



Citation: Rodelli, R. (2024). In the Shadow of the NORGE. Applying New Technologies for Storytelling in Historical Geography and History of Exploration. *Bollettino della Società Geografica Italiana* serie 14, 7(2): 123-136. doi: 10.36253/bsgi-7477

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Data Availability Statement: All relevant data are within the paper and its Supporting Information files.

Competing Interests: The Author(s) declare(s) no conflict of interest.

In the Shadow of the NORGE. Applying New Technologies for Storytelling in Historical Geography and History of Exploration

Seguendo l'ombra del NORGE. Applicare nuove tecnologie per lo storytelling nel campo della geografia storica e della storia delle esplorazioni

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Abstract. Year 2021 marked the 95th anniversary of the first transarctic flight, conducted by airship NORGE in May 1926. To celebrate the expedition, an international cooperation among institutional partners organized an ICT-based commemoration within a project called "ShadowOfNorge". On this occasion, our workgroup carried out an experiment for investigation purposes. The intended research goal was to assess the technical and applicative feasibility of developing a cultural dissemination product in the fields of historical geography and history of exploration, using innovative, low-cost technologies. The activity did not specifically aim to conduct a comprehensive analysis of the project's social impact. Despite some technical difficulties that limited the diffusion of some of the project's components, the measurable results suggest a satisfactory potential for public dissemination and education. This provides, in our opinion, a positive answer to the research question.

Keywords: NORGE, Augmented Reality, History of Exploration, Historical Geography, Storytelling.

Riassunto. Nel 2021, in occasione del novantacinquesimo anniversario del primo volo transartico, realizzato dal dirigibile NORGE nel maggio del 1926, un'ampia rete internazionale di partner istituzionali ha coordinato una serie di iniziative dedicate alla spedizione, basate sull'impiego di diverse piattaforme ITC, nell'ambito del progetto "ShadowOfNorge". In questa occasione, il nostro gruppo di lavoro ha cercato di realizzare un esperimento a scopo scientifico. L'obiettivo di ricerca era valutare la fattibilità tecnica e applicativa dello sviluppo di un prodotto di divulgazione culturale nei campi della geografia storica e della storia delle esplorazioni, utilizzando tecnologie innovative a basso costo. L'attività non mirava specificamente a condurre un'analisi articolata dell'impatto sociale delle iniziative. Nonostante occasionali difficoltà tecniche, che hanno limitato la diffusione di alcune componenti del progetto, i risultati misurabili conseguiti indicano un buon potenziale in termini di divulgazione pubblica e di didattica, fornendo così, a nostro avviso, una risposta positiva alla domanda di ricerca.

Parole chiave: NORGE, Realtà Aumentata, storia delle esplorazioni, geografia storica, storytelling.

1. Introduction

Year 2021 marked the 95th anniversary of the first transarctic flight, conducted by airship NORGE in May 1926. The operation, officially designated “*Amundsen-Ellsworth-Nobile Transpolar Flight*” (Alessandrini 2019, 66), was a complete success and was widely celebrated in its time and for decades, often in association with bitter nationalism in the explorers’ home countries. However, many polar expeditions in those times – and later – owed their effectiveness to international cooperation. This was particularly evident in the 1926 flight: the expedition concept and general framework were established by Norwegian explorer Roald Amundsen; the airship, its navigation and logistics were taken care for by Italian engineer Umberto Nobile; crucial financial support was provided by US entrepreneur Lincoln Ellsworth; technical assistance was given by the governments of USSR and UK; technical and scientific support, supplies and collaborations were acquired from several other countries including Sweden and Czechoslovakia. Being the first undisputed transpolar flight, the expedition was welcomed by public international euphoria, and, at the same time, harsh controversies arose about leadership and merits (Casagrande 2019, 17-18).

As with other famous expeditions of the past, much of the public remembrance about NORGE’s endeavour faded with time. While slipping out of lay people’s view, active memory and historical dissemination of the events remained driven by institutions and individual “memory agents”, often linking their actions to particular – and sometimes unrelated – cultural and political purposes (Aas 2022, 116).

Based on this element, as celebrations for the NORGE’s 95th anniversary were being planned in 2020, an international workgroup was progressively gathered with the intention of proposing a series of memorial events.

This framework, however, was to be implemented in the form of an entirely “online” initiative. Such a formula was necessary for two parallel reasons. On the one hand, the strict travel limitations imposed throughout Europe by the Covid-19 pandemic were still widely effective in 2021. On the other hand, there was the intention of increasing the social outreach of the initiative, which was also intended as a “public geography” and “public history” series of activities.

The overall cultural project was officially named “Shadow of NORGE”, also presented in the more web-oriented expression “ShadowOfNorge”.

In this context our workgroup took the opportunity to investigate the feasibility of implementing a low-

cost, innovative technology-based set of information platforms to develop the commemoration project in an impactful and effective form of dissemination. The technologies chosen for the project included communication methods such as a website and social media, as well as traditional and innovative methods for conveying contents. These methods ranged from online seminars to a website for retracing the history and an augmented reality mobile application. The set of ICT tools was used to highlight physical locations and places by augmenting their historical values. This was done in relation to a specific case in the history of exploration, with the goal of achieving both public geography and public history objectives. The decision to test the feasibility of a complex digital storytelling, by various integrated tools, was based on theoretical research supporting its potential validity as a method of dissemination and education.

As highlighted by Ryan and Aasetre (2021), a narrative approach can be a good teaching strategy in geography, engaging interest through emotions. This engagement can be enhanced by integration with the visual component. Stories can captivate their audience and evoke emotions. Therefore, storytelling plays a crucial role in human culture for transmitting values and knowledge. (Ryan, Aasetre 2021, 3). “Stories do not simply *represent* [...] they affect, they move” (Cameron 2012, 581).

Today, storytelling is often associated with the concept of “visual” or “digital”. Visual storytelling involves using images, graphics, and videos to supplement or replace traditional oral or written narration (Roth 2021, 85). Digital storytelling combines various digital media using computer software (Robin 2016, 18).

Digital storytelling has been the subject of investigation in research studies on knowledge dissemination strategies across different age levels and contexts (Robin 2016; Ryan, Aasetre 2021; Roth 2021). Robin provides an overview of how it is used to support teaching and learning at different levels in schools, and to engage audiences in different settings including museums, communities and non-profit organisations (Robin 2016). Ryan considers digital storytelling as a deep-learning tool for conveying geographical knowledge. He also highlights its ability to emphasize the “sense of place”, by creating a connection between people and the narrated places (Ryan, Aasetre 2021, 4); a “sense of place” which could be connected to the past of the considered place (Relph 1997, 207-208). In geography education and in outreach projects such as Shadow of NORGE, where the spatial component is fundamental, digital storytelling based on cartography can be highly effective. Roth reviews reflections and techniques for map-based visual storytelling, identifying common themes. Among oth-

ers, their being “intuitive”, “memorable”, and “situated” (Roth 2021, 85-86).

The geo-historical backbone in the project’s public dimension was the idea of creating a multi-platform “information system” to reproduce a “geographically distributed” “real-time” digital storytelling of the NORGE’s travel from its homebase in Rome, Italy, to its final landing site in Teller, Alaska, US. The narration was to be “aligned”, chronologically, with the real expedition, e.g. “departure” at 9.32 Rome’s time on April 10th (Nobile 1928, 167) “arrival” at 7.30 GMT on May 14th (Alessandrini 2019, 97), 2021 instead of 1926. A more challenging task was to “geo-localize” the storytelling and to find an effective way to give the audience an at least basic impression of “witnessing the event”, to somehow generate a feeling of (historical) sense of place.

Augmented reality (AR) appeared to be the ideal solution as it can provide a situated visualization of the represented historical event. This means that it can be localized and “overlaid” onto the place where the representation holds significance (Lobo, Christophe 2020, 163). We could therefore enable the viewers to experience, through their mobile device, the NORGE’s flyover as it happened 95 years ago, *in the place where it happened*.

The development of AR technology for heritage virtualization projects was explored by different studies aiming to analyse the methodology of creation and benefits in various fields (Challenor, Ma 2019, 11). Successful experimental AR applications have been employed in education. AR apps have been developed for helping students learning, for example, human anatomy or chemistry, or for creating simulated lab activities (Albores, Lao 2019, 1). AR can also be used to support teaching in humanities such as history or archaeology, by allowing virtual visits to historical sites and/or recreation of past events (Fitria 2023, 19). Significant results have been achieved in applying AR also to teaching complex – even abstract to some degree – concepts in subjects such as astronomy and geography in primary and middle schools (Rellia 2022, 46-47; Sahin, Yilmaz 2020).

Regarding public dissemination, AR can also foster understanding of different kinds of phenomena, since physical real world is integrated with computer-generated elements providing information (Raghaw et al. 2018), with effective interaction, high attractiveness, and strong connection with the surrounding environment (Renalia, Suprpta 2022, 111). For this reason, AR APPs are also successfully used in heritage tourism, especially when the experience is enhanced by accurate and carefully developed contents (Nevola et al. 2022, 372).

According to Lobo and Christophe’s review of augmented reality APPs (2020), geo-visualization applica-

tions that combines GIS and AR might be classified according to their function. Based on this classification, the APP we wanted to implement would have been mono user, geographically situated (outdoor/in situ), showing historical data. This means that the physical representation is in the same geographic position as the *geographic reference* and that it would have presented a *temporal indirection* by displaying a historical datum (Lobo, Christophe 2020, 163-165). An augmented reality mobile APP would have made a virtual 3D model of airship NORGE visible in a real location.

Combination between GIS and 3D modelling has been especially used in historical research and projects showing the configuration of ancient environments or settlements: GIS highlights the “spatial relationship between natural and manmade objects while 3D modelling allows the reconstruction of ancient urban and rural landscapes” (Mezzino, Rinaudo 2014, 143). The APP project added the AR component to Shadow-OfNorge, to visually show a past event that once happened in a certain place but left minor or no material traces whatsoever in the local landscape. Furthermore, AR requires the user to be physically present on site, in order to live the first-person experience. Consequently, in a case like the one we discuss, AR could create a far stronger connection between the memorialized event and the physical place in which it occurred, giving the user a higher emotional impact (Challenor, Ma 2019, 4).

The goal of the workgroup was, in summary, to verify the feasibility of applying the theoretical concepts, methods and tools to practically implement a cultural dissemination project through innovative ICTs (including digital storytelling and AR), around a concrete case. The result was to be achieved under three additional conditions: first, the implementation should have used low-cost and widely available solutions; second, the system architecture was to be built without the need to rely on a high technical expertise; third, the development from design to deployment was to remain within a severely short timeframe (4 months).

2. Implementation of communication channels

For the project to be developed as a properly integrated set of components, it was necessary, first of all, to consider both its commemorative and communication-related priorities and aspects.

Considering the ground operation sites only, the NORGE expedition involved five countries (Italy, UK, Norway, USSR/Russia, and USA), which were obviously not within the same border/travel system in 2021. To

be basically inclusive, the whole commemoration would therefore require the involvement of institutions from all these countries. As it was previously mentioned, the Covid-19 pandemic made it impossible to hold any public “in-presence” events, ceremonies or seminars, as various mobility limitations were in place at national and international levels. For this reason, all the initiatives requiring synchronous attendance to an individual conference or meeting were to take place online. In principle, since mobility limitations were assumed to be temporary and variable through different sites, they would not necessarily affect visits to – at least some – historical places by individuals and small groups of people. Of course, these trips could not take place at the same time and to all destinations in an organized manner. Being this the case, however, some kind of information should be provided for visitors so that they could move “a-synchronously” on their own and understand the historical value of the site about the 1926 expedition.

An important aspect is that both types of activity (“synchronous” and “asynchronous”), if they were to be associated with the general commemoration framework, had to be supported by an appropriate set of information and communication environments and channels.

The first type of activity, i.e. the “synchronous” events such as seminars, conferences and meetings, could easily be switched to online form by usual free communication platforms (e.g. Google Meet, Microsoft Teams and Zoom). The second type of activity would have involved the use of an *ad-hoc* APP for mobile devices: such application had to include adequate informational contents and some sort of location-pointer to identify the historical sites in present-day landscape.

The general commemoration framework could have obviously been managed by widely available Web and social networking platforms to share videos, podcasts, images, and other multimedia outputs. Their usefulness and reliability have already been proven in different forms of digital narratives and storytelling (Conrad 2013, 459).

The commemoration was to be developed through a quasi-real-time, step-by-step, chronological reconstruction of the 1926 expedition, in a thread mimicking the timeline of the real events.

Therefore, it was necessary to focus on historical and technical aspects of the endeavour, and, at the same time, render the feeling of the amplitude of the expedition’s organizational effort and geographical span. All these elements would have been conveyed in 1926 by the then-available mass-media (newspapers, radio, photographs, film footage) and by public initiatives; each one of those would use a specific channel to reach its target

audience. These social involvement processes would have to be somewhat echoed in 2021.

When the Amundsen-Ellsworth-Nobile Transpolar Flight took place, it marked several important achievements: international cooperation and participation; demonstration of technological innovation; geographical exploration in the then-anaecumenic Arctic environment.

These pinpoints were to be properly highlighted by the 2021 commemoration. It should be noted, however, that the purpose of the commemoration was not merely to attempt a “time-machine” operation by repeating the contents of the 1926 initiatives. On the contrary, it was important to show what had been relevant in the past, and shed light on the legacy of the expedition 95 years later.

These themes were widely discussed in a series of online seminars, hosted in virtual form by international organizations in the partnership. The discussion began on April 8th and lasted until May 12th, 2021, and included four scientific webinars and two online didactic and public-engagement events¹.

The general information hub for ShadowOfNorge² was certainly the website that hosted all the fundamental contents about both historical elements and present-day initiatives stemming from the project. The graphic interface was conceived to maximise inclusivity for visually impaired users: a colourblind-friendly palette and a reader-friendly font were chosen. The only exception to this visualization policy were the main titles, which featured dynamic motions due to general design style requirements. It should be noted, however, that the same titles were repeated in a reader-friendly format within each respective page. Every article and page were also provided with an audio version of the text content, thus providing further assistance to visually impaired users. The entire website was also available in four different languages (English, Italian, Norsk Bokmål and Russian).

¹ Two of the four international webinars were focused on the past, discussing the NORGE’s expedition and its context in historical perspective. The first webinar, “Custodians of Memory”, hosted by the “Museo Umberto Nobile”, Lauro (Italy), investigated the themes of preservation of family memories. The second webinar was hosted by the NORD Universitet, Bodø (Norway) and was entitled “Flying towards the Great North through countries and cultures”, highlighting the international cooperation that made the 1926 expedition possible. The following two encounters, both hosted by the Italian Geographical Society, were instead looking at the present and future of exploration. “Technologies and Museums for storytelling of places and exploration” was focused on current and innovative tools for narrating historical places, travel and exploration. The last webinar, organized on May 12th, 2021, (the actual anniversary of NORGE reaching the North Pole) explored new ways of sustainable travel in the polar regions. Its title was “The Pole and Beyond”.

² www.shadowofnorge.eu

Although it would have been possible to develop the website in English solely, it was deemed more inclusive to ensure that non-English-speaking readers from the countries involved in the 1926 expedition could access the texts in their own language.

The website main bar allows access to the various sections and to the menu that allows switching language. Sections such as ‘Institutional Network’, ‘Project’, and ‘Contacts’ provide information about the main work-group that managed the operation, the partners who contributed to the implementation of the various activities and explain the entire project in its various facets. Informative static pages offering insights about different themes related to the 1926 events were gathered in the “In History” section. Here it is possible to find information about various aspects of the expedition, list and images of crew members, summary explanation of the airship structure, and a series of digitized documents courtesy of “Centro Documentazione Umberto Nobile” – Museo Storico Aeronautica Militare (Vigna di Valle), “Museo Umberto Nobile” (Lauro), classified and digitized as part of the “Polar Memory” programme (Italy’s National Research Council).

Along with the static pages of the website, a timed news stream was created by automated scheduling and manual input to recreate the events timeline. The stream published “real-time” updates from 95 years ago. Information on the airship position and progress were provided by issuing brief text updates along with 1926 photographs, if available, and excerpts from contemporary newspapers reporting news. Particular attention was put in trying to always present the user with parallel information about the historical elements, and the present-day initiatives that were scheduled in the 2021 commemoration.

The information flow provided by the website was conveyed through associated social network platforms. Dedicated Twitter, Facebook and Instagram profiles were created and linked to www.shadowofnorge.eu. Via such communication channels, appropriately formatted contents were disseminated, keeping in mind that each social network appears to offer its own information and messaging type. Based on this, Twitter was used to mimic a news agency, by posting short updates pointing to more detailed news on the website; Facebook and Instagram were used for more visual-oriented messaging, calls for actions to followers and to foster public interaction.

A key role in generating interest and involvement through a first-person interaction was played by combining social networks with a prototypical AR Android application, downloadable from the website.

The project’s social channels, especially Instagram and Facebook, invited followers to share photographs

and videos of the virtual NORGE, as displayed by the AR APP, from various places in Europe, where they physically had to be present to capture a picture of the airship.

As it was previously explained, by providing the project with an AR APP, ShadowOfNorge tried to establish a direct connection between the commemoration and the places where the 1926 events occurred. The APP was designed to acquire positioning from the user’s smartphone internal GPS and developed through an engine platform integrated with a GIS-based add-on software. Inclusion of 3D objects in maps for learning purposes has been proven to be efficient for generating interest in relation to a certain area of landscape (Renalia, Suprpta 2022, 112). The ShadowOfNorge group planned to build a full-scale, GIS-referenced virtual model of the airship that could be animated and visualized, through mobile devices, in various places along the historical routes.

3. Implementation of NORGE’s virtual model

After its transpolar flight, the NORGE was dismantled in about two weeks beginning May 14th, 1926 (Alessandrini 2019, 101).

Except for a few minimal remnants (an engine, one or two propellers, bits of the airframe, scarce pieces of cloth and the emblem formerly on the gondola), what is left today of the airship are photographs, brief films, pictures, and technical drawings. Information derived from technical drawings enabled us to obtain detailed knowledge about the features and material characteristics of the machine. Furthermore, old photographs and films could render well how the airship looked and moved like to witnesses and observers, in different places along the route. Therefore, even though no material remains are left of the large aircraft, there was enough information for an attempt to create a 1:1-scale virtual model for an AR application. By visualizing such model in some relevant sites of the 1926 journey it could be possible to recreate a socially shared feeling of “witnessing the historical event” for present-day audience in the same locations where it took place.

Our project required the use of a software for easy hand-modelling and featuring adequate graphical tools so that the outcome would be sufficiently accurate from a philological point of view.

For determining the feasibility of developing a multi-platform dissemination system using low-cost tools and without relying on high technical expertise, 3D Studio Max, release 2020, was the chosen software. It is a professional application developed by Autodesk (Media

& Entertainment) for computer graphic, solid modelling and animation, that offers a free Educational Licence for no-profit projects.

Although designed for professional graphic, animation, and visual effects, it features an intuitive, user-friendly interface. The 3D editor is already provided with many primitives, including various geometric solids. This enables the user to conveniently model and refine entities starting from precast shapes which are manageable in every sub-part of their geometry, from points, to edges, to polygons (3DS Max 2022). Such set of tools appeared to be the best choice for our project of reconstructing an airship whose geometrical elements were complex in their individual shapes and connections.

The software measurement system allowed to define a reference unit so that all the dimensions of the model along the three axes could be properly scaled.

Accurate scaling – in all static and dynamic properties – was essential since the virtual airship was supposed to appear in the real physical locations showing the correct size, behaviour, and general appearance as close as possible to those featured by the original NORGE in 1926.

To achieve the best possible accuracy, considering the imperfection of a fully manual reconstruction, it was mandatory to work based on information we had about dimensions and proportions of the original craft and on a reliable source such as the original drawings.

Good quality documentation existed in several digital versions both for airship NORGE and for sister ship ITALIA. The ITALIA was involved in a polar expedition in 1928 and its structure was very similar to the one of its predecessor: the two vehicles were in fact twin ships. In the development of the virtual model, due to differences in level of detail of the available documents, drawings of both machines were used. As the structure of ITALIA presented some differences, they were identified and eliminated to make sure that our NORGE was as correctly modelled as possible.

NORGE was a semi-rigid airship, which means that the envelope was kept in shape by a central girder or keel, whose elements were made of steel and aluminium, connecting the structures of bow and tail for a total length of 106 metres (Pinucci 2018, 97). This arrangement is evident if we observe the lines that compose the technical drawings. Starting from these *blueprints* from almost 100 years ago we began to build the 3D structure of the virtual model by following individual lines. To facilitate this reconstruction, scanned images of the technical drawings were imported into the 3D environment of 3D Studio Max and placed in a coherent way that allowed an easy control of modelling procedures in the three dimensions (Fig. 1).

3D Studio Max allows to produce models – and digital images derived from these models – that can fully simulate objects, materials, and environments in a

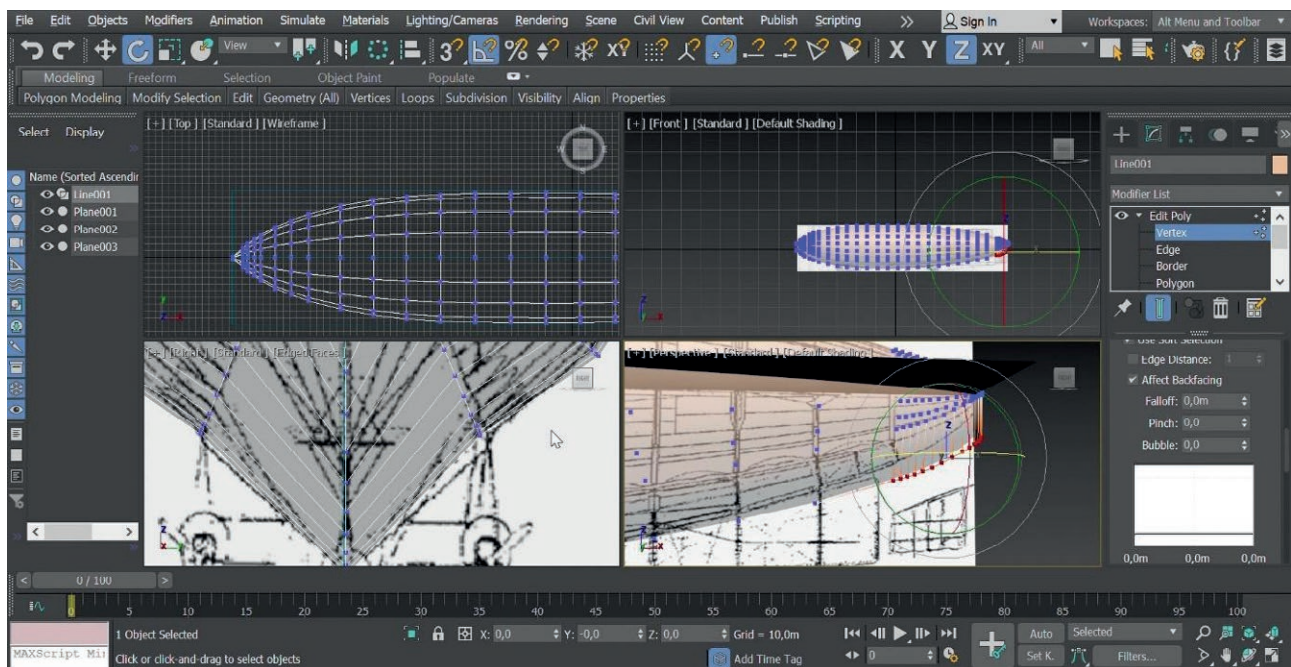


Figure 1. Screenshot of the modelling process in 3DS Max. Source: ShadowOfNorge project.

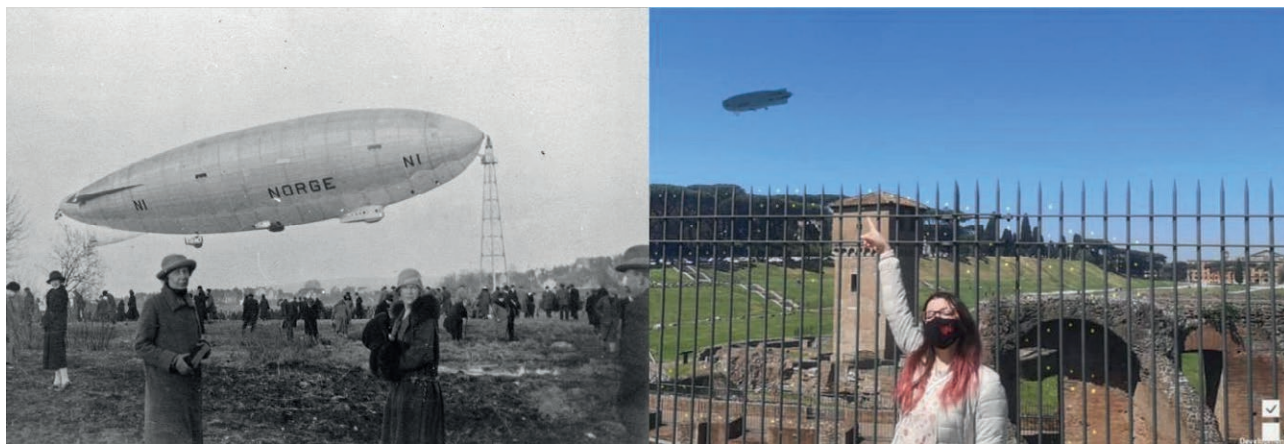


Figure 2. “Witnessing” the NORGE expedition in Ekeberg (Oslo), 1926, and in Rome 2021. Sources: DM Museene i Akershus (left); ShadowOfNorge project (right).

photorealistic way. 3DS Max is equipped with a Material Editor that can create different effects to be assigned to an object to change its appearance. This rendering is based on how the specific object is supposed to interact with light, so it is possible to adjust various parameters and to apply designs and texture simulations to achieve high levels of realism (3DS Max 2022). Using these capabilities, it was possible to assign the mesh the appearance of a rough grey cloth material, to simulate the envelope that covered the gasbags and the rigid structure of the airship. A more “metal-like” grey was used for the engine cars. The final purpose of these actions was to achieve the most possible realistic light effect once the airship would have appeared to the user.

What we wanted to achieve through the AR APP was the storytelling of an explorative expedition, an event that extended through a period of time and that involved a wide geographical area. This idea raised the necessity for our airship not to be static, as it happens with digital reconstruction of, for instance, monuments or buildings, but to be an AR model that could move in space, fly through the skies of cities and moor in specific places. 3DStudio Max also offers animation capabilities, based on the production of a specified number of still images, called *frames*, displayed in a quick succession to be perceived as a continuous motion. Animation can be very complex since it is applicable to any object or scene’s parameter. We could then recreate the airship motion as much similar as it was possible to the original one. An average cruise speed of approximately 85 km/h was calculated,³ based on historical information,

³ The NORGE could reach a speed of 115 km/h on the three engines at full power, but normally it would cruise on 2 engines at about 80-90

to be applied in the straight-line flight segments while a motion of increasing or decreasing speed was created for the departure/arrival manoeuvres (Fig. 2).

The original NORGE was equipped with three 1919 Maybach IV, 245Hp piston engines, preferred for their reliability in long-haul flights (Trojani 1964, 736). They were fairly slow, operating at 800-1200 rpm during cruise (Nobile 1928, 170) therefore they would sound quite differently from faster and smaller present-day motors powering general aviation airplanes. The capability of approximately reproducing such sound would add to the user’s experience. For this purpose, simulated engine sounds were acquired from an open-source library and further processed to obtain a plausible recreation of the sound of NORGE power plants.⁴

The overall reconstruction process was sufficient for recognising a first positive result of our investigation goal. In the end, we developed a full-scale 3D model of airship NORGE which reflected, in appearance and dimension, the original one using the free educational licence of a professional software, without deep expertise in the field of 3D digital hand modelling. Combining the software with information acquired from historical sources, it was possible to attain a fair deal of precision in size, photorealistic rendering of materials, and an animation that could coherently reproduce motions and speeds of a 1920s airship.

The model and the animation scenes that were created inside 3D Studio Max, once completed, could easily

km/h, to save fuel and increase range.

⁴ As the three engines of the real machine could operate independently from one another, when the start-up procedure was re-created in the AR model, three independent sounds were generated, separated by short time intervals, and associated to an initial rotation of the corresponding propellers. The overall effect turned out to be realistic.

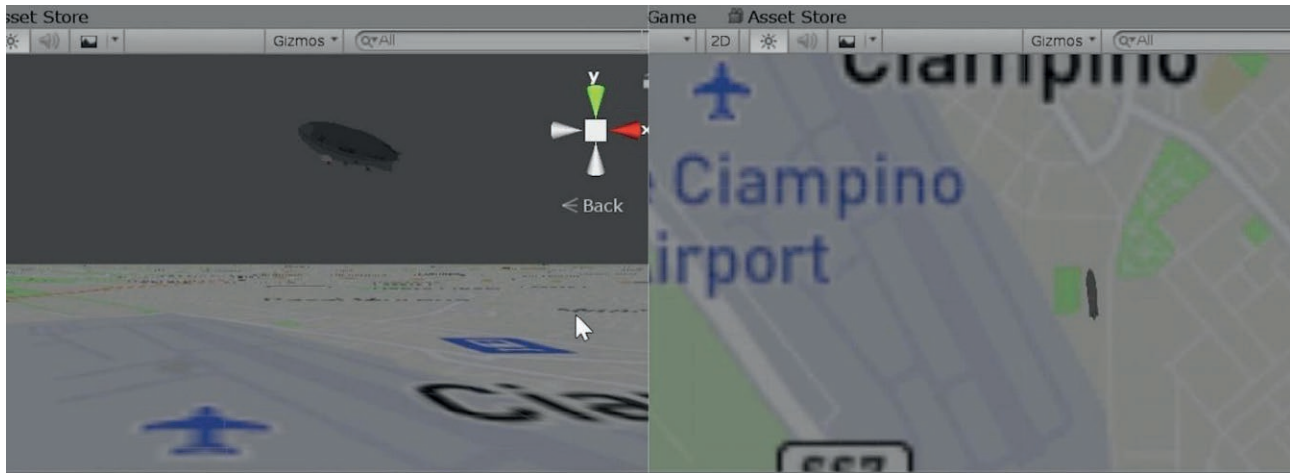


Figure 3. Screenshot of AR animation developing process on cartographic base. Source: ShadowOfNorge project.

interact with the free platform that was chosen to develop the smartphone Android application: “Unity”. The software is provided with a 3D Editor whose Drag&Drop interface proved to be very intuitive and easy-to-use to develop our augmented reality project to make the airship visible in some iconic places of its journey. As a matter of fact, models and animations can rapidly be imported and managed inside the editor (Kerimbayev et al. 2023, 541).

Given that its purpose was to narrate a real past event, the APP had to convey contents so to result both appealing and historically reliable. This kind of process requires a complex adaptation of data and contents; they must be organized to ensure the best possible trade-off between effective communication and historical precision/accuracy. In general, obviously, it is very difficult and might be inappropriate to attempt to “compress” large amounts of data from traditional sources e.g. books, reports etc... in the small (conceptually, even more than technically) space of a public dissemination APP.

Retracing and studying NORGE’s journey, in the first place, was a fundamental part of the entire project.

Bibliographic sources and newspapers from the 1920s were used to identify each segment of the route and each stopover. Pictures and film clips served as a reference to understand how the airship appeared and moved in the environment. Acquiring a clear picture of the expedition, being aware of places involved, timing, and distances, would have worked as a solid basis to create a feasible transposition, considering the limitations of a smartphone application. Necessary poetical licences and approximations in the representation were communicated to the user in the “Info” section of the APP, so that the overall spirit and, so to speak, *level of reliability* in the workgroup’s intent could be properly clarified.

Scientific transparency in transposing cultural heritage for dissemination purposes is crucial to avoid misinformation (Challenor, Ma 2019, 10).

To visualize the airship in relevant places of its journey, a base map obtained through the Mapbox’s appropriate plug-in was imported into the chosen engine platform – i.e. Unity. It was therefore possible to create and test NORGE’s routes and manoeuvres having a cartographic base under the 3D digital model so to develop large-scale animations (Fig. 3). Renderings could be controlled from a nadiral point of view, very useful for route adjustment, but also from an oblique view that really helped for reaching realism in movements and correctness in execution times (Fig. 3).

Different animations were created to reproduce NORGE’s journey: elliptical, circular, or straight movement, depending mostly on technical needs and, when possible, following the historical information we could rely on. To increase the model visibility, trajectories were programmed into the APP at slightly lower flying heights than the historical ones. Every section that was built digitally was at least 2 km long and was programmed to be perfectly reproducible and coherent in real environments.

Forty-one augmented reality scenes were developed and “positioned” using real-world coordinates and they were divided into twenty-two areas corresponding to each section of the APP navigation tree. Each place-based visualization of the virtual airship is associated with a “descriptive card” containing basic information about the 1926 expedition phase in that site. This was complemented by hints or suggestions for a better AR experience in that location and was paired with a map extracted from Open Street Map, showing the geographical area where

NORGE's model would have appeared. Cards were also, occasionally, decorated with original photos and reproductions of old documents, enriching the limited amount of textual information that could be included.

A final necessary choice for achieving a good AR scene rendering was to intervene on the opacity of the NORGE's digital 3D model. Knowing the user's position – along with the attitude and orientation of her/his device – with respect to the virtual airship at a given instant, the APP should visualize the model on the screen in the proper direction and apparent scale.

However, the AR technology draws the model on the background of the external scene as captured by the device camera. The model is necessarily generated always in the foreground because the mobile device cannot estimate, nor even “see”, the depth of the scene from the camera. In other words, it is unable to understand whether there are physical elements between the position of the airship and the observation point so that the view could be blocked. Therefore a 1 to 1 scaled NORGE consistently flying at a certain distance from the user could pass before a closer building, tree, streetlamp etc., inevitably interrupting the suspension-of-disbelief or “sense of presence” (Wilkinson et al. 2021). The chosen solution was to make the model slightly transparent so that it was visible not *before* but *through* other objects. This solution also served another, more philosophical, intent. The general idea of the APP project was to present the virtual model not as the real NORGE, but rather as a sort of commemorative “ghost” or, in fact, “shadow” of the original airship, based on its overall namesake “Shadow of NORGE”.

NORGE's expedition started in Ciampino airport (Rome, Italy) on April 10th and ended in Teller (Alaska, USA) on May 14th after crossing various European countries such as France, UK, Norway, and Russia. The final segment of the journey, from Svalbard to Alaska took 70h 40' of travel, covering 5,117 kilometres just to cross the Arctic cap (Nelson 1993, 280).

Creating a complete AR transposition of a journey that was overall 13,000 kilometres long, inside a smartphone application, was an impossible task due to the excessive amount of data that should have been stored in the user's device. It was therefore decided to select specific places where to create the geo-localized augmented reality scenes and make the airship “visible”.

NORGE's expedition was the result of a joint and international effort, so key symbolic places were considered where high public participation was reached and where significant support to the operational effort was offered in 1926. The first type included large cities and publicly visited airfields: Rome, Oslo, Saint Petersburg (then Leningrad), Teller. The second type included

technical facilities, mooring locations, hangars, that were made available to host the airship during its journey: Pulham (UK), Gatschina (Russia), Vadsø and Ny-Ålesund (Norway). According to this criterion, it is, for instance, possible to see the NORGE flying over the area of Prati in Rome, where the original airship had been built at “Stabilimento Costruzioni Aeronautiche” and where it flew over a few minutes after it departed from Ciampino airport on April 10th, 1926. A user standing outside Ciampino airport can follow the airship's departure manoeuvre as recreated in augmented reality. The animation is coherently visible depending on the spectator's point of view in different areas around the airport and was developed using available data from historical sources. As the original vehicle behaved in 1926, the digital model lifts slowly and, after reaching an appropriate altitude, it starts its three engines (one after the other) and unfurls the Italian flag outside the gondola, while the Norwegian one flies at the stern. Gaining speed, the virtual airship heads towards the Via Appia Antica and starts its journey. The first landing animation was created by geo-localizing the AR model in the locality of Pulham (England). In this case, it was possible to rely on original footage that helped in reconstructing the ground approach manoeuvre as it was performed when NORGE arrived, in the afternoon of April 11th. Similar animations, with location-based differences as needed, were created for NORGE's landing in Gatschina (Russia) where the airship arrived on April 15th, and Teller, the Alaskan village where the journey ended. Different kinds of motion paths were implemented for the two locations where NORGE did not land on the ground but was moored at modular masts: Oslo-Ekeberg and Vadsø (Norway). The original spot where Ekeberg's mooring mast stood is today a monumentalized site although minimal traces remain of the original structure. Its coordinates, extracted from Google Earth, were used to determine the exact point where to stop the airship's bow, thirty meters above the ground (the known height of the disappeared pole). Unlike the one in Ekeberg, the original airship mast in Vadsø stands to this day. It is located on the small island of Vadsøya and, preserved as a historical landmark, it has become a tourist attraction (Roura 2009). Through the AR APP, it is possible to follow the NORGE arrive far from the east, make a wide curve, and slow down until reaching the real mast, “docking” with it by its bow-connector.

AR scenes were also created to show arrival to and departure from Ny-Ålesund, the last stopover before the transarctic flight. Formerly a mining area, adapted in 1925 to serve as an outpost airfield, the site currently hosts scientific stations.

NORGE was recovered there for four days (Trojani 1964, 183) inside a wood-and-cloth hangar. During that time, it was maintained, refuelled, and prepared, while crewmembers for the Arctic crossing were chosen.

As far as the Ny-Ålesund stop was concerned, besides the already mentioned arrival and departure, it was decided to create a stationary version of the airship model placed on the ground in the exact spot where the hangar was. This would have allowed users to appreciate the huge – 106 metre model on the ground – a relatively unusual status in the APP situations.

Still waiting to be screen-shot by particularly adventurous APP users, a 3D model is also geolocated at Lat. 90°N, circularly flying over the North Pole.

An additional criterion for selecting locations was to look for major places where a wider attendance could be easily achieved but that, at the same time, were wide and open, possibly with a clearly visible skyline of distinctive objects⁵. Such features could ensure better GPS/GNSS coverage, which was one of the technical conditions for the proper APP functionality. Consequently, wide parks and villas in Rome and St. Petersburg, seashores in Italy, France, and England, squares in other major city centres were included. Furthermore, all the chosen localities were places where the real NORGE had flown over during daylight and so where its passage was witnessed by many people⁶.

Finally, three symbolic landmarks were included inside the APP for the anniversary celebration even though they weren't part of the real NORGE's route. The first one was Longyearbyen, the largest inhabited town in Svalbard, since the AR scene created for Ny-Ålesund would hardly have been used – and it has not been, as of this writing – due to internet restrictions in the area (Ny-Ålesund Research Station 2020)⁷. Then the “Museo Umberto Nobile” in Lauro (AV) and “Roald Amundsen's House” in Svartskog (Oslo) as a homage for the two leaders of the expedition.

It is important to stress, here, the geographical dimension of this kind of work, which is not merely

computer-science-oriented. There was once a real airship flying from one place to another in Europe. Its journey was documented on (obviously lower-scaled) paper-based maps and represented on paper-based documents. For 95 years those remained the only – reduced – ways of *expressing* the journey. The lines on those paper-based maps were then, in 2021, digitized into a geographic information system (Mapbox). And then a virtual, back-to-full-scale copy of the NORGE was created; this virtual copy was then made to travel again (some sections of) its original journey, *in full scale*.

5. Testing the APP

APP ShadowOfNorge functioned as a support service to help following the timeline of the commemorative events. It was made available for download on the project's website a week before the celebration started. People were invited to try it and send pictures or videos of NORGE's “appearances” in different locations to foster social involvement. Communications about how to send or share photographs were given and frequently recalled on the website, the social network platforms and during online seminars. The main target audience for the APP were people following the commemoration, who were already in, or close to, the selected sites. By inviting people to interact, we wished to create a socially shared reconstruction marking the stages of the commemorative timeline. The effort was in a fair deal successful.

An obstacle to the diffusion of the application was the impossibility of offering it either on Google Play Store or App Store due to the time constraints and the prototypical nature of the APP. It was made available on the website as a free APK file, easy to install on most Android devices.

Despite the difficulties, numerous images were received in different occasions from the main involved places. As a result, a collection of photographs (50 of which are visible in the “Gallery” section of the website)⁸ reproduces the *shadow* of NORGE in today's environment of some of the most iconic locations of the 1926 journey: Ciampino, Rome, Oslo, St. Petersburg, Vadsø (Fig. 4-8). Cooperation by different users in different locations – far away from one another – made it possible to echo the international participation to the historic endeavour. In some cases, pictures of the 2021 virtual NORGE could be compared with similar views of the 1926 real one, facilitating a comparison between “then”

⁵ The APP internal engine took advantage of optical references in the skyline to correctly visualize the virtual model. Individual clouds would also be used to achieve the same goal provided that they would appear well contoured from the clear sky and other clouds around.

⁶ The NORGE, as many other airships of its time, was not required to be, nor was, equipped with any navigation lights. Its internal cabin lighting – used through the flight until the expedition had reached the continuous daylight zone within the Arctic Circle – was disinstalled to save weight.

⁷ The ShadowOfNorge APP could only operate under GPS/GNSS coverage and activate data-traffic function. Therefore, it turned out that APP use in Ny-Ålesund could not be allowed without some specific – and difficult to obtain – special clearance.

⁸ <https://www.shadowofnorge.eu/en/the-project/gallery/>



Figure 4. Just after departure, over Via Appia Antica. Image by Claire Fedeli.



Figure 5. Over Piazza del Popolo, Rome. Image by ShadowOfNorge.

to a real scene is to convey the sense of attending a specific event. In this sense, ShadowOfNorge might give a small, though meaningful, contribution to the culture-through-AR paradigm.

Unfortunately, the workgroup was unable to obtain AR images from some important locations: Pulham, Gatschina, Ny-Ålesund and Teller, despite some attempts to communicate and send requests to that purpose. This proved that the most effective communication for disseminating the project was to be achieved through national and international partners who *actively* participated in the local diffusion.

The importance of creating an easy-to-use and intuitive platform is essential for the success of a public cultural heritage project. This factor led the workgroup, during the early stages of the APP design, to avoid timing constraints. The ShadowOfNorge APP requires the user to be in the right place, but not necessarily at the right time. Due to technical limitations in the APP, the virtual NORGE is visible in the sky up to a maximum distance of 1000 metres from the observer, in any direction. In a typical cruise, straight line animation, the model “moves” with an apparent speed of 85 km/h. An observer located exactly under the route, therefore, would see the NORGE for merely 2 kilome-

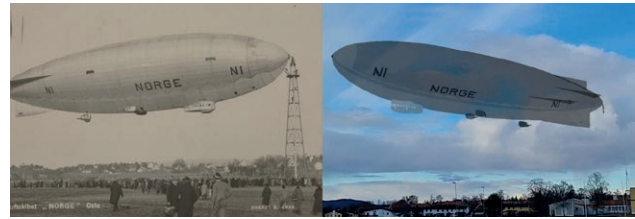


Figure 6. At Ekeberg Mooring Mast. Left: Airship NORGE Oslo, Nasjonalbiblioteket. Right: image by Ragnar Aas.

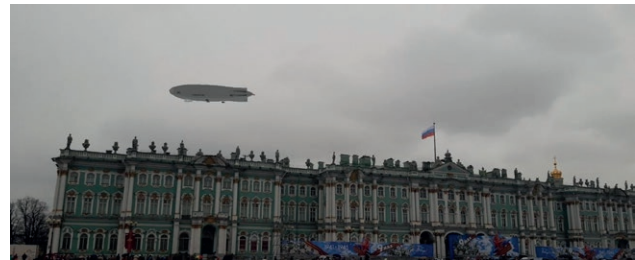


Figure 7. Over Saint Petersburg. Image by Adelina Terekhova.



Figure 8. Docking at Vadsø. Left: image by Centro Documentazione Umberto Nobile – Museo Storico Aeronautica Militare. Right: Image by Lisbeth Dragnes, Varanger Museum.

tres, which would give a total view time of slightly more than a minute. The workgroup considered that it would be too demanding on the users to require them to get to the exact location for a one-time, momentary view that could be easily missed for either positioning or timing errors. Had that be the case, the APP would have turned out impractical. Geographical positioning of the model was, instead, the key element for our purpose of linking events to places. In fact, it was the very core of the whole work. The simple location constraint, however, caused mixed feedback from some users. In several cases, as it was our ambition, it succeeded in generating a greater emotional impact and in underlining the sense of presence, or the sense of attending an event from the past in the very place where it unfolded.

In some other cases, nevertheless, it caused disappointment to users for not having the possibility of taking pictures of the virtual NORGE independently of

the location. They, evidently, considered the symbolical value of the commemoration regardless of its locational dimension.

6. Outcomes and conclusions

Our primary goal was to demonstrate the ability to story-tell NORGE's journey through a set of ICT tools – developed by a small group of non-experts⁹ – effectively implementing methodologies and criteria derived from those identified by the theoretical research in a practical case.

From this point of view, the workgroup was satisfied with the result, as we succeeded in developing a functional prototype of an integrated multi-platform system in a short time and at a very low-cost, despite some limitations. The project was completed in four months using open-source or free tools.

A full-blown quantitative measurement and analysis of the public outreach of the initiative was beyond the scope of the project and the intent of the workgroup.

Nevertheless, the quantifiable results, in terms of public interaction, collected at the end of the commemoration period, indicate the potential impact of the developed tools.

The communication channels have demonstrated effective engagement with the audience. The Facebook project's page gained 386 followers within 21 days of its launch during the project presentation event. Webinars and cultural encounters, which had an average of 40 participants through institutional channels, reached a significantly larger audience through contextual live streams on social media channels.¹⁰

Regrettably, due to the inability to publish the APP on the official stores, we were unable to determine the number of individuals who downloaded and used it. Despite the obstacle of being able to distribute the APP only by direct download from the project website and

its ability to run only on Android devices, we received over fifty photographs of the airship in various locations, which we consider a satisfactory outcome showing the potentiality of captivating the audience.

Among the most positive outcomes of the ShadowOfNorge APP, we can list its fostering didactical activities organized by the local history museum of Vadsø, Norway. In the summer of 2021, after the end of the celebration, the Varanger Museum¹¹ in Vadsø set up a series of school visits to the original mooring mast, located in the Vadsøya Island. The museum was one of the international institutions that had been very actively involved in testing the APP during the development process. The airship mast is today a landmark in Norwegian history, and, consequently, a popular tourist attraction in that Arctic community. During summers, Varanger Museum uses to organize didactical visits to the Vadsøya Island, for outdoor lessons about the history of exploration. After the ShadowOfNorge commemoration phase, the APP has been used as a support for explanation as it shows, through augmented reality, the airship's arrival and departure. Lessons were given to students between age 11 and 15, and the use of AR as a medium for supporting didactics proved to be very effective, especially for younger pupils. They were enthusiastic in trying to see the full-scale airship approaching the mast through the smartphone. Using mobile device applications, based on AR, for didactical purposes has been proved as a very powerful practice to support *situated learning* (Pombo 2022, 254) as the learning process happens in the related environment. School field trip is, in fact, a very attractive method to improve capabilities of understanding reality, and it is essential in teaching geography (Bonetti 2020, 51). Augmented reality APPs, such as ShadowOfNorge, can add to the sensorial experience and can also be used to produce game-based learning approaches that foster students' engagement (Abd Halim et al. 2022, 5).

The positive outcomes in terms of audience, dissemination, and even education demonstrate the feasibility of creating a digital storytelling using low-cost and user-friendly ICT.

Shadow of Norge was a geo-historical initiative based on different forms of storytelling that served as a test bench for the development of similar multidisciplinary projects. It allowed us to test how modern, low-cost – or free – geo-technologies can be employed for cultural dissemination in historical geography and history of exploration. Starting from original documents and bibliographical sources it was possible to recreate, on a true-to-reality, some sections of an exploration journey

⁹ The workgroup was composed by twenty university students and volunteers from Italy, Norway and Russia who helped in the benchmarking and system testing, ten of whom were directly involved in Web and social communications. Development was carried out by one laboratory intern under supervision by one university professor. Archival and historical resources were proposed by the latter and by a PhD student.

¹⁰ For example, the Facebook livestream of the project launch event on March 28th was watched by 569 people, rising to 853 in the following days. 577 users attended the event at the Società Geografica Italiana entitled "Technologies and museums for storytelling of place and exploration" through social channels, and 322 followed the webinar "The Pole and Beyond". The figures confirm that connection of web 1.0 communication channels to social networks remarkably widens the overall outreach.

¹¹ <https://www.varangermuseum.no/en/>

that took place 95 years before, and that was previously only studied and expressed through bidimensional maps. Furthermore, it was possible to test how to convey different kinds of information using the most appropriate format and media both for a public audience and for didactical applications. Although our work was prototypical in nature, it was a full-blown project, built up in short time and with limited resources.

In the end, ShadowOfNorge achieved its intended results and proved to be useful as an experimental base for further public geo-history projects.

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