



Map of Humanity

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allen (A - B - C - D)
bouw werktulbouwkunde
enstwoningen

41 Bromfiets en rijwielloods
42 Campus centrum complex
43 Boerderij II

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1. Introduction

This graduation project is about building a prototype for Map of Humanity in order to test its feasibility and its effects on people.

1.1. What is the Map of Humanity prototype

Map of Humanity's prototype is a map with a time dimension. This means that the appearance of the map changes according to the date selected. Changing the date shows the area was at that time.

The map is enriched with relevant information such as photos, texts and references to provide context. Map elements, such as buildings, roads and parks will be clickable revealing more contextual information. In simple words, it is a map similar to Google maps but with a time dimension.

The goal is to simplify the process of exploring historical information which traditionally are in the form of text located in a long wikipedia article and books. Today, using modern technology, historical information could be presented in a visual and interactive way, that is the idea behind this research.

Changing the date will be done using a date picker enabling the map to change to a specific moment in time. The map will be the closest representation possible of that specific area and time.

To enhance the user experience, map elements such as buildings, roads and parks will show more information when selected. This information can include pictures, titles, names, information text, links to other information on the map and external links such as Wikipedia to provide the user with more sources of information. This goal is to enable the user to explore information unknown to them before.

1.2. Motivation to Start with Map of Humanity

I believe that knowing more about history improves your ability to understand and appreciate the present. However, my interest in history has been suppressed because of long Wikipedia articles and boring books.

A year ago I discovered that all the separate pieces needed to create a map with a time dimension existed. This could change how we experience the past, transitioning from mostly text-based information to a visual and interactive history.

Knowing that this was feasible in combination with the impact this could have on how humanity experiences the past is the basis for my strong intrinsic motivation.

1.3. Graduation project and Startup

This graduation project is written by the same person as the person who founded Map of Humanity. Map of Humanity is a non-profit organisation with the goal of creating a complete aggregated history of humanity on a macro and micro scale and present it in a visual and interactive way.

Map of Humanity needs a proof of concept to show that its goal is achievable. Having a proof of concept helps validate Map of Humanity's beliefs and will help rally support. That is where this graduation project comes in. Building the first proof of concept involves choosing an area and an era. The University of Twente was a logical choice, it has a rich history. The University agreed to be the client of this graduation project and thereby also helping Map of Humanity acquiring their proof of concept. To be more specific, it is the Marketing and Communications department of the University of Twente which is interested in having a

historical map of the Campus. Their role as a client is to tell what they would want to see in a history map of the campus and give feedback on the progress.

1.4. Research questions

To evaluate the final product research questions are used. It is used as guidelines for the final evaluation. These questions were generated based on the different requirements that came up during interviews with the stakeholders.

- R.Q.1. How to design a map with time-dimensions, taking as instance the UT as a proof of concept for Map of Humanity?
- R.Q.2. What is the state of the art in history maps?
- R.Q.3. How to technically realise a historical map with complex information?
- R.Q.4. Which type of data should be presented on the map?
- R.Q.5. How to visually comprehensively present a large amount of data on a map?

1.5. Digital map jargon

In this graduation project, there is jargon used specific to maps and digital maps. This segment is to get readers up to speed with the terminology and some of the technical aspects needed to understand the rest of this graduation project.

Digital maps are built out of layers. There are two different kinds of layers. Vector layers and bitmap layers. Bitmap is another word for images made out of pixels, basically the same as a photo. A vector is when a shape is drawn by lines of code that describe the position of the beginning and end points and the characteristics of a line. These are different techniques and are not always interchangeable. Satellite imagery, for example, can not be displayed in a vector layer. Bitmap layers are limited by the drawing made by the pixels. Vector layers, however, have some advantages. Vector information is organised with tags that can be used to select it once loaded on the user's browser. This is important in order to change the appearance of shapes displayed in the vector layer. During this graduation project almost only vector layers are used.

All digital map layers, vector and bitmap, are cut into many different squares to be sent from the server to the user's browser. These squares are called *map tiles*.

Vector tiles are filled with shapes such as roads, buildings, and more. These shapes are called *map elements* or *map features*. Features can be a point, a line or a polygon. A feature has tags connected to it to identify it. These tags can be read by the browser of the end user. Tags used in this graduation project are for example:

- name: used to display the name of a map feature to the end user.
- start_date & end_date: used to read by the time dimension filter.
- info: to add a small text to a map feature that can be displayed to the end user.
- img: the URL of the image to be displayed to the end user.
- img_URL: the URL of the page where the image should link to when clicked.

Georeferencing is a process used to match the position of an image such as a scanned map to the correct coordinates. This process is used to load old scanned maps on the vector layers. This is the only case where there is the use of bitmap layers in this graduation project.

Open Street Map is the biggest and most accurate open-source map in existence. Open Street Map is sometimes referenced to as OSM. For this graduation project, it is the source of the data used to work backwards from. It creates the map of today and from there the maps of the past are created.

Geojson is one format in which map features are written and stored, and it is used in this graduation project. It can be read as a code document or displayed on a map for more user-friendly editing. Displaying it on a map is done by loading it into geojson.io, a website built for this purpose.

Qgis is a powerful open source program. It has a strong learning curve, meaning it is not easy to use the first times. However, it can do some powerful computations such as georeferencing.

JSON is the most common software used to edit features from Open Street Maps. It can also be used to download data from Open Street Map.

2. Ideation

2.1.Related work

2.1.1.Introduction to related work

Below there is a list of different historical map projects. It will start with the general description, then follows a paragraph about why this project is remarkable and followed by a paragraph about what lessons can be learned from this project.

For the sake of the reader, only the most notable projects have been selected to be analysed.

2.1.2.Topo Tijdreis¹

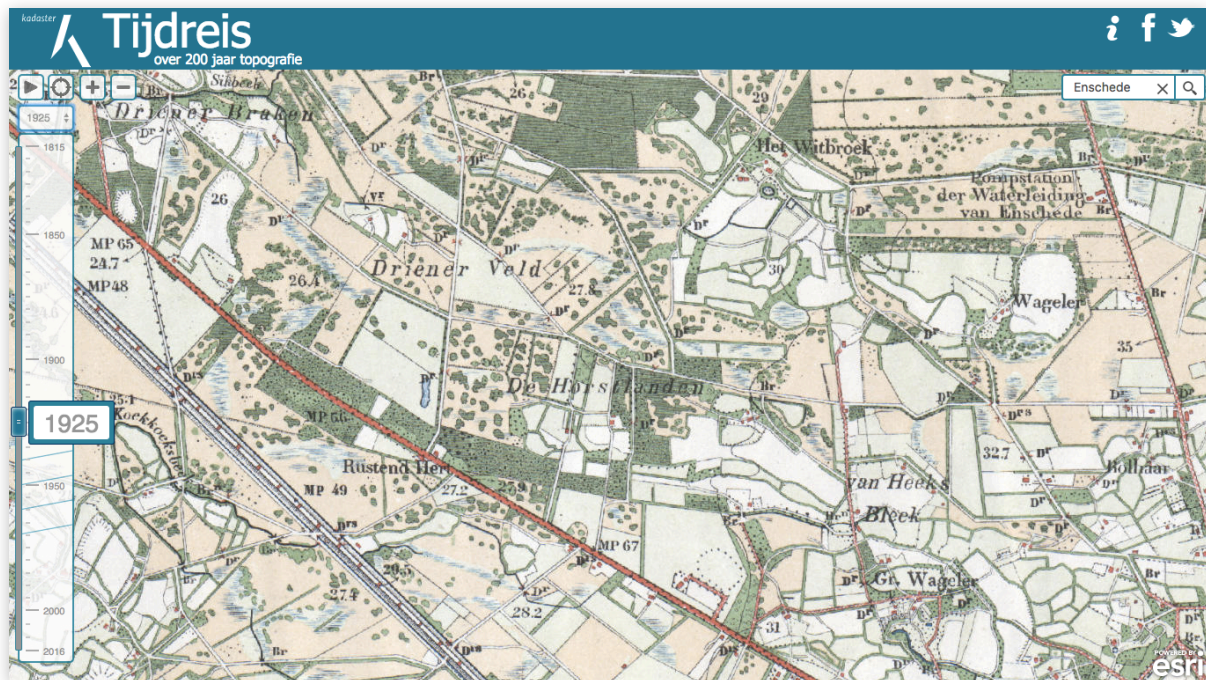


Figure 1: Topo Tijdreis website.

This map could be compared to the satellite view found around the internet, but instead of using pictures from the air it uses scans of old maps. The time span is from 1815 to 2015. The newer the maps get, the more detail can be found.

¹ <http://www.topotijdreis.nl>

These maps cover the whole of the Netherlands and add the maximum amount of details available to maps of the Dutch 'kadaster'. These maps are limited in the amount and precision of the data by the original drawn maps. For instance, it is only from the early nineteenth hundreds that detail levels reach the level of individual buildings.

Topo Tijdreis can be used as a great reference point if uncertainties in map data arise. For example, if the construction year of a building is missing, then Topo Tijdreis could help estimate its construction year based on its appearance on the map. However, the use of bit-map as opposed to vector data limits the usefulness. If there are ambiguities on a bitmap map there will be no information but for the pixel per pixel colour, as opposed to vector tiles that have information tags connected to all data points.

Worth noting is that the date selector in the form of a timeline (Figure 1, not the left side) at the left of the map is easy to use and user-friendly. This is a feature that might be reused.

2.1.3.Remonter le Temps (IGN)²

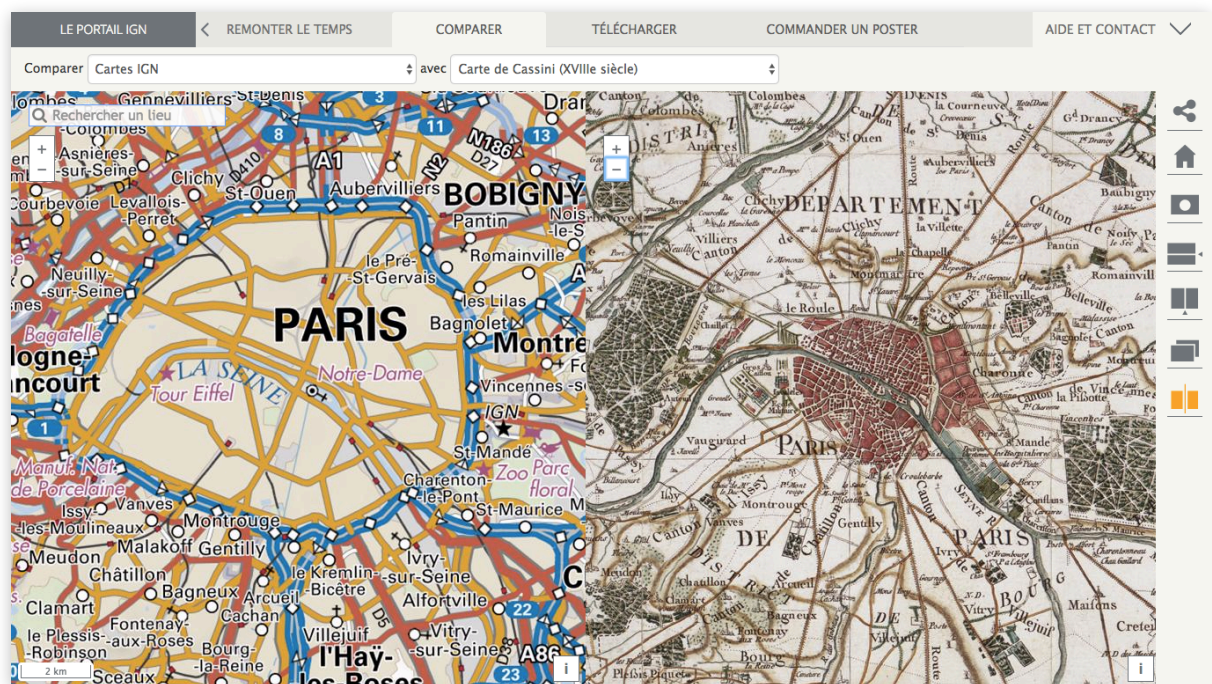


Figure 2: Remonter le Temps (IGN) website.

This french website is similar to Topo Tijdreis. It displays scanned images and maps in an interactive map frame. Similarly to Topo Tijdreis, it is on a national level. This website compares maps of France.

What makes this website noteworthy is its use of a split screen displaying the same area twice but using different imagery. These can be changed independently and create a potent comparison tool. It even uses a second mouse icon on the other viewport to locate the same location on both imageries very precisely.

This type of comparison view is compelling when comparing two periods. This is a powerful feature that might be reused.

² <https://remonterletemps.ign.fr/comparer/basic>

2.1.4. Map story³

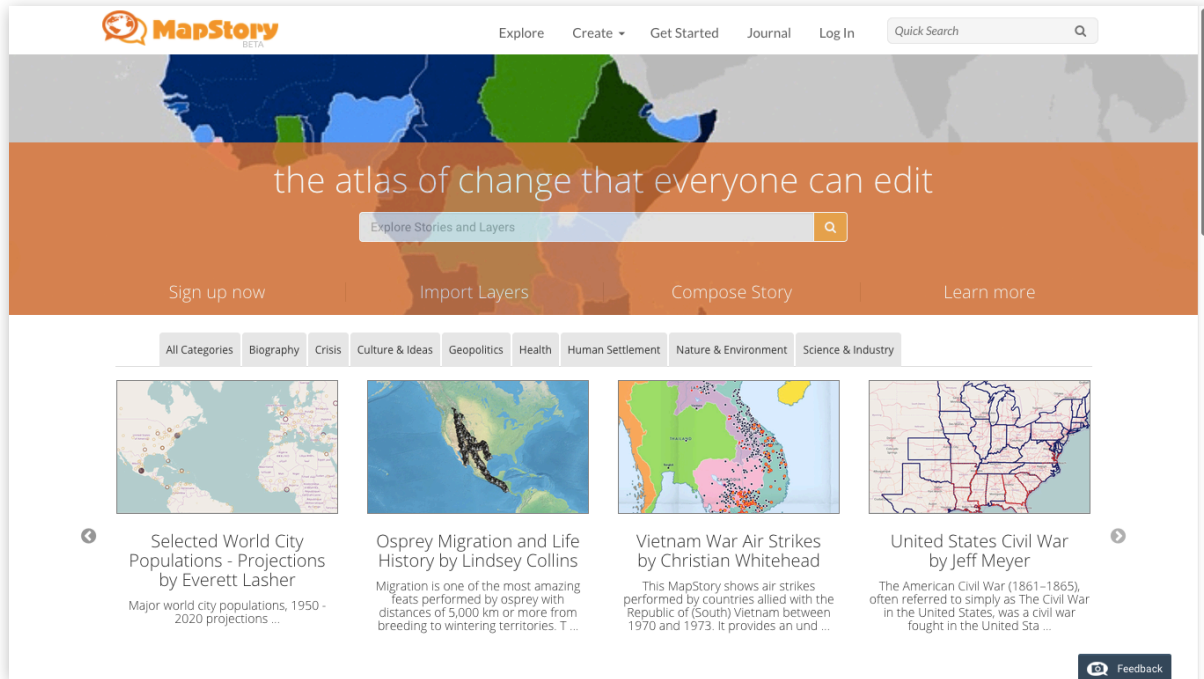


Figure 3: Map Story website.

This website is meant to facilitate storytelling on a map. It is a platform to find people, data and the tools to create a story on a map using animations.

The idea behind the project is interesting, but the platform is complicated and unclear.

The most useful aspect of Map Story is the idea of storytelling on maps and its tools. It also stands as a warning that the complexity of the platform can damage the user-experience.

³ <https://www.mapstory.org>

2.1.5.HISGIS⁴

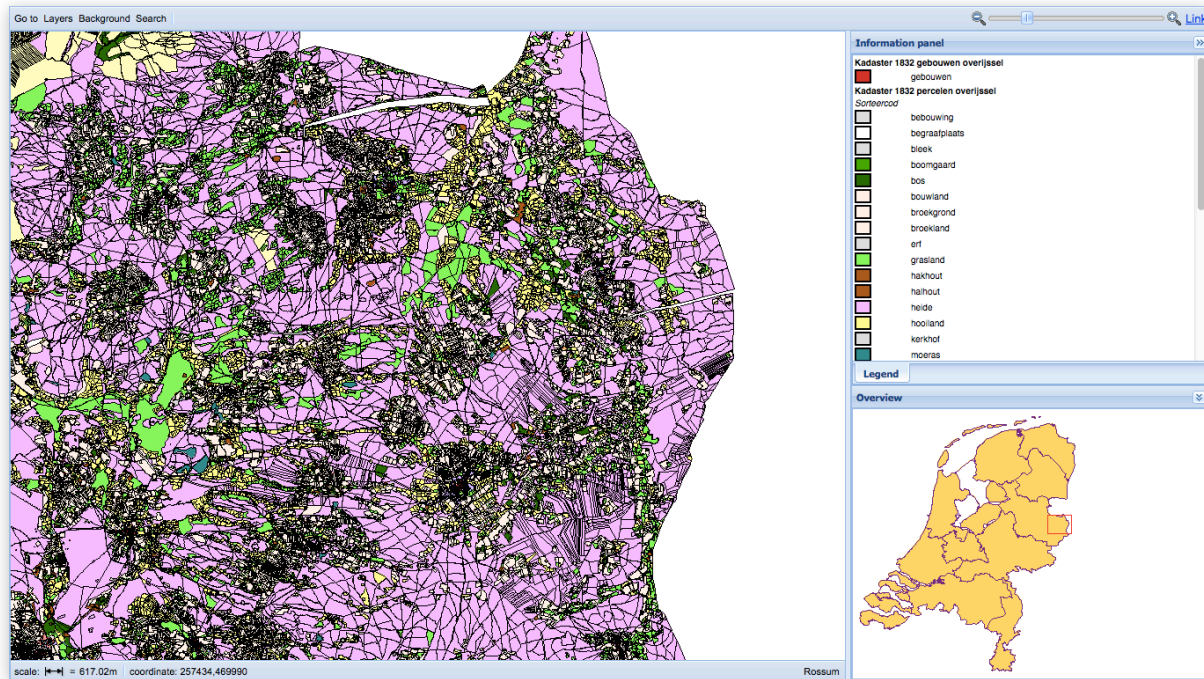


Figure 4: HISGIS website.

HISGIS is a tool of the Dutch 'kadaster' similarly to Topo Tijdreis. The difference between both is that this website uses vector data. Shapes on a map that can be selected to show more data such as construction and ownership data.

It is a powerful tool; it gives the ability to explore data from a visual interface. This is its strong point of which Map of Humanity should learn. However, This comes with a side note of being careful to keep the interface simple, beautiful and fast. HISGIS is slow and does not look attractive to use.

⁴ <http://www.hisgis.nl>

2.1.6.Nostalgeo⁵

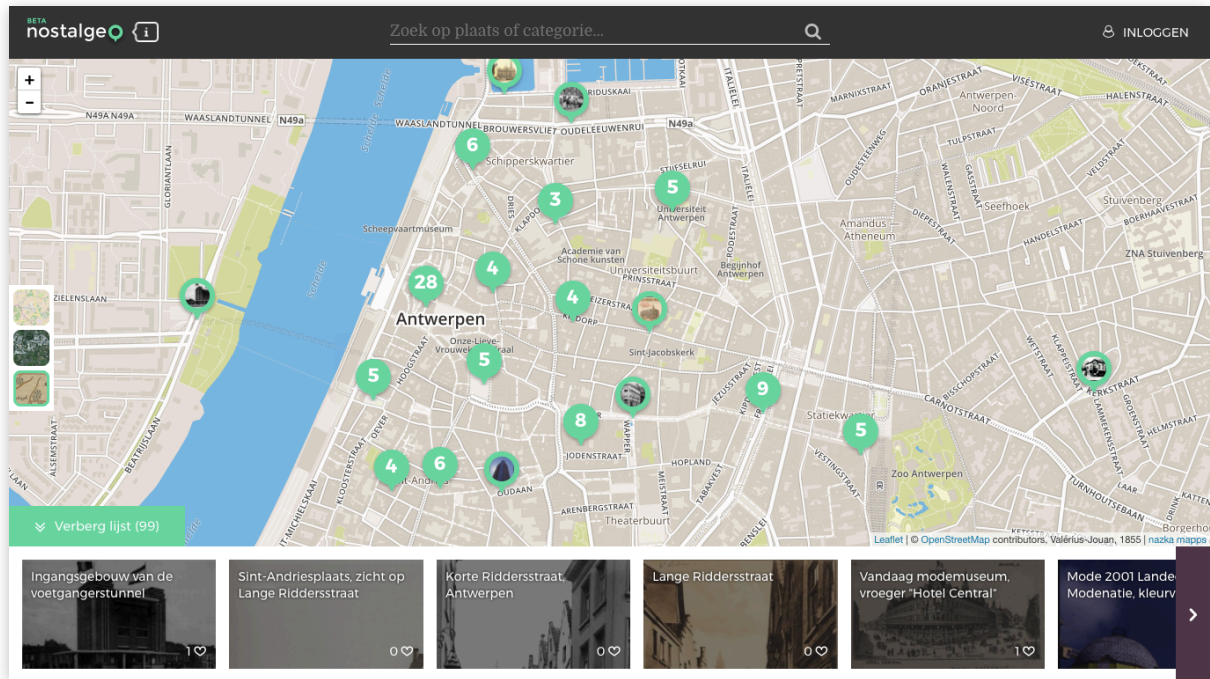


Figure 5: Nostalgeo website.

Nostalgeo is a fascinating project where the goal is to place old pictures in a google street view image to give the current context to an old photograph.

This is a great well-designed tool of which inspiration should be drawn. It is also about storytelling and providing context to someone who is exploring the time dimension of a map.

⁵ <http://www.kaart.nostalgeo.com>

2.1.7. Tragen Wegen⁶

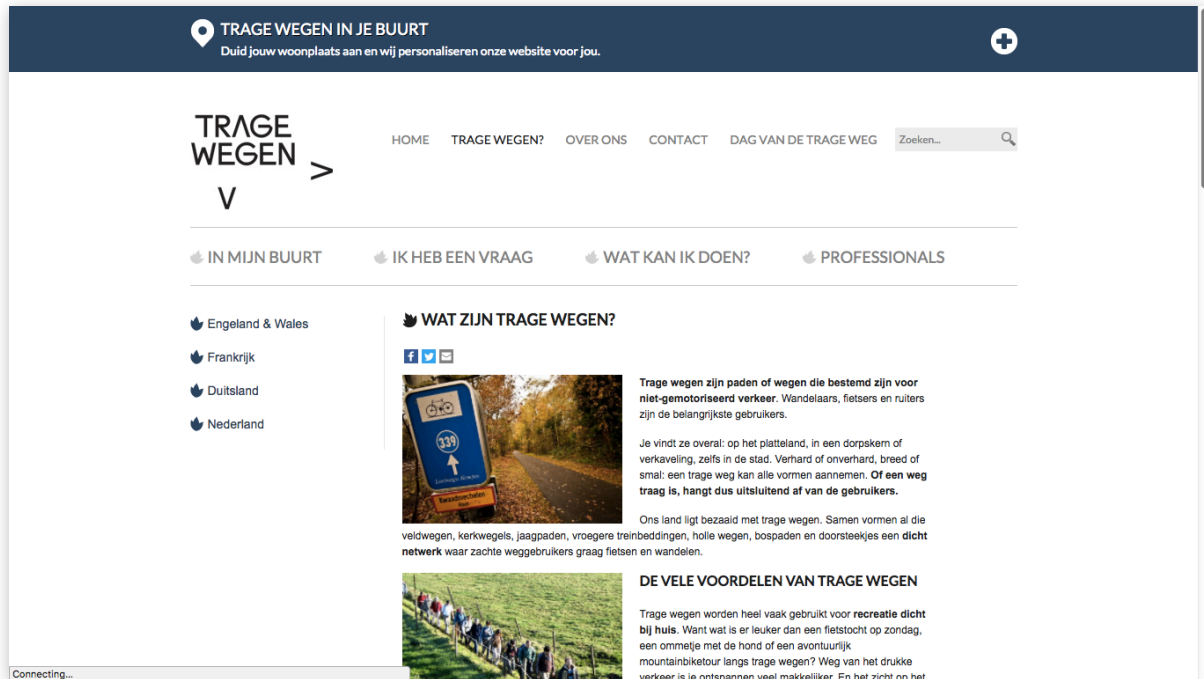


Figure 6: Tragen Wegen website.

Tragen Wegen is a project in which they try to protect or reopen hiking trails that are threatened to be closed or have been blocked. In Belgium, there are rights of passage if there was a path in the past. It means that they can now use old maps to see if there was a passage and then demand its reopening.

The inspiring aspect about this project is that they use old data and maps to make changes in today's society. Recreating such a link between the past and the present would grow Map of Humanity's relevance today.

⁶ <http://www.tragewegen.be>

2.1.8.Open Historical Map⁷

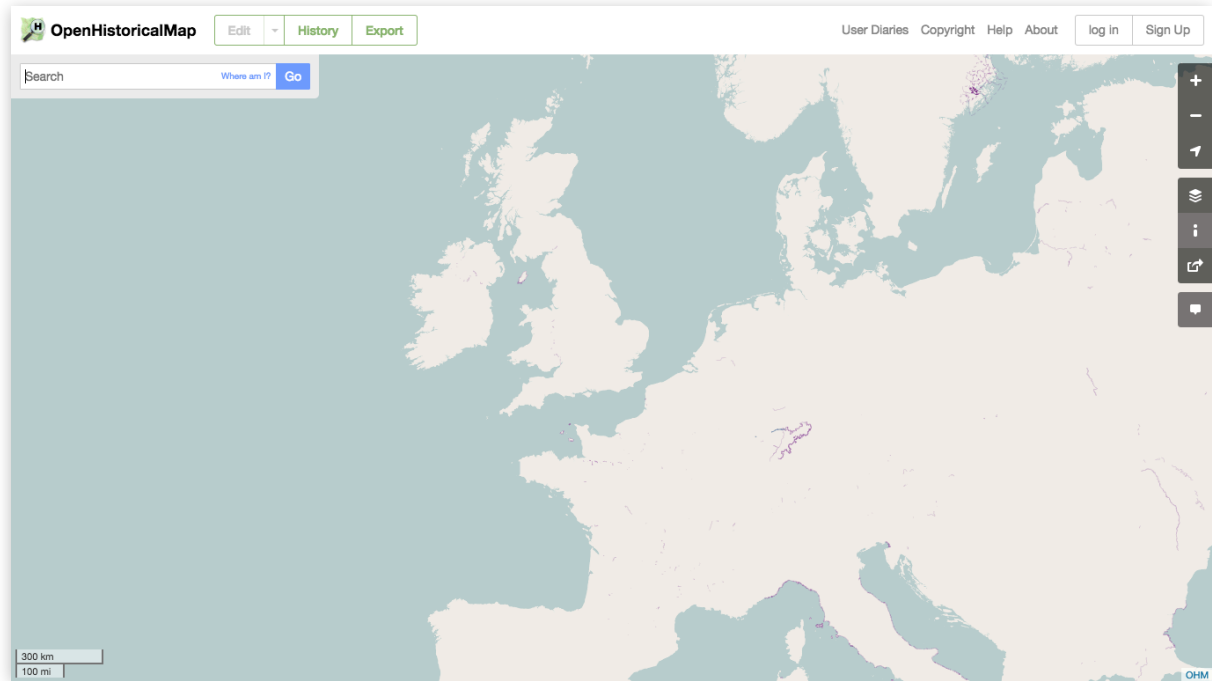


Figure 7: Open Historical Map website.

Open Historical Map is an open source effort to create a historical equivalent of Open Street Map. It is the project which is closest to Map of Humanity.

However, this project has been inactive for the past months and did not show any progress since the beginning of Map of Humanity. It seems like a side project for some OSM mappers.

Its lack of momentum and apparent stagnation should serve as a warning for Map of Humanity. Map of Humanity's goal is a monumental task with many different layers of complexity. Losing its focus could be its demise.

⁷ https://wiki.openstreetmap.org/wiki/Open_Historical_Map

2.1.9.ORBIS, The Stanford Geospatial Network Model of the Roman World⁸

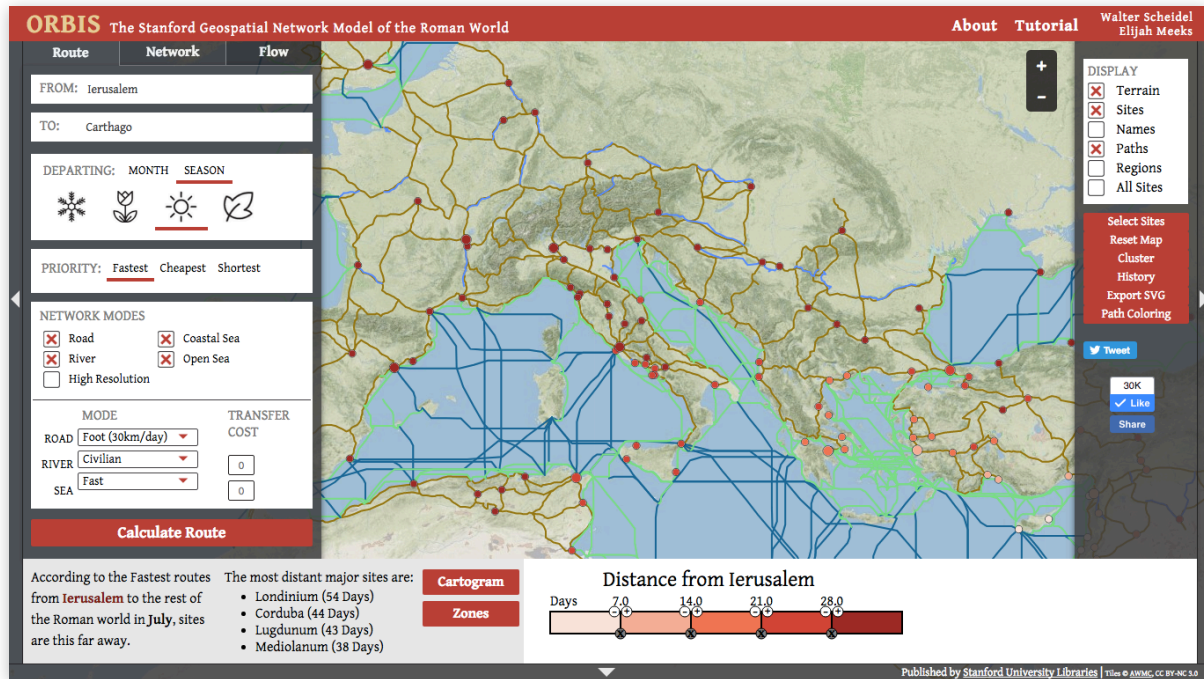


Figure 8: ORBIS (Stanford) website.

It is a remarkable project that aims to recreate the Roman road network and provide travel time estimations.

It is very inspiring because it is well presented and it does stimulate the imagination. Some travel options such as oxcart, horse, horse relay and many more do stimulate the imagination. It propels the mind into the context of the time when trying to understand the implications of all the different transportation modes.

The many options and dense information in the data visualisations invite exploration. This should be sought after. Creating a tool that captures the imagination and stimulates to explore would be an excellent outcome for Map of Humanity.

2.1.10.Conclusions from related work

There are many different projects and websites in existence today that have overlap with Map of Humanity's goals. Even if some of these projects are of very high-quality none of them are as inclusive and complete as Map of Humanity aims to be. Thus seemingly leaving space for its creation.

2.2.The long term vision

2.2.1.General product

The long-term goal is to create one unified visual history of the world. It is a project of an epic scale. Therefore the choice is made to employ strategies similar to Wikipedia. These tactics include crowdsourcing, open source and crowd funding. These strategies have shown in projects like Wikipedia that they work extremely well for tasks of an epic scale. One of the long-term goals is to replicate these techniques.

⁸ <http://orbis.stanford.edu>

2.2.2.Goals

The long-term goal is to create a platform which includes all history data available to humankind. Organising and presenting it in modern interactive visualisations to make history as easily accessible as possible. With the intention to make human kind's connection with the past as strong as possible. This modern way includes technologies that create the most immersive visualisations possible such as augmented reality or virtual reality.

2.2.3.Features

Here follows a long list of features that should be included in the long-term Map of Humanity platform. This list is based on brainstorming, discussions with potential users and the general creative process that was involved with the creation of the concept behind Map of Humanity prior to this graduation project.

Front-end

- F.1. Normal in browser map: A web page that shows the map and the basic user interface. Very similar to what can be found on Google Maps or Open Street Maps.
- F.2. Time slider/selector: this will be a user interface element of the web page mentioned above. This element will be used to select the date of the visualisation. It could maybe resemble the time selector of Topo Tjdsreis.
- F.3. 3D visualisations: This would be a reconstruction of the world using existing data. It would include artist impressions to fill in the gaps since we will never know exactly how it looked.
- F.4. Augmented Reality platform: This would be a smartphone app showing a detailed 3D reconstruction. Similar to the 3D visualisation mentioned above but with much more detail.
- F.5. Normal smartphone app: This would be a native smartphone app for each platform to explore the historical map on the move. There will not be any editing options. If editing options are created, it will be in a separate app specialised for editing and possibly using gamification.
- F.6. Tablet app: similar to above, but made for tablets.
- F.7. Mac & Windows online app: similar to the above but native to the desktop operating systems.
- F.8. Tutorials on how to get involved: To keep the hurdle low for newcomers there is a need to create simple tutorial videos to explain the different parts of the platform. It is meant for welcoming and binding newcomers to the service.
- F.9. Explanation video: there should be an explanation video for every newcomer to show the potential of the platform. This should be very quick and dense.
- F.10. Educational exploration tools: a tool tailored for teachers to emphasise specific information to create lessons for their pupils. It could include, for example, animations and interactivity. There will also be general, such lessons available tailored to education requirements in countries. It could be both used as basis for the teacher to build on or for curious people that are just exploring on their own.
- F.11. Click for more info: as much as possible on the map should be clickable. The goal is to show additional information about the clicked item. This could include linked data of external data such as Wikipedia articles or other platforms.
- F.12. Links to Wikipedia, and other non-profit projects: The goal is that Map of Humanity could be used as a graphical search engine. Therefore showing external links to relevant information is crucial.

- F.13. Comparison slider/dubbel view: a double map that uses 2 different years. For example, on the left side you could see 1960, and on the right side, you could see 2015 of the same area.
- F.14. Mobile compatible website

Editing

- F.15. General in browser editing platform: this would be a tool that resembles the Open Street Map ID editor a lot. A simple interface where people can add points, lines and polygons.
- F.16. Editing apps for all platforms: platform specific apps that enable editing of map data. It is to ensure maximum ease-of-use.
- F.17. API's to function with traditional map editing tools: much the same as Open Street Map, an API that can communicate with powerful software to edit maps such as JOSM.
- F.18. Access to a layer used as data sources (areal photography, old maps, ...): these layers are not visible in normal usage. They exist to help to edit the map.
- F.19. Visualisation editing tools & Artist tools to create generated enhanced visualisations (very relevant to 3D AR, but not limited to that)
- F.20. Discussion pages like Wikipedia: every area, data sets or page will have a discussion platform to resolve unclear situations.
- F.21. Admin editing status for historians: professionals will have more controls.
- F.22. Special spaces for partners such as museums and archives: this could be something like a dashboard, a place for them to see relevant information such as their contribution reach, their contribution views, progress on their raw data and more.
- F.23. Gamified tools to perform specific tasks (including smartphone on the go editing): this is something I have worked on during my minor, it is using specific tasks and gamification to enable simple editing on the go.
- F.24. Guidelines for periods, civilisations, and much more: guidelines to be written by professionals to give the general public an idea of how to edit the data peculiar to that era and area.
- F.25. Monitor boards. For example filters for edits that admins can survey to do quality cheques
- F.26. User statistics to show the impact on organisations

Back end

- F.27. Map data points database: this is everything loaded on the map.
- F.28. Links to other databases like a unified world family tree, objects database,
- F.29. List of external links to other databases, for example, Open Street Map for contemporary data
- F.30. Artist enhancement database: a database of graphical information
- F.31. Map tile server (gigantic and complicated due to the changing nature through time)
- F.32. Themed layers database: graphical data.
- F.33. Edit-history database: a history of all the edits within Map of Humanity.
- F.34. Discussions database: storing all the discussions

2.3. The scope of this graduation project

2.3.1.Goals

To make this graduation project feasible in the given amount of time the scope is smaller than the perfect prototype for Map of Humanity. The goal is to create the proof of concept, using the area of the campus of the University of Twente, to be used as a proof of concept and showcase for the vision of Map of Humanity.

2.3.2.Stakeholders

S.1.Marketing and Communication of the University of Twente

The marketing and communications division of the University of Twente is the client of the prototype that will be generated by this graduation project. They intend to use the map and its data for various marketing plans.

In some cases they intend to use parts of the prototype only, this means that the prototype should be well designed and documented.

Their goal is to use the prototype to show the history of the University.

S.2. Map of Humanity

Map of Humanity as an organisation is an important stakeholder. Its future might depend directly on the quality of the proof of concept generated by the graduation project. Its ability to produce funding from this proof of concept may determine its lifespan.

S.3.Peter Timmerman

Peter is a historian who wrote a book about the history of the campus of the University of Twente. He has much knowledge about the University campus. His role will be to check if the prototype is correct and does not misrepresent the campus.

S.4.The open-source map community

In the open source map community, there are not many examples of maps using a time dimension. This prototype might show new techniques in which time sensitive maps can be displayed. This graduation project could stimulate other open-source projects using similar time dimension innovations.

S.5.Creative Technology

Creative Technology, as a study at the University of Twente, is facilitating this graduation project of its Bachelor. It is giving support and guidance to help make this graduation project a success. The success of this graduation project could be an interesting showcase for Creative Technology's recruitment of new students by showing the possibilities of this Bachelor.

2.3.3.Requirements

The foundation of this graduation project is a set of requirements. These requirements are used to create the research questions. The combination of both research questions and requirements will be used in the end to evaluate if this graduation project was successful.

These requirements are based on interviews with all the different stakeholders.

- R.1. The prototype must look professional and include as many as possible of the map of humanity front-end features.
- R.2. The prototype must be partially and completely reusable for marketing purposes of the University of Twente.
- R.3. The prototype must only include real data.
- R.4. The prototype must be open source
- R.5. The prototype must include as much of the available data as possible
- R.6. The prototype must be intuitive and easy-to-use

2.3.4.Features

- F.1. Normal in browser map: A web page that shows the map and the basic user interface. Very similar to what can be found on Google Maps or Open Street Maps.
- F.2. Time slider/selector: this will be a user interface element of the web page mentioned above. This element will be used to select the date of the visualisation. It could maybe resemble the time selector of Topo Tjdsreis.
- F.3. 3D visualisations: This would be a reconstruction of the world using existing data. It would include artist impressions to fill in the gaps since we will never know exactly how it looked.
- F.11. Click for more info: as much as possible on the map should be clickable. The goal is to show additional information about the clicked item. This could include linked data of external data such as Wikipedia articles or other platforms.
- F.12. Links to Wikipedia, and other non-profit projects: The goal is that Map of Humanity could be used as a graphical search engine. Therefore showing external links to relevant information is crucial.
- F.14. Mobile compatible website.
- F.27. Map data points database: this is everything loaded on the map
- F.31. Map tile server (gigantic and complicated due to the changing nature through time)

2.3.5.Data sources

The prototype is populated with data from various sources. Data sources used to build the prototype are listed below.

- D.1. Open Street Map - Its map will be used as a starting point to work backwards in time.
- D.2. Facilitair Bedrijf - It is the most accurate data of the University. However, it is unclear if it can be directly reused.
- D.3. Topo Tjdsreis - As a general reference.
- D.4. Twentse Welle map archive (800 digital maps)
- D.5. Historical pictures from the University library's 'beeldbank'
- D.6. Documents from the city archives
- D.7. Historical articles of the UT Nieuws
- D.8. Books on the campus of the University of Twente

3. Specification and realisation phases

This graduation project has been done by using many iteration phases which all go through a cycle. A cycle consists of first determining the goal of the iteration face then followed by expanding on what has been done and decided during the iteration phase and ends with the lessons learned and what should be done next.

This technique is based on the Creative Technology design process. It ensures efficiency and quality while keeping the focus on the most important parts.

Iteration phases are revolving around a specific advancement that is sought after. However, in the creative process, there might be overlaps between iteration phases. For example, there is a specific iteration phases focussing on collecting and improving data displayed on the map, however, this is an ongoing process that spread out through all iteration phases.

In section 1.5 called *Digital map jargon* there is a broader explanation however here are some reminders and additional information about vector map tiles. These clarifications will help understanding the iteration phases. Today, the more modern maps are based on tiles with vector data. In vector data, lines are not a number of pixels of the same colour in a row but a simple beginning and end point connected by an invisible line that can be drawn in any thickness and colour by the computer displaying it. This is very efficient because it is possible to draw map features using only some lines of code instead of a long lists of pixels with colour data. Using Vector maps, tiles can contain the data of all the different years, allowing the end user to only display data of the selected year and hide other data. Using vector tiles in a custom map is done with Mapbox, a service that helps turn geographical data into vector maps that can be loaded on a webpage.

3.1.Iteration 1: Minimum viable map

Screenshot

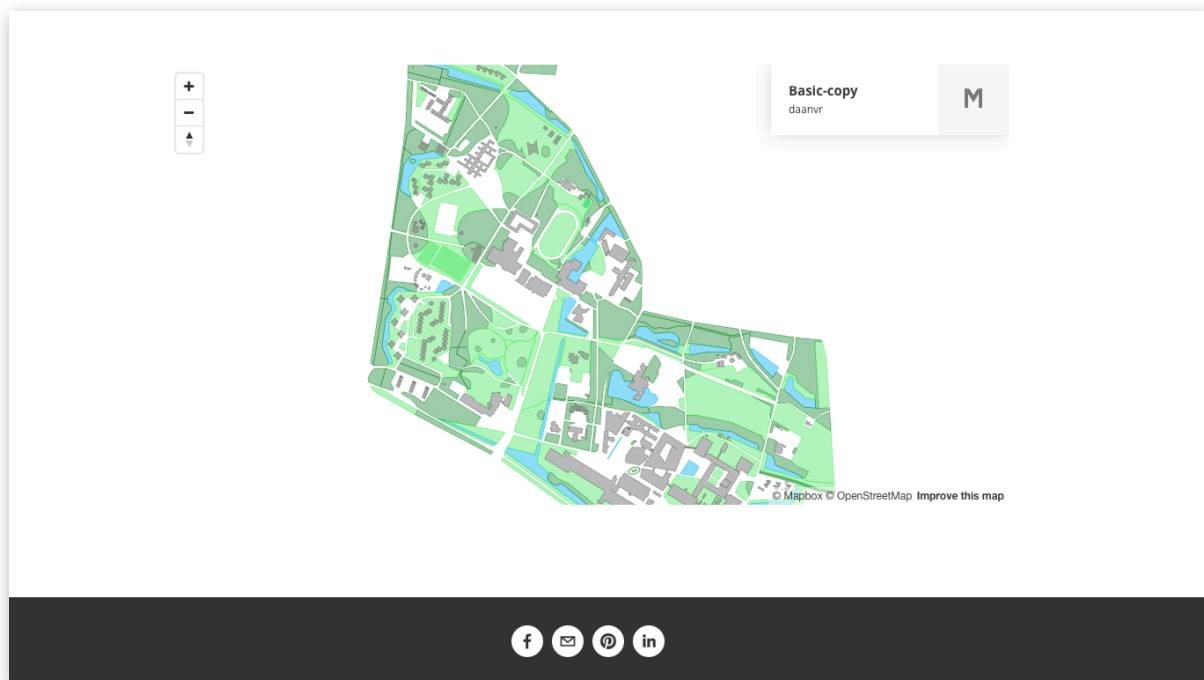


Figure 9: Minimum viable map - On this screenshot we see small map integrated to a website. This map can be zoomed in and out and moved horizontal, however, interaction is not possible.

Goals

Create an interactive map with custom map features such as buildings, water and forest. This map must be displayable on any website. This would be the most basic version of a map about history. No time dimension and no more information when features on the map are clicked. Making this work is the first step.

Design decisions & technology to be used

To create this first version a starting point is needed concerning data. Using an up-to-date map of allows for a clean start from which can be worked backwards. The most accurate and accessible map data available is Open Street Map. It provides open source data that can be downloaded and altered. This is the reason that we choose it as the starting point.

Furthermore, the map data needs to be displayed in a browser. This is done by using existing service called Mapbox. It allows for adding and editing map data that can be displayed on any website. The result is similar to an integrated Google maps API on a website except that there is full creative control on the data and appearance of the map.

To download map data a program will be used called JOSM. JOSM is the most popular software used to edit map features of Open Street Map. However, the data coming from OSM is in not directly compatible with the Mapbox service. To convert it to a format that Mapbox can read we use Qgis, powerful open source geo information systems software. after converting it from .osm to .geojson Mapbox can load it.

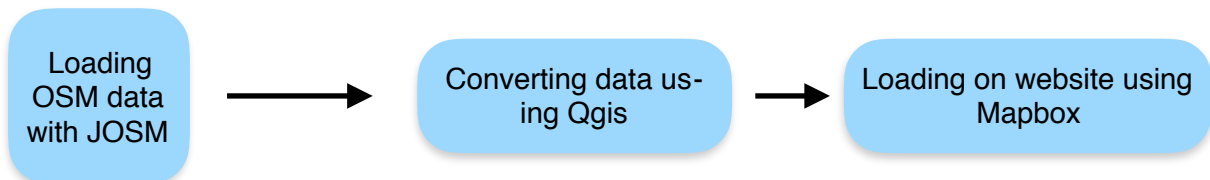


Figure 10: Diagram depicting the data processing flow for the minimum viable map.

Lessons learned

JOSM does not support the same map data formats as Mapbox. This was a problem right away because the data from Open Street Map exported through JOSM could not be uploaded to Mapbox.

To work around this issue, other software called Qgis has been used. The conversion of the data from formats supported by JSON to formats supported by Mapbox using Qgis was problematic. It involved data corruption and loss. Other options were explored, but no conversion methods were satisfying.

Finally, an acceptable conversion was done. It included data losses such as all roads and tags. Even though data loss accused, the data was complete enough to start the new iteration phase.

3.2.Iteration 2: Improvement cycle for a minimum viable map

Screenshot

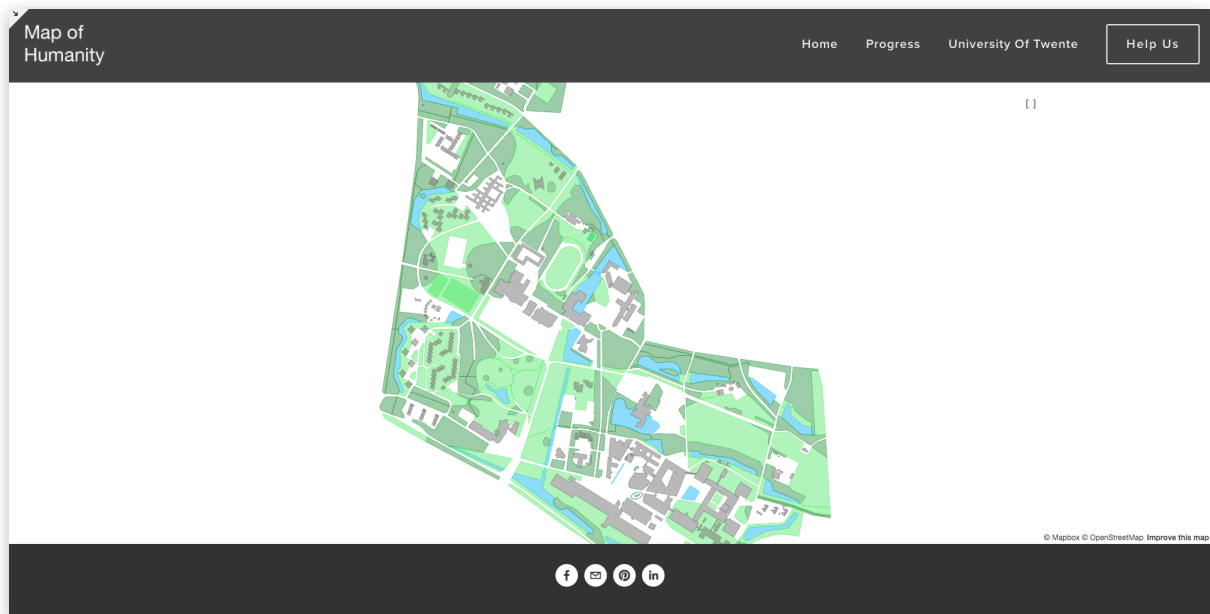


Figure 11: Improvement cycle for a minimum viable map - On this screenshot we see a larger map filling the entire width and much of the high of the website.

Goals

In this iteration phase, the goal is to integrate the map better with the webpage. This is done by using the official Mapbox API and by making the map bigger. Using the official Mapbox API sets the groundworks for later iteration phases to be able to interact with the map on deeper levels such as clicking map features and showing and hiding map features.

Design decisions & technology to be used

The focus on this graduation project is on the proof of concept and not on the website surrounding it. Therefore we use a very simple version of website, Squarespace. To make

the proof of concept feel as a platform it is almost full screen, as opposed to a small map on a webpage.

The use of the official Mapbox API allows for a deeper integration of comping Integra-
tion. Integration such as bidding map features and information upon clicking the map need
the use of the API.

Lessons learned

Squarespace is a platform that allows for easy and fast website building. However, it is
also limited in its functionalities. To create a big map view, it is needed to inject custom CSS
in the page. This is done to overwrite default styling that prevents big page elements. This
basically means breaking part of the design of the website to make it work as intended.

The first adepts to implement filtering in the map, it is needed to write code in java-
script. This is at the edge of the writer's knowledge and takes more time than anticipated.

However, clickable map features were successfully implemented. For this iteration
phase, it works in a very rudimentary way. The basic implementation shows that it is feasi-
ble.

3.3.Iteration 3: first correct data collection

Screenshot

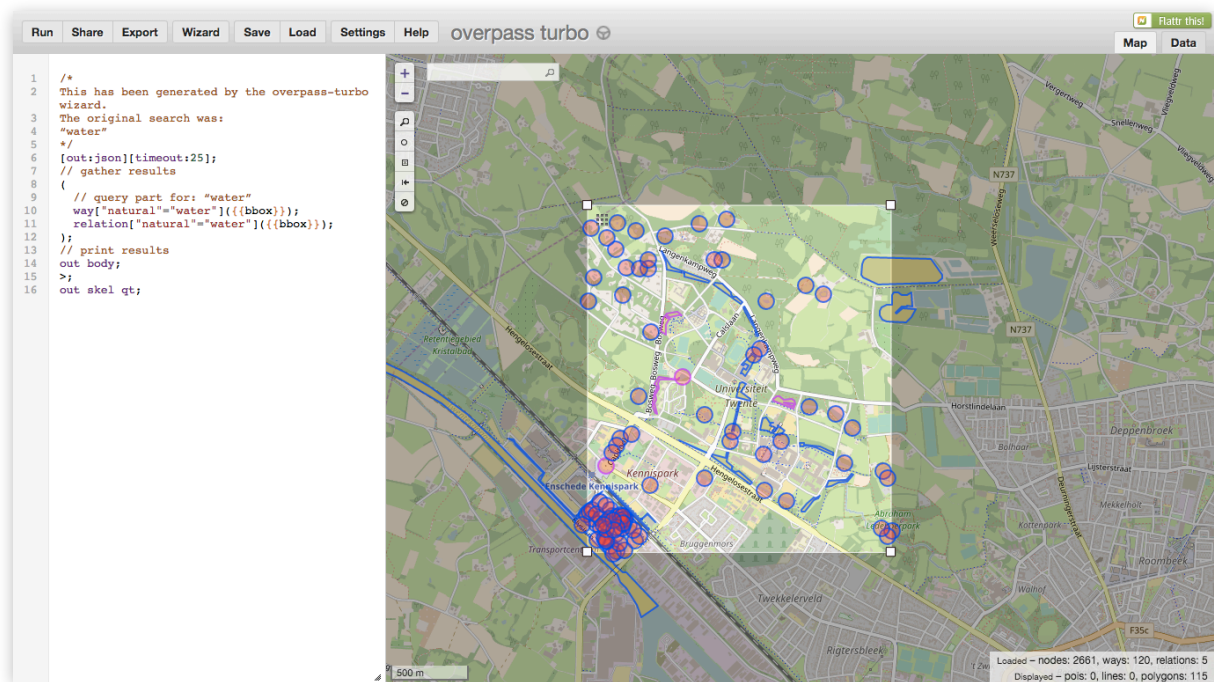


Figure 12: Overpass Turbo screenshot showing the data extraction process from Open Street Map to geojson.

Goals

Finding a way to extract data from Open Street Map and converting it to geojson with-
out any data loss. This data provides the basis from where can be worked backwards in
time.

Design decisions & technology to be used

Qgis and JOSM exports generated data loss, therefore other solutions are explored. A
website called Overpass Turbo (Figure 12) has the ability to export Open Street Map data
directly in geojson. Geojson can be read directly by Mapbox and many other online services.

Overpass Turbo allows for filtering data before exporting it, resulting in an export of only buildings data for example.

The use of geojson data format seems to be a solid choice because it is used by many online tools which can be useful in following iteration phase.

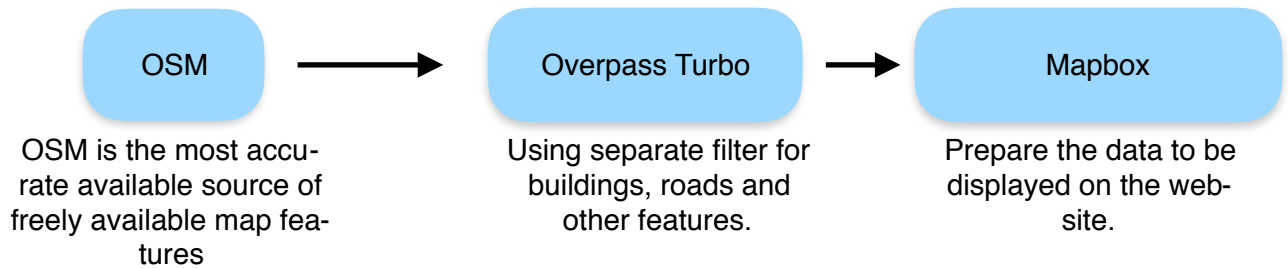


Figure 13: Diagram explaining the collection of data about today.

Lessons learned

Using Overpass Turbo results in a shorter and simpler path from Open Street Map data to the custom made map. This is more efficient and more reliable.

3.4.Iteration 4: adding time dimension

Screenshot

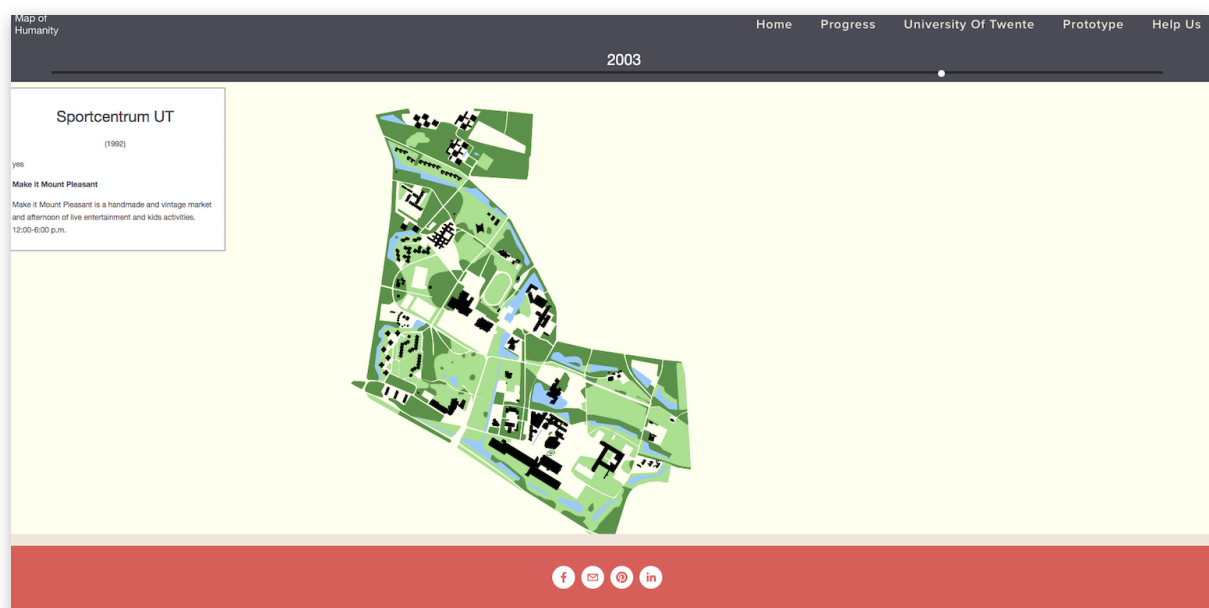


Figure 14: Time dimension integration

Goals

The goal of this Iteration is to create a time dimension by filtering out all data that is not in the selected year. This will change the map live in the browser instead of reloading the map.

Design decisions & technology to be used

To filter all map elements it is important that every feature has a start and an end date tag connected to it. These tags are the basis of the filtering effect. The filter checks all map elements on their dates and besides to make the element visible or invisible.

The time resolution of a year as chosen to avoid over complication of data collection. It will result in about 60 different map versions of the campus area. This year is selected based

on a slider above the map. (figure 14) In later iterations, it will move to the bottom of the map.

Filtering on the user side, in the browser, means that the map first loads with the map elements from all the years stacked on top of each other. The filtering occurs when the map is fully loaded. Filtering on the user sides results in instant filtering instead of reloading different map tiles.

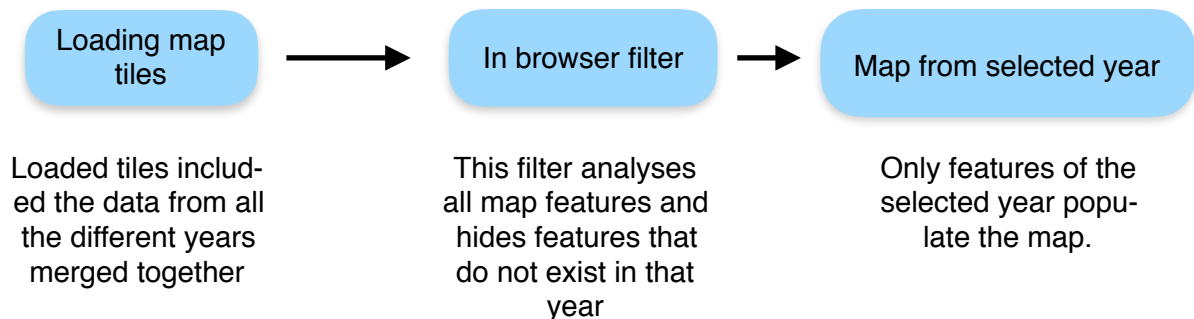


Figure 15: Filtering process

Lessons learned

It was possible to filter the map elements based on the tags mentioned above. This is an elegant solution resulting in a very responsive map because the data is already in the user's browser and does not need to be loaded.

Javascript, the language used for writing the filters, caused delays because of its intolerance for mistakes. It blocking progress because of small programming errors, due to the inexperience coding javascript

3.5.Iteration 5: showing the correct data in info box

Screenshot

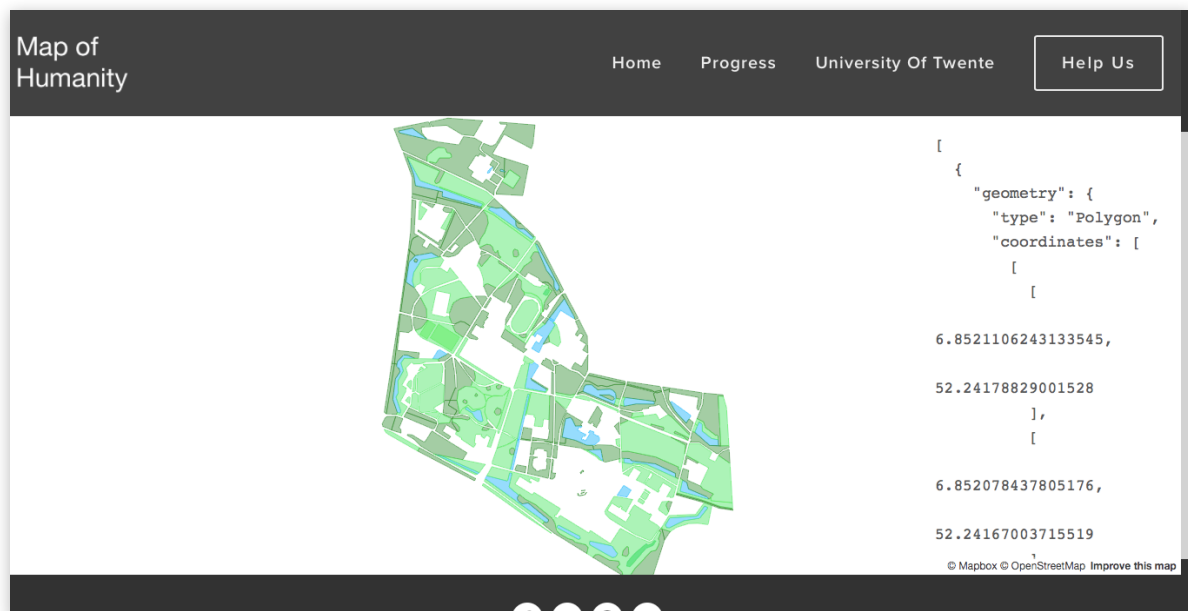


Figure 16: reading data from map features

Goals

There was previous success displaying a raw output from features hovers on the map (right side of Figure 16). However, this information extracted from the map needs to be dis-

played in an organised way. Displaying the title, dates, image and text of any feature in an ecstastically pleasing way.

Design decisions & technology to be used

For efficiency and simplicity of building this prototype, it has been decided to integrate all the texts and image URLs in the map data. This is done similarly to the `start_year` and `end_year` tags, but instead of containing a value such as “1978” would contain the image URL or text.

The solution mentioned above might not be scalable if the data density becomes too high. Vector tile son maps have size limits, putting data in tags of map elements augments the size. This growth in size might cause problems when information density is very high. A solution for that is to store the data in a separate database that is called upon when map features are selected.

Lessons learned

Displaying the information of the clicked map features in a fixed information box that overlays the map seems to be the most user-friendly solution. (Figure 17)

Having the extra information of the map elements integrated in tags is a simple and straightforward solution. It might, however, not scale.

3.6.Iteration 6: design improvements

Screenshot

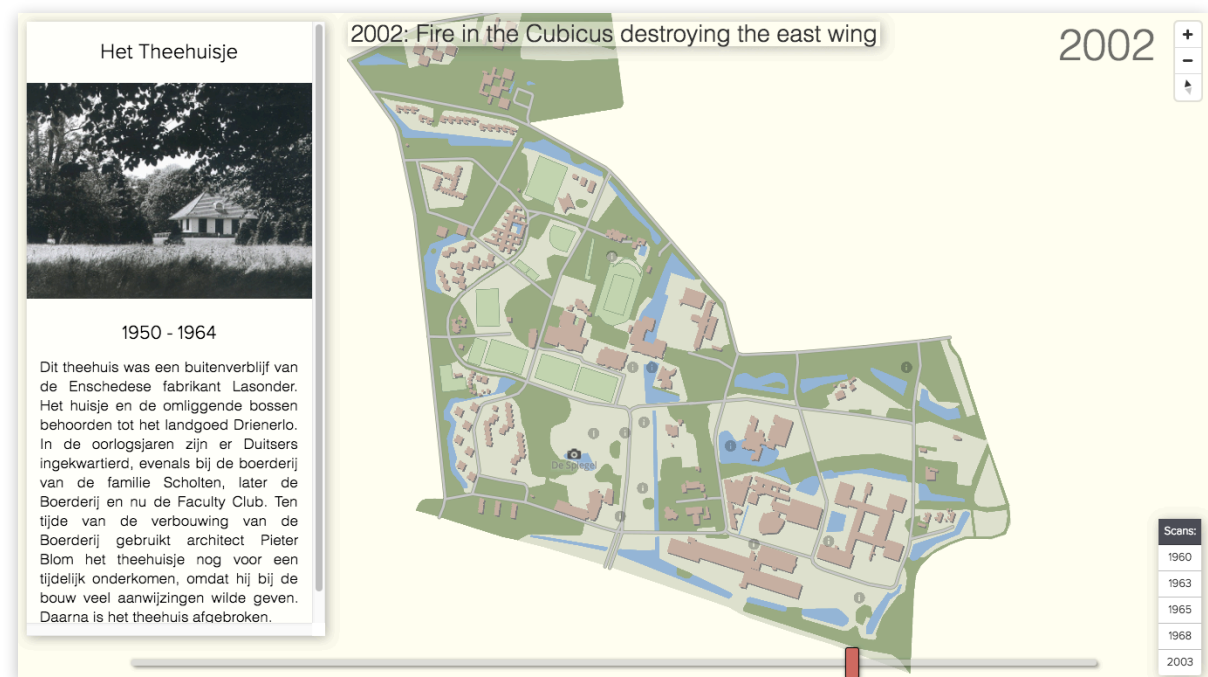


Figure 17: improved design.

Goals

The goal of this iteration phase is to make the map more user-friendly and intuitive. Moving some user interface elements around and clarifying them.

Design decisions & technology to be used

A fixed info box on the left side. The consistency of always having the information on the left side adds to the usability. It shows the information available about the last clicked map feature.

Moving the timeline to the bottom makes it easier to find. Redesigning it slightly makes it pop out more.

All user interface elements are disconnected from the sides allowing for a corner map under the user interface elements. This makes the maps feel important and brings the attention to it.

Lessons learned

Since the prototype is functionally ready, it becomes important to add all the correct data to the map. The following iterations are therefore longer than other iterations because of the amount of data that needs to be processed by hand

3.7.Iteration 7: Data sources

Screenshot

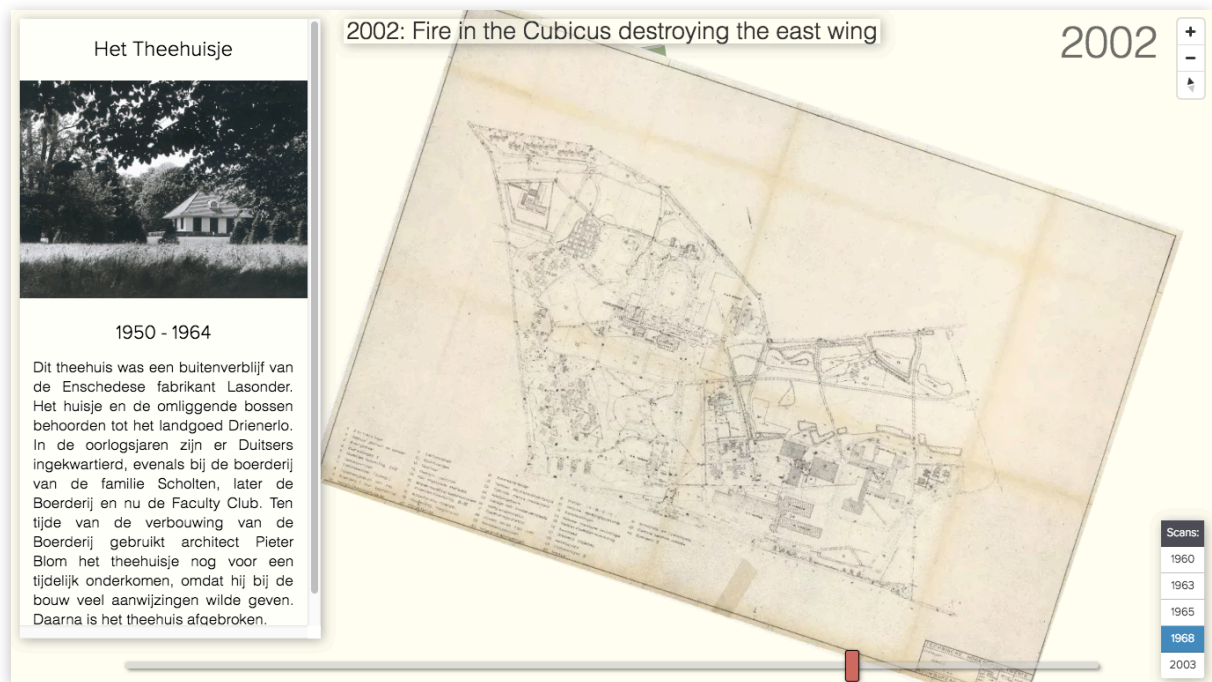


Figure 18: a scan of an old paper map digitally geolocated on the map of the campus of the University of Twente.

Goals

In this iteration, the goal is to find all the data sources and to get them ready to be processed. In order to improve the features of the map in the following iteration phases.

Design decisions & technology to be used

Four major data sources were found.

1. Open Street Map. As mentioned before, this is the source of the map elements used as a starting point.
2. Old maps from the archive of the University. These have been digitalised and geo-referenced so that they can be viewed in the correct position on the map (Figure 18). This can be used to add map element that do not appear today. Additionally, these maps can be used to date map elements.
3. Images and texts from the campus app. LISA, the technical department of the University was so kind as to give an export of the data from the campus app. This resulted in many pictures and texts that have been integrated to map features.

4. Pictures from the Beeldbank of the University. The Beeldbank is the digital photo archive of the University. When pictures and text from the Campus app did not suffice, data from the Beeldbank was used. It provided old pictures and sometimes it also included a small description of the picture that could be used as a text.

Lessons learned

Many different data sources are available. To use them efficiently it is important to find the strong and weak points of the data sources. Scanned maps are useful for drawing map features that do not exist anymore and photos are good to augment the viewing pleasure for users.

To create a map of history, it is not always needed to have only historical information. Working from data from today helps a lot when working on recent history.

Digitalising big maps from archives can be a complicated process. Above the A0 format, it needs to be outsourced to professionals since special equipment is required.

Having a close relationship with the different organisations providing the data is very important. Close collaboration with the Beeldbank resulted in covering the costs of the outsourced scanning. Without the Beeldbank it would have been impossible to obtain such a high quality of the scans.

3.8.Iteration 8: Data processing process refinement

Screenshot

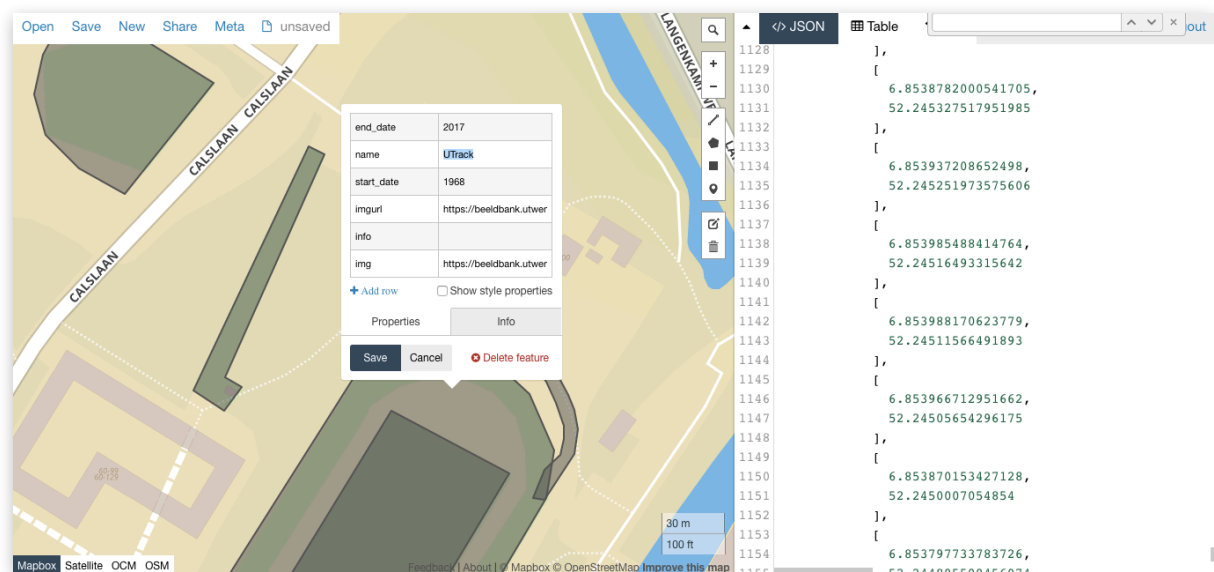


Figure 19: geojson.io, a website to edit geojson files. Topical edits are adding shapes or lines to the map, and adding tags to those map features.

Goals

The goal of this iteration is to refine the data processing operation. This consists of examining old data sources and adding features to the map or adding tags to existing features. This is fundamental, features that incomplete date tags are not displayed at all.

Design decisions & technology to be used

To process the data in a scalable way the choice was made to host the data on Git-Hub, an open source collaboration platform. This has several advantages. It allows for different people to work on the same data at the same time. It keeps versions of all the

changes made, meaning if anything goes wrong it can be recovered either by browsing the older versions or by simply reverting to it. In other robust, a strong collaboration tool.

The geojson data hosted on GitHub is editable on a website called geojson.io. This site allows loading, editing and saving geojson files hosted on GitHub. [Geojson.io](https://geojson.io) speeded up the process considerably because some of the data edit tools available within Mapbox were not reliable.

Georeferencing is done using Qgis. The ability to georeference old maps and to display these maps in geojson.io speeded up the drawing process. The georeferencing is done by matching points on the scans with points on existing maps. Qgis will then transform the scan in the ways needed to match it exactly with the existent map.

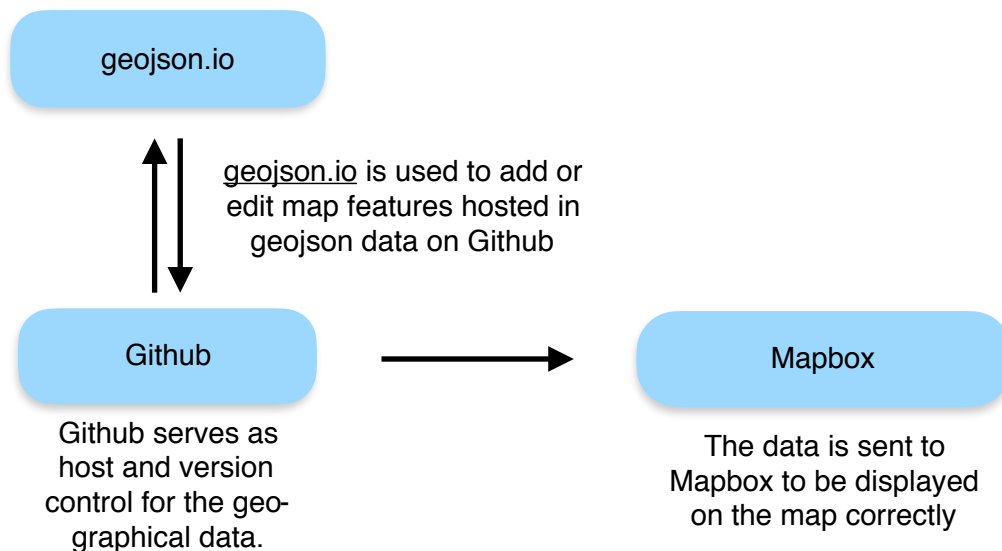
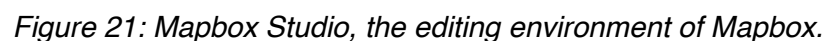


Figure 20: Diagram illustrating the data editing process.

Lessons learned

Hosting the data on GitHub was an improvement. It resulted in the data being open-source. Combining it with geojson.io allowed for crowdsourcing. This is a great improvement towards a big open source platform.

Screenshot



The goal of this iteration is to add all the necessary data. After the copying the data of today from Open Street Map there is still a lot missing. Map features, such as buildings, that have been removed in the real world do not appear on Open Street Map, therefore must be added by hand using references such as pictures and old maps.

Design decisions & technology to be used

Similarly to the problem above, when the location or shape of a feature is not exactly known the best estimate is made.

Processing the data by hand is a slow process. This resulted in some weeks of adding and editing data. This process can be tedious if a map feature does not have a clear sorting point, sometimes the solution is to scan through many pictures, however, this is very time-consuming.

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3.10.Iteration conclusions

Part of the purpose of the iteration phases was to answer or attempt to respond to the following research questions.

R.Q.3. How to technically realise a historical map with complex information?

R.Q.4. Which type of data should be presented on the map?

R.Q.5. How to visually comprehensively present a large amount of data on a map?

Through the iteration phases, challenges were encountered and solutions were explored to the research questions above. These solutions are only attempts at resolving the challenges and do by no mean claim to be perfect. The next section of this graduation project will show qualitative interviews used to evaluate the chosen solutions.

R.Q.3 - Through the iterations phases it became apparent that the utilisation of a service providing vector based maps was crucial to create the ability to show or hide specific map elements. Vector based maps allowed to filter the map elements that did not exist in the selected year. This filter options created the possibility to integrate the time dimension in the map. This time filter could be applied to all elements of the map including forest, water bodies, buildings, roads and point of interests creating the appearance of showing an entirely different map without loading a different map.

The use of these filters to change the time element of the map has never been done before according to the state-of-the-art.

R.Q.4 - Through the iteration phases the core layers of the map built up to the following five different layers; forest, water bodies, buildings, roads and point of interests. In some of the iteration phases, there have been explorations to add a grass layer. However, it was too complicated to find enough accurate data to maintain this layer through the history of the campus. In the final prototype, there is a distinction between points of interest showing information about physical elements on the campus and the point of interests referring to historical photographs.

R.Q.5 - Two important decisions have been made through the iteration phases to avoid an overload of information. The first has been to display photos and texts specific to an element only after the element has been clicked. The second was not to own the data such as photos and text but to leave them to the source. The prototype shows photos from the Beeldbank of the University of Twente by loading them directly from their database. This avoids building a big database.

During the iteration faces, there has been a delicate balance between perfection and feasibility. As an illustration, the map features about 200 photos even though there was access to thousands of photos. This had the advantage of being feasible without leaving out the feature.

4. Evaluation

4.1. Methodology

The prototype that has been built previously is evaluated by performing qualitative interviews with specific people. The goal of the interview was to observe the reactions of the interviewees. Interviewees are from divers, therefore questions and the focus of the interviews varies from interview to interview based on their expertise.

Observations focused around: their first reaction, their recommendations and the answers they gave to some questions. Questions used during the interview had the goal to cover a wide range of information desired from the interviewees. There was a list of questions used to make sure the full breadth of the range of information was reached by all interviewees. All interviews started with a small video explaining the user interface, similarly to the explanations shown when a user first opens a newly downloaded App. Questions and observations includes the following but where not limited to these.

Questions:

- Would you use it again?
- Which user interface features are you missing?
- Is the map data accurate? Are you missing data?
- Would you contribute to such a platform?
- Is the interface intuitive?
- Would you recommend this platform to friends?
- Is this something you where missing?

Observations:

- Did the test user find all the user interface elements?
- Did the test user seem confused during the test?
- Did the prototype work correctly on the test user's computer?

4.2. The interviews

The length of the interviews varies between 52 minutes to 2 hours. The biggest contributor to the duration of the interview variation is how much the interviewees told stories about the past. Some interviewees told many stories as a reaction to using the prototype.

Interviewees gave remarks on all kind of different subjects, however, in this evaluation segment, there will only be mention of the comments relevant to the scope of this research.

Here follows a list of people that have been interviewed and their relevant credentials. Interviewees where chosen to ensure diversity, expertise, knowledge about the campus history and diversity in their job titles. Thees interviewees represent a wide spectrum of roles and knowledge within the University of Twente.

- *Peter Timmerman* Wrote several books on photography and architecture about the campus of the University of Twente. He also manages and organises the tours about the history and architecture of the campus of the University of Twente.
- *René Bevers*: Content manager at the Beeldbank of the University of Twente. Beeldbank is the dutch word for photo archive. René was a key person in the collaboration with the Beeldbank financing the scanning process of the maps
- *Gerhard Kleinsman*: Semi-Static Archive coordinator at the archives of the University of Twente and has his own archival company.

- *Bert Groenman* has a great amount of knowledge about the past 40 years of the University of Twente because of his role at the University journal. Together with Tonnie Mulstegen, Bert is among the people with the greatest knowledge about the campus because of his work.
- *Tonnie Mulstegen* is currently working at the archives of the University. Furthermore, he previously worked as campus security personnel where he was in close contact with the students and the University whenever something happened. This makes him a great source of living memories about the campus.
- *Richard Bults*: Graduation Project Coordinator of Creative Technology
- *Alma Schaafstal*: Programme Director of Creative Technology.

4.2.1.Observations

Here follow all the observations made during interviews. Solutions are presented in the next section.

A concern raised during the interviews was the management of copyrights from aggregated data. This refers to data, such as photos, coming from a third party archive. This concern could be solved with a clear mention of the copyright when third-party content is shown.

The wiki type crowdsourcing environment should be easy-to-use for both experienced and less experienced users of this platform.

Some of the interviewees were enthusiastic about the possibility to compare the map to old scanned aerial photography and maps. However, this feature also created confusion among other interviewees. The conclusion is that this feature should be part of advanced options hidden behind a menu.

Many interviewees missed a search option. The ability to write a location in a search which would move the map and highlight the results.

One of the interviewees mentioned a timeline as a user interface. This could be either a replacement of the map with a time dimension or as a way to organise additional information shown in the sidebar.

Interviewing also mention the use of other types of data such as videos and audio.

Interviewees react positively when mentioned that the images are shown in the prototype were originating from the University archives and could be traced back to their origin by clicking on it.

Names of map elements such as buildings, change throughout the years. This ended up being confusing to many of the interviewees because they did not always know the new names.

The prototype used a mix of Dutch and English text. This raises the question of how to use different languages.

4.3.Lessons Learned

One of the red lines throughout the interviews was that there is used for both a simple and a more powerful interface. This could be solved by creating a straightforward and basic interface as a starting point for all new users and creating options to add more features for advanced users.

Another red line throughout the interviews was the use of a map. Some of the interviewees used it with ease; others were confused. Maps feel logical to many people but not to everyone. Some people have a great difficulty recognising locations. This is something that can not be influenced when keeping a map as the central part of the platform.

Some observations through the various interviews pointed to features more relevant when the map area would be bigger. For example, a location search box would become relevant if the area is the county of the Netherlands.

Several user interface improvements arose through the different interviews. The main wish was to simplify the entire user interface by hiding the layers of scanned maps behind advanced options and by displaying the currently viewed year on the year selection bar at the bottom of the screen. Next, to this, almost all the interviewees mentioned that the cursor should change if it hovers above clickable data on the map.

In the prototype, there was no support for different names throughout time for the same elements; such as four example buildings. This resulted in confusion to interviewees. This is a problem that needs to be solved in future versions.

Future versions should support multiple languages, allowing users to select their preferred language.

5. Conclusion

Innovations in map technology such as vector tiles unlock new possibilities. Vector tiles result in faster maps and better user experience, however, it also unlocks innovations such as an adding time dimension.

Through the iterations of this graduation project, an innovative prototype emerged. It shows that it is technically feasible to build a map with a time dimension. The prototype sets a precedent showing that it is possible to make a platform which could be used to collaboratively document history.

The ability to join the time dimension with spatial dimensions open the door to new types of visualisations of the past. This is the kind of innovation that is needed to experience history in a modern way.

The next version of this platform should innovate on the data storage options. Storing all the information in the map layers is not scalable for dense maps showing longer periods of time. A next version should also explore possibilities to simplify the data processing process. Processing the data of the campus was a considerable amount of work, scaling to a bigger area and era only generates more work. Segmenting the different processing tasks could help specialise the various collaborators.

Showing that it is feasible to collect the 60-year history of the campus of the University of Twente raises the question if this could be done on a bigger scale. It would be interesting to explore if the same technology could show something in the range of the last thousand years of the Netherlands.

The interviews showed a very positive response from most participants, even starting a nostalgic mood for a few. Telling stories about the past. More research needs to be done to confirm the reactions of people to such a visual history platform.

The process of doing this graduation project, meeting all the people I interviewed, and the confirmation that it is technically feasible gave the confidence to take Map of Humanity to the next level. The aim is to launch an organisation by September 2017 that is going to develop a history visualisation platform. To make it feasible to process the significant amounts of data Map of Humanity is going to stimulate a community to crowdsource the data collected from collaborations with archives. Becoming an aggregator of historical data.

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