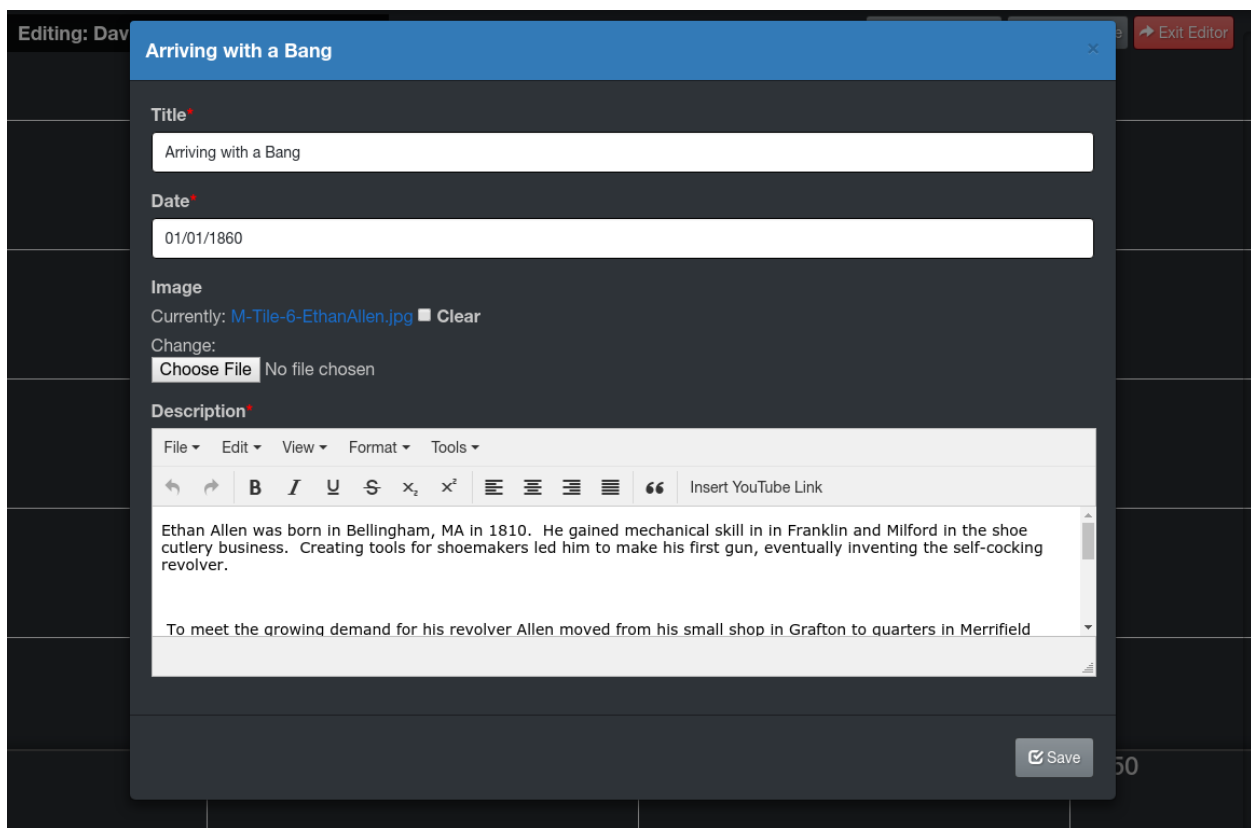


Image 8. Editing a tile in a timeline

For “exhibit tiles,” likewise one can choose using an already existing “default exhibit”, or create a new one. When creating an “exhibit tile”, an “exhibit” similar to the original “exhibit” pops up, except that it is smaller, and it can be edited just as the original “exhibit.” As with creating a new “tile.” one can choose to display image and/or title of the “exhibit tile.” When the “exhibit tile” is finished, they similarly appear on the background image of the original “default

exhibit,” and these “exhibit tiles” can be moved and resized. Even after “tiles” and “exhibit tile” are finished, they can be edited by clicking the “edit” icon on the top right of the “tile.” “Tiles” and “exhibit tiles” can also be deleted from the “exhibit” by pressing the “delete” icon, also on the top right of the “tile”.

When creating a “timeline exhibit,” the length of the timeline reaches from the earliest to the latest dates of “timeline tiles” selected. As in “default exhibits,” one can choose between adding already existing, or to create new “tiles.” The creation of “tiles” work the same way as for “default exhibits,” and additionally dates for the “tiles” are needed, so the “tile” can be automatically placed on the timeline.

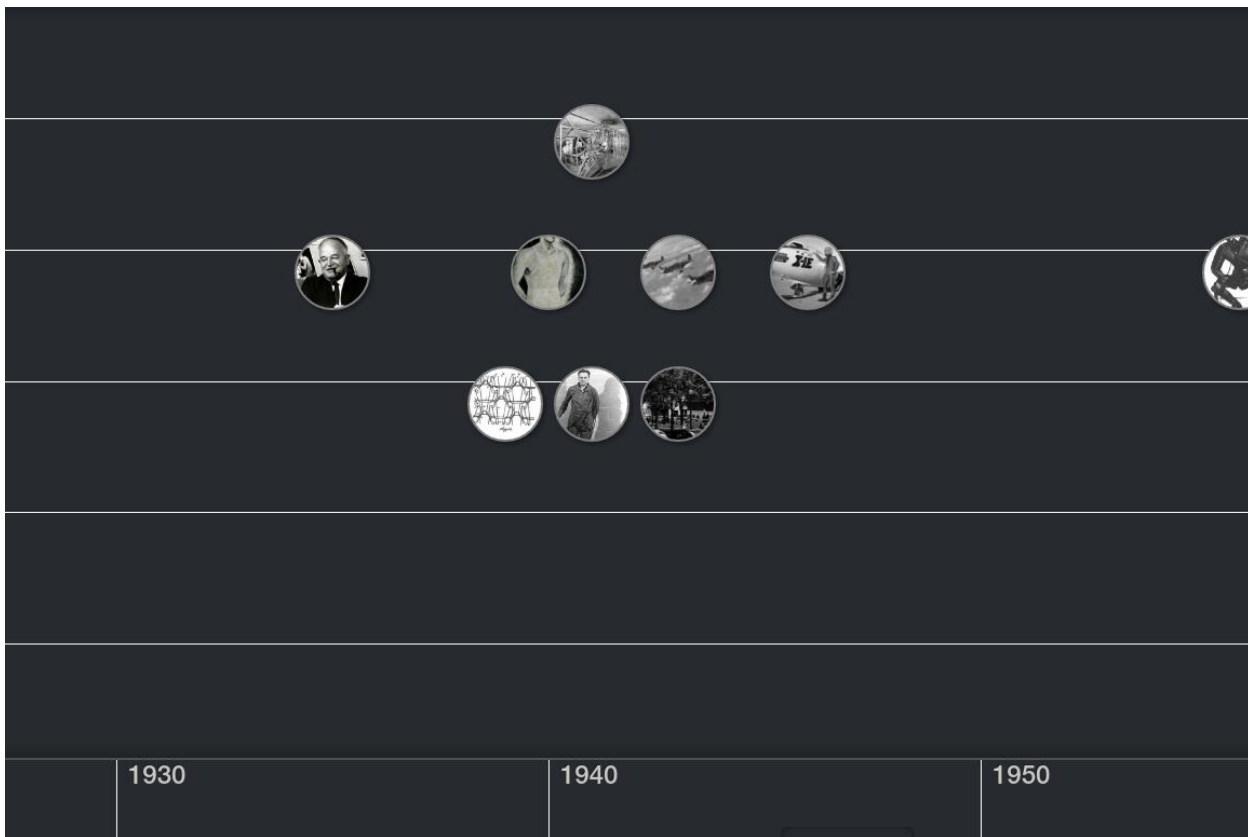
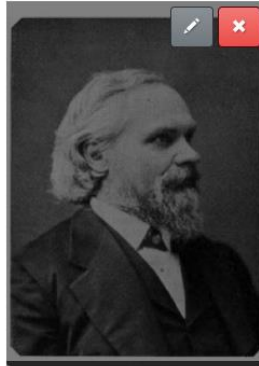


Image 9. The David Clark timeline in view mode

When choosing “map exhibits,” the setup will look the same as for “default exhibits.” In fact, the only difference in creating and editing a “map exhibit” is that any “tiles” will have a pin placed in the center of the “tile”.

When finished creating or editing an “exhibit,” one should select the “Exit Editor” button. This will direct the user to the normal view of the “exhibit,” which is the mode used for presentation of the exhibit. For “default exhibits”, the screen will show the background picture, and any “tiles” that have been selected to show image and/or title. Touching any “tile” will result in the information on the “tile” popping up in another window above the “exhibit”. For “timeline exhibits”, there will be one or more timelines going from left to right, which can be scrolled by sliding the finger over the timeline. Upon touching “timeline tile” icons, which are represented by their images, the information on the “tile” will pop up. For “map exhibits”, “tiles” that are placed on the background, for example a geographical map, will have pins in their centre, and will represented a geographical area. If these “tiles” are touched, the information on the geographical area will pop up in another window.



CLARK JILLSON.

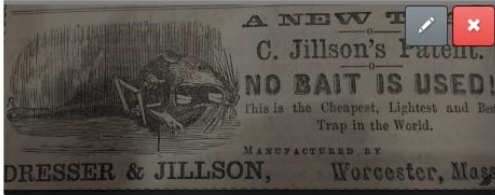
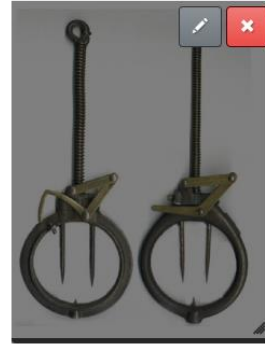


Image 10. Editing a standard exhibit

CHAPTER 4: DESIGNING RAT TRAP: THE GAME

Setting and Genre

The educational mini-game takes place inside the Merrifield building in Worcester, Massachusetts between 1857 and 1859. The reason for this is that the Jillson Rat Trap was invented and produced in the Merrifield building at this time. The game will be set at night in the building at which point the player will take the role of an exterminator trying to stop rats from sabotaging the machines in the building. In order to stop them, the exterminator is tasked with assembling newly produced rat traps which can then be placed throughout the building in order to prevent the rats from reaching the machines.

Given the play mechanics, the game can be placed in a few different genres. The first is as a puzzle game as the player will need to assemble the appropriate pieces of the rat trap in order to place one down. The second is that it is a strategy game as the player will need to figure out the best places to put the rat traps down in order to prevent the machines from being destroyed. The final genre the game would fall under is educational. This is because, as the player goes through the game they will also be learning about the history of the Merrifield building as well as the various products that were produced there.

The Unity Engine and Targeted Platforms

One of the greatest assets about using Unity to build this game is that it can be easily ported to nearly any feasible device. While this may seem like a given, it is actually a blessing for game developers. This is because many game engines often charge copious amounts of money for development packages that allow developers to create copies of the game that are compatible with certain devices. For example, one engine may charge \$80 for a package that

allows the game to be compatible with iPhones and the developer would need to pay another \$80 if they wanted to make it compatible with a Google phone.

This will help to cut costs greatly in the production of the game and, due to the developer packages already being built into Unity, the game will even more easily be able to be ported to any platform that is desired. For the best results when playing this game, however, we suggest that a touch screen tablet, preferably running on a Windows or Android operating system, would be ideal. This is because the game consists solely of dragging and dropping as well as tapping interactions, making a touch screen device ideal for optimal gameplay.

Targeted Audience

While the game was designed to be simple and playable by anyone, it was mainly designed to grab the attention of younger museum goers. This game will focus on engaging younger generations in nineteenth-century technologies they never witnessed through an interactive adventure.

Project Scope

Depending on the reception of the preliminary game, further development of the project can go as far as the museum would like. Further polishing of the game can be made by a single person, but further expansion of unused concepts would likely require a team of people to accomplish efficiently.

Pitch

“Rats are planning the ultimate sabotage in Worcester’s Merrifield building where the new Jillson Rat Traps are being produced. In order to stop the building from being overrun and the production of the traps halted, you have been hired as a rat exterminating specialist. Using

your knowledge of the Jillson Rat Traps, you will quickly assemble as many as possible before the machines are destroyed by the renegade rodents. Stop the rats and save the traps!”

Core Gameplay Mechanics

Trapping Rats. The main goal of the game is to protect the Merrifield Building from invading rats through strategic placement of rat traps. The building will be rendered in a maze like map viewed from the top down. On the map, small rat holes will be seen on different places along the walls. From the rat holes, rats will be running through the maze of the building from one hole to another in real time. The player will be able to place rat traps at any of the holes in the wall in an attempt to trap the rats in a timely manner.

Assembling the Rat Traps in Real Time. Alongside the main game, the secondary mechanic will be to assemble the rat traps through drag and drop interactions on the side of the screen. A pile of parts will be displayed, and before the player can place a trap, they will first be required to assemble the trap part by part. After it is assembled it will play a short animation of it being primed, and will then be placeable by the player onto the map of the main screen.

Player Interaction with Real Life Artifacts. An important part of the game will be to engage the player with the history of the Merrifield Building by showing different things being manufactured there. Pausing the game will display the different artifacts that are also displayed in the museum. Selecting any of these artifacts will display more information, as well as its physical location so that the player can see it in the museum.

Story

The game takes place between the years 1857 and 1859 during the time that the Jillson Rat Traps were first being produced in the Merrifield building in Worcester, Massachusetts. At the beginning of production, all is happy and well and the rat traps are becoming a success.

However, workers in the factory soon begin to hear rumors of rats going rogue and gathering their forces in order to avenge their fallen brethren and prevent the slaying of any future wall-dwellers. Their goal: destroy all the machines in the Merrifield building to prevent any further production of the dreaded rat traps.

Terrified of their precious rat trap producing machines being destroyed, the owners of the building hire a newly trained rat exterminating specialist. He is given all the pieces needed to assemble as many of the Jillson Rat Traps as he needs and is told that the rats are rumored to have their rat raid time set to begin late into the night. Showing up for his first night on the job, the rat specialist must assemble as many traps as possible to place them in areas where rats emerge in order to stop the destruction of the Merrifield building.

Gameplay

The main game will consist of a screen split between two different panels. The left side of the screen will be a map of the Merrifield Building, with different rooms and machines creating a maze for the rats to navigate through. On the right side of the screen, there will be a workbench with piles of materials. Displayed on the workbench will be blueprints for the rat trap designed by Jillson, which will show the player how to assemble the rat traps.

The game will begin at the start of the exterminator's night shift. Rats will spawn and run from rat hole to rat hole spending some time gnawing at the leather belts of the various machines. The player will have to assemble a rat trap from the provided parts by dragging and dropping them onto appropriate places of the blueprint, snapping them into place. After the last piece is snapped into place, the rat trap will become an object that can be dragged onto the other side of the screen and into the maze. The goal will be to predict where the rats will go next and to assemble and place a trap before a rat goes into or out of the rat hole. Each machine will have a

life bar that will slowly go down when it is gnawed by a rat, and if a machine is completely disabled, the player will lose points. If all machines on a given level are disabled, the game is over.

CHAPTER 5: FINDINGS AND RECOMMENDATIONS

Digital augmentation can be used in a variety of ways to enhance the Fuller Gallery of the Worcester Historical Museum. Open Exhibits proved to be a professional and well tested system to implement. Despite its clean finished product, it is made virtually unusable by any except its developers (Ideum). Subsequently, it was not able to be implemented within the scope of this project.

Instead, a separate web based application was developed that could handle basic information storage and retrieval to display in front of artifacts within the exhibit. Because of the limit in time and resources, this application was not developed to be as powerful as Open Exhibits, but rather, as a simple tool that can be used by anyone with moderate knowledge in managing databases. Among its basic functions are: information storage, timeline display, map display, and basic exhibit display. All modes share the same data, and as a result can be easily modified across the system.

In addition to the exhibit display application, a mini-game was developed within the theme of the gallery. While the scope of this project could not accommodate the development of a full game, a basic prototype was developed as well as a detailed plan mapping out a completed game.

While serving as only a proof-of-concept, these programs could be incorporated into the redesign of the Fuller Gallery with little investment. For example, the completion of the Rat Trap game, could serve as a future project for IQP students, which would require some game development experience. Augmented Exhibit could be used as it is, as a temporary digital technology, and then be improved and extended upon, also by a IQP group, or by a free-lancing

developer. Conversely, a sizable investment could be made in contracting Ideum, resulting in an elegant and professional final product.

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Appendix 1. Links to Code

Augmented Exhibit link:

<http://solar-10.wpi.edu/rmaiudi/Historical-Society-IQP-Timeline-Exhibits.git>

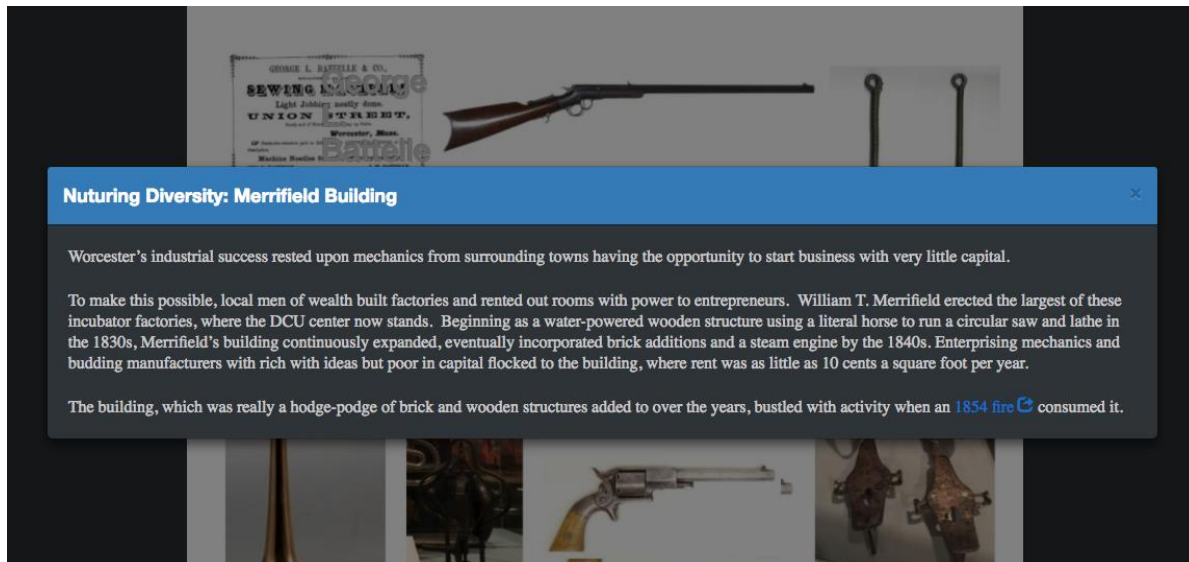
Contact Professor Joseph Cullon at jcullon@wpi.edu to log in.

Rat Trap: the Game link:

<http://solar-10.wpi.edu/rmaiudi/Its-A-Trap--IQP-Game-Demo.git>

Contact Professor Joseph Cullon at jcullon@wpi.edu to log in.

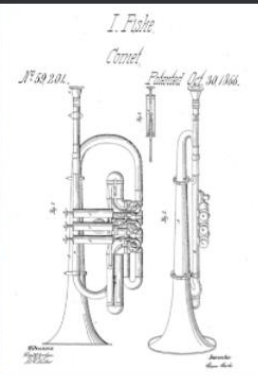
Appendix 2. Merrifield Building: Touchscreen Panels



Leader of the Band

At the age of 22, Isaac Fiske moved from Holden to Worcester, Massachusetts to take up instrument making. He lost his first shop in the great 1854 Merrifield Fire.

He rebuilt his business quickly, employing 10 people with a \$350 a month payroll by 1860. By the middle of the 1860s, Fiske hit his stride patenting a string of improvements to wind instruments, beginning in 1866 with a patent for a piston rotary valve design on a three valve cornet. He went on to patent four additional improvements to valve design and forming pipe bends over the next eight years. He would continue to manufacture a variety of brass instruments until he retired and sold his factory to Charles Gerard Conn in 1887.



On the Ice

Brothers Samuel and Seth C. Winslow moved from Newton Upper Falls to Worcester in 1856. They rented space in the Merrifield buildings and began to make a variety of metal parts to order for other companies. In 1857, responding to the public's growing fascination with ice skating, the Winslows made twenty-five pairs of skates. They sold nineteen. The following year they made and sold 2,500 pairs. After Seth's death in 1871, Samuel moved the company to a new factory on Mulberry Street. By 1880 Samuel Winslow's company was the largest producer of skates in the country.

Production figures for 1889 indicate that the company turned out 1,200 pairs per day: forty styles of ice skates and fifteen styles of roller skates.



Appendix 3. Jillson Rat Trap: Touchscreen Panels



CLARK JILLSON.



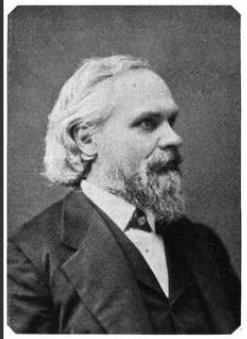
Clark Jillson - Inventor, Judge and Mayor ✕

A Turn Toward Invention.
 Clark Jillson, the son of a Whitingham, VT blacksmith, was like many country lads who arrived in Worcester as the railroad connected the city to distant markets.

Arriving in 1845 with smithing skills, he quickly found work first manufacturing carriages and shear blades and then serving in the shops of L. & A.G. Coes, wrench manufacturers.

Like others drawn to Worcester's inventive ecosystem, Jillson's mind turned to invention. In a few short years, he filed a string of patents from everything from improvements to lightning rods, a machine for turning tapers and a mold for making strawberries.

He is probably best remembered for his impaling rat trap.



CLARK JILLSON.

Inventive Community in Worcester

Once settled in Worcester, Jillson found himself surrounded with other men eager to turn their ideas into industry and profit. He need not go far to find others writing up patents or to find a lawyer to help him file his own.

The attorney, practical mechanic and solicitor of patents James G. Arnold offered his wisdom on "very moderate terms." In addition to promising confidentiality, Arnold also offered aid in building patent models. Jillson would easily have found him at Mechanics Hall, which he joined in 1864 to engage with other enterprising craftsmen.



Gathering Raw Materials

Once Jillson received his improved rat trap patent, he entered into partnership with Samuel Dresser to manufacture the traps in Merrifield's building for \$25 a month. By 1857, William T. Merrifield had already built his famed building with "rooms with power to let."

Given Worcester's inventive ecology and ready rail connections to many markets, Dresser and Jillson did not need to go far to acquire all the pieces to start their business and commence manufacturing.

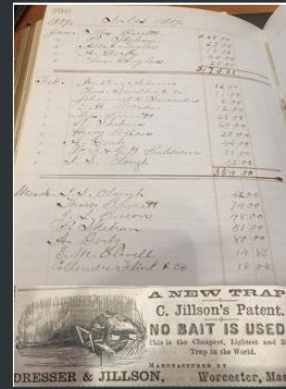
For raw materials, Dresser and Jillson turned to all local business a short walk their shop in the Merrifield Building – Ichabod Washburn for wire, Pratt & Inman for iron goods, and Arcade Malleable Iron for castings and patterns. They purchased tools and equipment from other Merrifield residents, such as a lathe from Charles L. Bacon, pulleys from Towne & Harrington, and a tapping machine from Charles E. Staples.

For offices materials, they turned to local dealers for engraving, account books, shipping labels and boxes.



Marketing the Rat Trap

Once Jillson received his improved rat trap patent, he entered into partnership with Samuel Dresser to manufacture the traps in Merrifield's building for \$25 a month. By 1857, William T. Merrifield had already built his famed building with "rooms with power to let." Given Worcester's inventive ecology and ready rail connections to many markets, Dresser and Jillson did not need to go far to acquire all the pieces to start their business and commence manufacturing. For raw materials, Dresser and Jillson turned to all local business a short walk their shop in the Merrifield Building – Ichabod Washburn for wire, Pratt & Inman for iron goods, and Arcade Malleable Iron for castings and patterns. They purchased tools and equipment from other Merrifield residents, such as a lathe from Charles L. Bacon, pulleys from Towne & Harrington, and a tapping machine from Charles E. Staples. For offices materials, they turned to local dealers for engraving, account books, shipping labels and boxes.



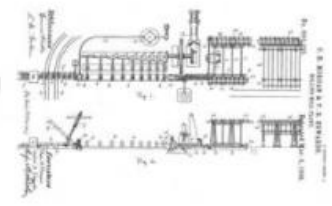
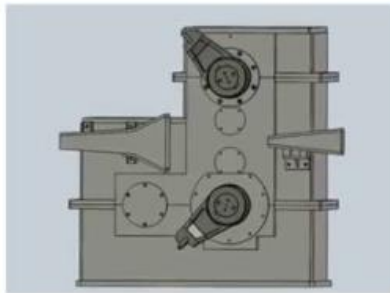
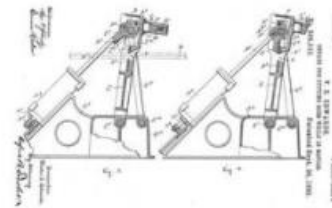
DRESSER & JILLSON, Worcester, Mass.

GRINDSTONE, BEAN SEED,
and a variety of other articles
Washington Sq., Worcester, Mass.

Appendix 4. Morgan Construction: Touchscreen Panels



Victor E. Edwards.



Flying Shears

The unassuming scaled model displayed here cannot really capture the size or significance of Edward's invention. The "flying shear" as it became known proved a crucial component in the Morgan and Edwards's entire plan for continuous rolling mills.



The first shear invented for a Jones and Laughlin Steel Mill proved a challenge of engineering design. It had to be strong enough to cut a 1 1/2" billet into lengths as fast as it emerged from the finishing process without causing the slightest slowdown in the 250 foot per minute delivery speed.

Victor E. Edwards

After graduating from Worcester County Free Institute of Industrial Science (later Worcester Polytechnic Institute) in 1883, Victor W. Edwards held a series of positions in machine shops, wire works and a steel mill. Lured back to Worcester from a steel mill in Cleveland, he joined Charles H. Morgan and Paul B. Morgan in founding the Morgan Construction Company on September 23, 1891. Edwards quickly took the lead in designing new machines to speed the work of continuous rolling mills and became best known as the inventor of the Edward's [Flying Shears](#) for cutting hot billets while in motion. The patent for [Flying Shears](#) would be the first of many for Edwards, he went on to invent other key pieces for the Morgan Construction Company, including an apparatus for handling band iron, mechanical cooling beds and, with Morgan, the design for a patented rolling mill plant.



Victor E. Edwards.

Founding Morgan Company

Charles H. Morgan arrived in Worcester to work at Washburn and Moen Wire Works, but after several years as a highly creative engineer and inventor, Washburn and Morgan fell out over rights to Morgan's reel patent.

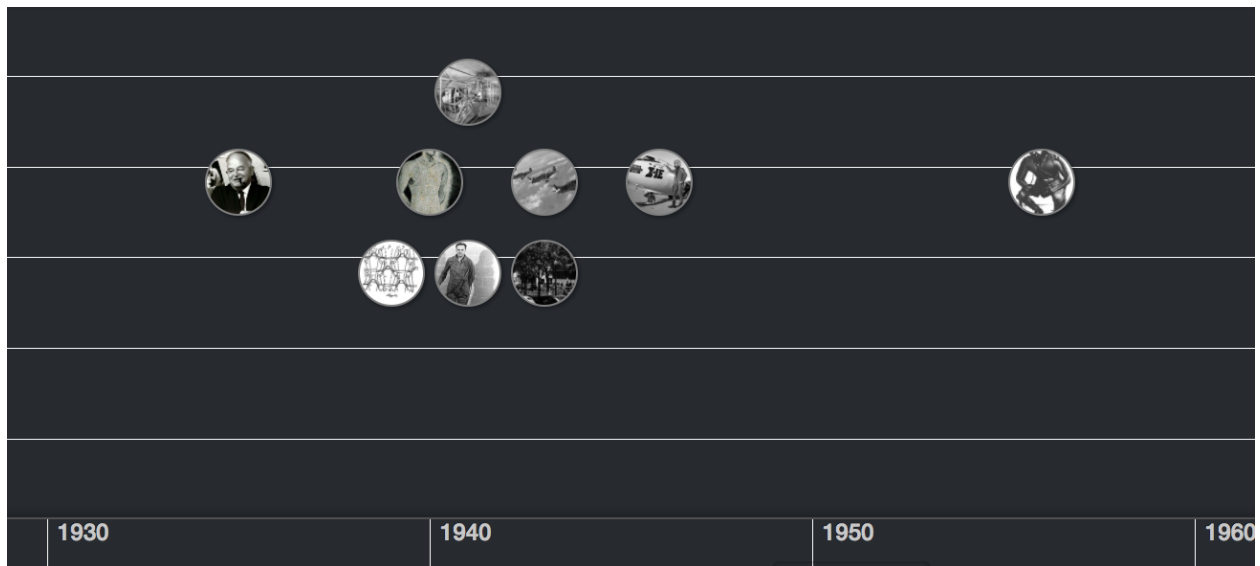
In 1891, the newly independent Charles H. Morgan incorporated the Morgan Construction Company with the twenty-nine year old [Victor E. Edwards](#) and his son Paul B. Morgan (both graduates of WPI) with \$10,000 in capital assets.

The company sold custom machinery to steel mills and wire manufactories. More significantly, they contracted to build entire mills, first for wire drawing and later for rolling steel. Although Morgan footprint in industrial Worcester would be comparatively small, its impact was felt throughout the steel making regions of the United States and the world.

After patenting a host of custom machines and an entire plan for a rolling mill, Charles H. Morgan was an enthusiastic booster for his technology, exclaiming (while president of the American Society of Mechanical Engineers), "the steamer going East and the railroad going West are built and burdened with the products of the mill. How much of the great West, and all the wealth which is in it, would have been ours without the help of the rolling mill?"



Appendix 5. David Clark: Touchscreen Timeline



Anti-G Suit

David Clark's experiments with the Mayo Clinic eventually resulted in an improved flight suit. Using the Mayo Clinic's human centrifuge to simulate flight conditions, David Clark experimented with different designs to improve the flight suit.

The Anti-G suit (or G-Suit) was worn by aviators and astronauts who are subject to high levels of acceleration force (G). It is designed to prevent a black-out and G-LOC (G-induced loss of consciousness) caused by blood pooling in the lower part of the body during acceleration, depriving the brain of oxygenated blood.

Blood deprivation to the brain leads to hypoxia, or low oxygen. This first manifests itself in a greyout (dimming vision), followed by tunnel vision, and ultimately complete loss of vision ("blackout") followed by G-induced Loss of Consciousness (G-LOC).

The danger of G-LOC to aircraft pilots is magnified because on relaxation of G there is a period of disorientation before full sensation is regained. A G-suit does not so much increase the G-thresh old, but it makes it possible for pilots to sustain high G longer without excessive physical fatigue.



The Anti-G Success

Pilots universally disliked all of the early G-suits but began to change their minds once the statistics began showing their combat performance, as measured in "kills" of enemy aircraft, improved while wearing the suits. For example, a P-51 Mustang fighter group of the Eighth Air Force reported that pilots wearing [anti-G suits](#) shot down 67 enemy aircraft per 1,000 operational hours, compared with only 33 kills for other pilots.



1930

1940

1950