A Virtual Cradle for Democracy:
Reconstructing the Ancient Agora of Athens

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Abstract: The paper relates the main traits of the archaeological VR representation and its methodology and production issues through the case study of VR reconstruction of the Ancient Agora of Athens in three distinctive time periods: the Classical period, the Hellenistic period and the Roman period. The time-span covered corresponds to more than fifty different buildings, some of which had more building phases. The issues of environment are also addressed, as well as the scenario and action themes, that is the historical enacting of a *locus* notoriously known as the birthplace of the Western Democracy.

Introduction

Virtual reality has been, already for more than a decade, in use for archaeological representation. The rapid progress of computer science hasn't allowed specialists much time and space to formulate their own needs and priorities in an organized and methodic way.[1] Thus, there is a still growing number of VR projects related to archaeology evolving independently and usually facing various methodological and conceptual problems. Some of these issues are related to the target groups, to the content requirements and to the bounds of the available technology.

techniques, including photorealism, real time rendering and interactivity.[2] In the Foundation of the Hellenic World we are working, experimenting and innovating on such issues for more than ten years, based on a close collaboration of the Archaeology and Virtual Reality Departments. Our main projects, as well as this paper, deal with V-realities, not E-realities, where the last stand for digital domains with no affordances (predetermined) and the former for virtual environments with feedback, characterized by behaviors (not predetermined).[3]

Fig. 1: The temples of Apollo Patroos, and Zeus and Athena Phratrioi in real-time VR rendering.

Fig. 2: The temples of Apollo Patroos, and Zeus and Athena Phratrioi in photorealistic rendering.

Some more concerns surge from the time and space conventions, the specificities of the infrastructure in use, and the representation

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[1]   Barceló (2000) 9:35, Sideris – Roussou (2002) 31:32.

[2]   Most of these projects use distinctive techniques mainly based on 3D laser scanning and/or photogrammetry. A characteristic example: Bodoni - Rubino (2006) 17:21 and many more in VAST (2006).

[3]   Forte (2006).

Production process and methodology in VR representations of archaeological sites

Working with the current stat-of-the-art technology for immersive and interactive VR representation, or in other words choosing the real-time rendered show instead of a prerendered one, means accepting that the interactivity grows in detriment of the photorealism. The final result is aesthetically less attractive and less realistic, but it recompenses the visitor with a practically total freedom of movement and interaction.[4]

Any project of reconstruction of an archaeological site in VR, not using 3D scanning or/and photgrammetry, is articulated in five main steps, which may slightly vary but they always include the following work procedures and phases [**Figs. 1 and 2**].

The *first step* is the definition of the area and the historical moment to be represented. Together with the time and the space go the relevant buildings and the appearance of the natural environment of the area at each time spot. This practically corresponds to a job plan, which usually starts with the DTM creation (DTM of the actual situation with modifications according to the historical, archaeological and geophysical data). At the same time the target groups and their specific needs are analyzed, the main divergence occurring between the educational or the scientific scope of a project.[5]

The *second step* deals with the documentation, which includes new pictures of the actual landscape and ruins, collection of the excavational data (metrical data, textual descriptions, photographs and drawings) whenever published, and evaluation of earlier proposed reconstruction for each particular building, either graphic or as a plaster model.[6]

The *third step* is the building of 3D models according to a given LOD, which stems from the technical capacity of the available hardware and software.

The architectural forms are simplified to basic geometry as much as they keep a visually acceptable verisimilitude (for example, the column circumference may correspond to a number of triangles varying from 10 to 64).

Realistic textures, mostly custom made, are added on the surfaces and ornamental details are rendered graphically (antefixes, painted patterns, sculptural details on the entablature, etc). In some cases an image-based technique is used for rendering surfaces more realistic.[7]

The *forth step* corresponds to the integration of the particular buildings on the DTM (or several DTMs if several periods are represented). Adjustments are yet to be made, and a 2D horizon is added in the circumference of the virtually represented area (distant structures and mainly the horizon line of the surrounding hills and mountains).

The *last step* includes the addition of minor details (small walls, steps, enclosures, light structures etc.) and the organic forms of the environment (trees, statues, animated animals and humans) according to a given scenario of varying flexibility and interactivity.[8]

After a final control of its technical operability and its historical/archaeological accuracy the virtual environment is ready to accept the visitors.

Project's frame

The latest project in FHW, still under development, is the reconstruction and representation of the Ancient Agora of Athens.[9] This is an Information Society project, funded both by European and national resources. A first version of the project is in display (since December 4, 2006) in the new Foundation's infrastructure called "Tholos", a dom-like theatre.[10] It addresses the general

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[4] For concerns about photorealism and real-time rendering: Valinho - Cerdeira - Franco - Serras (2006) 332:335, Sideris (2003) 65:68.

[5] Sidiropoulos – Sideris (2002) 63:68, Sideris – Roussou (2002) 39:41.

[6] In the case of our reconstruction of the Agora of Athens we had to deal with several plaster models made by or under the guidance of John Travlos in the 1960s and 1970s.

[7] Gaitatzes - Christopoulos – Roussou (2001) 103:110, Christopoulos - Gatatzes – Papaioannou (2004) 61:71.

[8] Sideris - Roussou - Gaitatzes (2004) 208:216.

[9] All the building models of the project have been crated by the FHW 3D department, head of which is Vaggelis Christodoulou. The terrain model, the VR rendering and the figures of the show have been adapted and crated by the FHW VR department, head of which is Saki Gaitatzes. The archaeological and architectural information has been gathered and interpreted by Dimitris Palaiothodoros and Iannis Arvanitis. The author is the scientific (archaeological) responsible of the project.

[10] The Tholos Theater is the latest and more sophisticated of the FHW VR installations. There are also a Magic Screen™, a Virtual Cinema and a Kivotos Theater (Cave™). The technical characteristics of the Tholos are: diameter 14.14 m, inclination of the dom screen 23 degrees, capacity 132 people (including 5 PSN). The interaction

and the young public and has both educational and entertaining character.

The Ancient Agora of Athens is a highly symbolic and ideologically charged site in the centre of the modern city under the North slopes of the Acropolis, since it is widely considered as the birthplace of the western democracy. The site was continuously occupied for more than five millennia, but it reached its peak in the period between the blooming and the fall of the Classical Greco-Roman civilization, from the 5th century BC to the 3rd century AD. It has been the administrative, commercial and religious centre of the city. It was bourgeoning with everyday activity, commercial exchanges, festivities, official ceremonies, athletic and religious events, political rivalries, juridical procedures, intellectual debates and artistic expressions.[11]

The main concern during the conception of the project was how to represent this constantly mutating space, and the destruction, demolition, construction and adaptation activities which took place so often in the Agora area. Another crucial issue was how to render all the activity in a historically accurate way, and how to limit the inevitable assumptions and conventions implied by both the archaeological interpretation and the current technology capacities. We already had a large experience from similar projects of the FHW, but we also had to face new challenges connected with the live atmosphere of a remote past, for which neither do we know everything, nor can we visualize everything we know. Furthermore, the real site lies a few miles from the location where its virtual representation is displayed and the potential comparison should not belittle either of them.[12]

Previews experience
The FHW has already produced several programs of archaeological immersive VR representation.[13] The first was the

representation of Miletus, a Greek city in Asia Minor, during the Roman period.[14] Only the public buildings have been represented and a few elements of the environment. The representation, though archeologically entirely reliable, lucks the vitality of the human presence and leaves the visitor with the impression of visiting a deserted land, a kind of digitally preserved Pompei. The same is partly valid for the second similar project, the representation of Olympia. But there, beside the sumptuous buildings of the famous sanctuary, we opted for an interactive representation of some of the Olympic contests.[15] As soon as the visitor enters the stadium he can see athletes competing in the foot race, in the jump and in the wrestling. Furthermore he can participate with them in the games and throw the javelin and the discus. A clamouring crowd all around is rendering more realistic the experience, which culminates with the crowning of the victor. Both projects are intended to the general public and on display in the Cave™-like installation of "Kivotos".[16]

A different approach has been adopted for the representation of the Asclepius Temple in ancient Messene, a Hellenistic city in South Peloponnese. Here the aim is both educational and scientific and the target groups include pupils, students and specialists (architects and archaeologists).[17] We represented only the temple itself, on which the young public learns some basic elements of the ancient Greek architecture, while the specialists have the opportunity to experiment varying solutions according to varying reconstruction hypothesis without the time, cost, effort and irreversibility linked with any real restoration work. Besides, the

devices include a joystick and 4 buttons on each seat.
Projection: 12 F3+ projectors, Single – Chip DLP (Projection Design), resolution 1400 x 1050. See also Christopoulos –Gaitatzes – Papaioannou (2006) 35:40.

[11] The best and most recent overview of the history and archaeology of the site is Camp (2004).

[12] The Scientific Committee of the project is composed by Prof. John Camp, Prof. Petros Themelis, Dr. Alkisti Choremi, Dr. Richard Anderson.

[13] Furthermore there is a number of smaller non-immersive or/and non interactive projects

realized either as exhibits for the Foundation's exhibitions, or as parts of its educational programs.

[14] Pape - Anstey et al. (2001) 85:89.

[15] Gaitatzes - Christopoulos - Papaioannou (2004) 19:28, Gaitatzes - Christopoulos – Papaioannou (2005) 155:165.

[16] The technical characteristics of Kivotos are: 4 Barco 808 CRT projectors SGI® Onyx2® InfiniteReality2TM with 8 R10000 processors running at 300Mhz and 4 graphics pipelines ReaCTor™ cubic immersive VR display with 4 3x3m. projection surfaces, 1024 x 768 at 96Hz stereo 6DOF electromagnetic position/orientation tracking system Ascension Flock of Birds™, CrystalEyes3™ StereoGraphics® active stereo glasses Interaction devices Wanda™.

[17] Sideris - Roussou - Gaitatzes (2004) 208:216.

environment, represented by means of image based modelling, is very realistic.[18]

We have some experience also with interior space. In Miletus already one can visit the interiors of the Council House and the Gymnasium. Another project is entirely based on interior activity. It happens inside Pheidias' workshop in Olympia, a few days before the famous sculptor accomplished his chef-d'oeuvre, the gold and ivory statue of Zeus, in the mid 5th century BC. The visitor can participate in the final touches on the statue and simultaneously learn about the instruments, the methods and the techniques of work with gold and ivory for monumental statuary in antiquity.[19]

Some more experience with interior space, human figure and archaeological artefacts comes from two smaller projects of educational character. One represents the room of a girl in Athens with many furniture, clothing and jewellery items represented in detail, and the other asks the visitor to be the conservator of five broken ancient Greek vases.[20] All the above proved not enough to answer the challenges of our latest project.
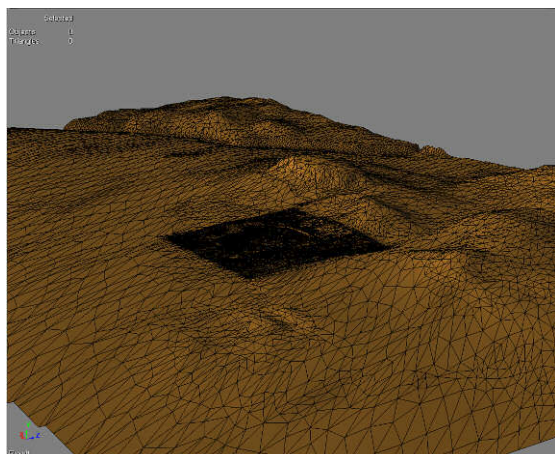

Fig. 3: The Agora area DTM in shaded wire frame.

The time

Starting with the time parameter, for our new project we decided to choose three moments from the long life span of the Athenian Agora, a choice which practically means that we had to produce three models of the site. We situated the first representation in the high Classical era, approximately around 400 BC, in a period when already some important construction work has been accomplished.

Just before the trial of Socrates, and a little after the last "ostracisme" it is a time, when still the democracy happens there, the politics are very important, the religious life not yet altered with foreign influences, and the athletic contests not yet moved out of the Agora.[21]

The second time spot is placed in the mid second century BC, when the city, not any more a political and military power, remains however the venerated centre of Greek culture, especially of philosophy and arts. At that time the Athenian Agora benefited from the generous donations of the Hellenistic rulers and imposing buildings remodelled its face.[22]

The last time spot shows the Agora around the mid second century AD, when it already has lost its administrative and commercial priority by the adjacent new Roman Agora, but in exchange it starts to gain in symbolic value with several new buildings of religious and cultural function (temples, odeon, library, fountain). Its legendary fame is reflected on the visit to the site and the generosity of some Roman Emperors.[23]
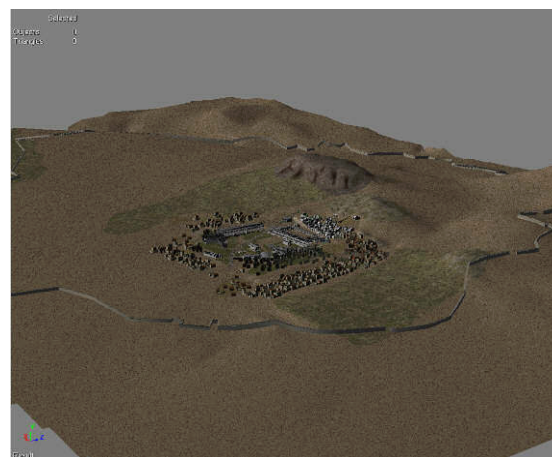

Fig. 4: The Agora area DTM with texture and buildings.

The space

The Ancient Agora of Athens, archaeologically speaking, is a rather well defined area, measuring approximately 50 hectares.[24] This area however changed a lot during the centuries of its life and even more since the end of the antiquity to modern times. The

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[18]   Christopoulos - Gatatzes - Papaioannou (2003) 61:71.
[19]   Sideris – Roussou (2002) 35:36
[20]   Sideris – Roussou (2002) 36:38

[21]   Camp (2004) 85:183, fig. 66.
[22]   Camp (2004) 185:216, fig. 129.
[23]   Camp (2004) 217:255, fig. 153.
[24]   The area reconstructed in the project corresponds roughly with the actual enclosed archaeological site. The area of Eleusinion (out of the enclosed site) will be included in the next phase of our reconstruction.

modern digital terrain model, which initially has been made for the "Society for the Unification of the Archaeological Sites of Athens", has been largely reworked by the FHW GIS department in order to cope with several level changes, occurred due to the erosion of the North Acropolis slope, the human activity and the changes of the bed of the adjacent Eridanus river. In some points the differences between the modern ground level and its historical height attain several meters [**Figs. 3 and 4**].[25]

Along with the Agora changed in time another highlight of the Athenian urban landscape: the buildings and the fortification on the Sacred rock of Acropolis. Most of it either happened before our first time spot or it was invisible from the Agora and it does not affect our model.
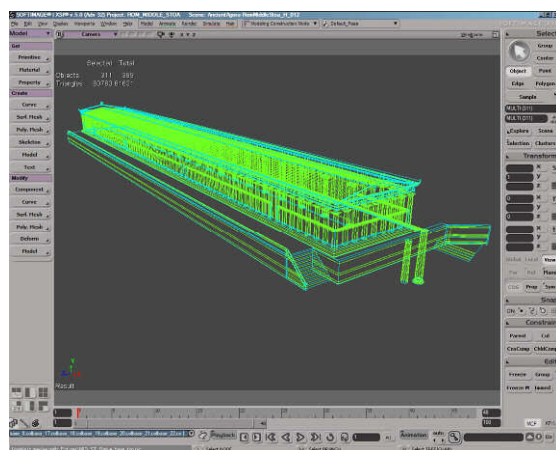

Fig. 5: The Stoa of Attalos wire frame model.

Around the Agora developed the densely populated demes (urban quarters) of Melite and Kollytos. Representing them in detail should be both out of the scope of our project and highly conjectural, since only small parts of them have been excavated. We opted however for a representation of some house blocks, based on sparse archaeological information, in order to avoid a false picture showing the Agora isolated in the midst of a deserted land. As for the vegetation, which in ancient times was more scarce than today, we took advantage of the botanical research, which re-established the variety and the species of plants of Athens in antiquity. The tradition about Kimon planting five hundred plane trees in the mid 5th century BC, is

reflected into somewhat bigger and denser trees in the Hellenistic period model.[26]

The buildings
The Agora was originally an empty space, a square around which developed by the late 6th century BC some administrative and commercial buildings. With the time it took the shape of a roughly rectangular space, bordered by colonnades belonging to various buildings. The empty space was in use for unofficial and official assemblies of the people (among which the ostracism voting), for religious processions and athletic games. By the Roman period an imposing theatre and

Fig. 6: The Stoa of Attalos in real-time VR rendering.

several temples have substantially diminished the free space, which then was forming two separated squares on the North and the South of the Agora.

By choosing to represent three time points of the Agora we had to identify the buildings (and sometimes their use) standing at those particular moments. We also had to define which of the building survived from one period to the next one, with or without changes in their morphology and ground plan, and when necessary the importance of those changes. Of course much of the job had already been accomplished by the scientific publications of the excavations by the American School of Classical Studies in Athens. Nevertheless, one would not believe in which extend may be contradictory the interpretations of various archaeologists, all based upon the same (often tiny) excavational data, and leading of course to dramatically different hypothetical reconstructions [**Figs. 5 and 6**]. The assistance of the current excavator and of the architect of the Agora in resolving in an acceptable way these puzzling questions was inestimable.[27]

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[25]   Our thanks go G. Tsiomis and G. Andreadis, who kindly provided the modern DTM of the Agora area for our project. On the general approach Sidiropoulos – Sideris (2002) 63:68.

[26]   Kent Thompson – Griswold (1963).
[27]   Professor John Camp, director of the Agora Excavation and Dr. Richard Anderson, architect of the Agora Excavation offered to the project their profound knowledge of the site and its history, as well as many original, often

First there have been buildings erected and demolished in the time span between our points of representation. These buildings have not been included in our project. Then some of the earlier buildings underwent major or minor interventions on their ground plan, on their facades or their roof, and continued to be in use during the following periods. For most of them the details of the entablature and the pediment are poorly known, if at all. We used comparative material from similar buildings of the same period for some

Fig. 7: The remains of the Roman Monopteros.

capitals, simas, for the application of colours, for the pedimental sculptures and the acroteria. This practice has been long in use by the archaeologists themselves in graphic representations. When we had two or more hypothetical reconstructions for one building we chose the more widely accepted by the scientific community, but in some cases we constructed both 3D models and tested them on the DTM to judge the overall impression. Minor details, such as windows, doors, roof tiles and ornamental elements are often based only upon our general knowledge of the trends of the relevant period. Last, some buildings have undergone so important modification or even relocation that we decided not to treat them any more as one and the same structure[**Figs. 7 and 8**].[28]

Besides the main buildings an enormous multitude of light structures and objects furnished the space: altars, podia, statues and monuments with their sometimes voluminous bases, enclosures, steps and benches, wells,

open air sanctuaries, votive dedications and commemorative structures, roads and areas for public information display. Much of it didn't survive to us and we represent only these features which appear necessary for the functionality of other structures, or those known only from literary sources but important for the historical context. Modelling so many forms of complicated geometry in 3D for real

Fig. 8: The reconstruction of the Roman Monopteros.

time rendering would not be wise knowing the limited capacities of the available hardware. Thus for most of them we used only 2D representations with position, colour and lightening enhancements.

The action

Despite its difficulties the modelling of the buildings seems only a game beside the real challenge of the project: namely representing in some realistic way four action scenarios, two taking place in the Classical model of the Agora, one in the Hellenistic and one in the Roman. For the Classical period we chose the Panathenaic procession the most important religious and state ceremony taking place every four years. In the procession, which started from Kerameikos, crossed the Agora and continued to the Acropolis, participated all the state officials, priests, riders and warriors, many Athenian citizens and even the foreigners living in Athens and the representatives of the allies of Athens.[29] In the centre of the procession a small boat was carried on wheels, with the mantel destined for the Athena statue on the Acropolis, placed

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unpublished, ideas for the reconstruction. We would like to express our warmest thanks to both.

[28] For example the enclosure of the so called "Heliaia", which later became the Aiakeion with the peristyle court, the South Stoa I and II, the Stoa of Attalos with or without covered staircases to the roof (Travlos vs. Anderson), etc. Camp (2004) passim.

[29] On the Panathenaic procession see Neils (1992).

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instead of sail [**Figs. 9 and 10**]. Here again a combination of iconographical, literary and archaeological sources provided the models. But showing a big crowd in motion, entirely

Fig. 9: The Panathenaic procession boat in wire frame model.

modelled in 3D, even without the limits of RTR is a very difficult task. The simplifying convention however has not affected the need for the detail. The patterns on the clothes are borrowed by the contemporary imagery on the Athenian red figure vases. The jewellery and the artefacts hold by the people (hydriae, incense burners, armours, etc.) are modelled according to real artefacts kept in various museums of the

world. The boat follows the results of experimental ship building according to ancient techniques. We tried the result to be highly convincing even on close view, although such a view will be avoided since it would cause important spherical distortion of the image in the display surface of the dom.

The other three scenarios, still under development, are similarly treated. The remaining Classical scenario will show some of the contests of the Panathenaic games, the Hellenistic one will present the subscription of people willing to participate in the Eleusinian Mysteries and the Roman one will enact the visit of the Emperor Hadrian in the Agora.[30] Four exceptional moments in the history of Athens, four representative moments of the role, which the Agora played in its history.

Furthermore another live scenario combines the presence of real actors on the stage with the virtual environment. All of the above

scenarios involve in some point the active participation of the public by intermediation of an animator. For the time being (January 2007) the only such activity is the voting in a
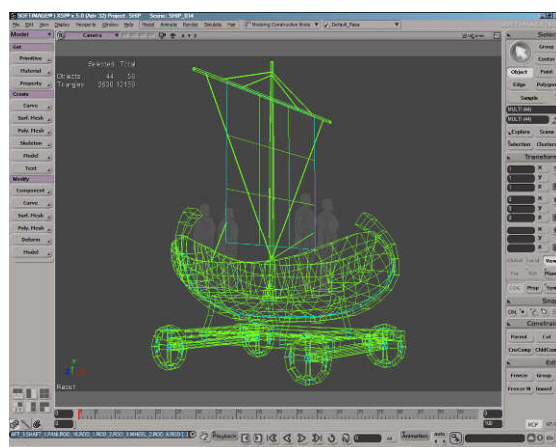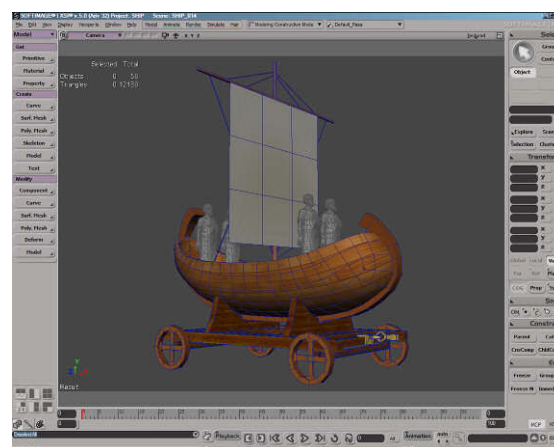
simulation of the ostracism of 416 BC, where the result of the public's vote is compared with the historical outcome of the ostracisme [**Fig. 11**].[31]

Fig. 10: The Panathenaic procession boat with some texture.

Fig. 11: The Ostracism voting scene of the show.

Future development

The project, although running already in the Tholos theatre of the FHW, is still under implementation. In the next phase

the area of the Eleusinion (SE of the currently developed area) with its buildings, the street which led from the Ancient to the Roman Agora of Athens, as well as the Roman Agora itself will be included into the show. In addition to the aforementioned action scenarios, some more educational scenarios will be elaborated for the younger public, inspired by the rich and

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[30]   On Eleusinian festivities Mylonas (1963), on Roman imperial building policy Schmaltz (1995) and Boatright (1983).

[31]   On the ostraka and the ostracism Lang (1990).

multifaceted historical and cultural context of the Agora.

The virtual "cradle of democracy" remains as much inspiring as its real prototype and prompts us to a discussion on the educational and artistic potential of the VR. Discussing on the aims of our actions, on our needs, and on the technical and financial means to reach them is exactly reviving the function and the spirit of the Ancient Agora of Athens.

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