Legend and virtual reconstruction:
Porsenna's mausoleum in X3D

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Abstract. What remains of the funerary mausoleum of Porsenna, the legendary Etruscan king of Clusium, is only a passage in Plinius, reporting a detailed description of this impressive monument. Notwithstanding the absence of any archaeological evidence, for centuries architects, antiquarians, historians and archaeologists have attempted to draw a reasonable reconstruction of the monument, quoted as one of the wonders of past architecture. So the creation of a 3D model of the mausoleum, translating into images the literary description, appears as a perfect "laboratory" to test a number of rules, practices and tools that the authors claim to be indispensable for a correct use of virtual reality models in archaeology and a philological approach to virtual archaeology. On the contrary, they stress that the increasing use of VR for archaeological reconstruction is rarely accompanied by the necessary care for philology, reliability and in some cases even historical consistency.

1 Virtual Reality and Archaeological Reconstruction: Use and Misuse

Since Archaeology is the study of history of mankind based on the material traces they left in their environment, the idea of reconstructing is connatural to it: archaeologists create in their mind, and then communicate, explanations of the past that in many cases have a spatial dimension: not only what happened and how it happened, but also which shape had objects, buildings as temples and dwellings and urban agglomerate, as small as a Bronze age village or as great as Imperial Rome. This is far from the popular concept of archaeologists as fascinating treasure hunters, diffused by adventure movies or video-games: no Indiana Jones nor Lara Croft, but "partly the discovery of the treasures of the past, partly the meticulous work of the scientific analyst, partly the exercise of the creative imagination" (Renfrew and Bahn, 1996:11). A direct consequence of this definition is the necessity for archaeologists of figuring out lost forms by drawing them, to explain them to themselves, to the scientific community or to the public. Thus reconstructing has been a common exercise since the very beginning of modern archaeology, and even before, as we shall show below in an example.

From another perspective, archaeology has always had the capacity of availing of state-of-the-art technology as soon as it becomes available, in a much faster way than other human disciplines as History or Philology. From photography, early introduced to document excavations, to X-ray exam of the finds, to radiocarbon dating, to modern computing, technological innovation has always been promptly accepted and revisited from an archaeological point of view, examining the impact of the new possibilities allowed by the new technology on archaeological practice and the constraint to set on its use to comply with the fundaments of the archaeological methodology.

This short excursus should explain why 3D computer reconstruction should occupy nowadays an important place in archaeological scientific practice, as envisaged by Reilly's seminal paper (Reilly 1991); but, as it happens with most sound theoretic arguments, it proves something that does not correspond to reality. The current use of virtual reality in archaeology is often limited to didactic explanation and popularisation and is considered by most archaeologists as a contamination: the same scholars that would accept and even suggest the presence of a maquette in a museum, raise an eyebrow when they are shown a 3D computer reconstruction.

The world of virtual reality applications in archaeology has been indeed (with some notable exceptions) the realm of software engineers wishing to test the computing power of their machines on some astonishing case study, to stuck the imagination of potential customers with unfamiliar applications. It mattered little if these supposed worlds had little to do with past reality.

But even in models without such flaws, the quest for photo-realism and the billions of polygons that software can process in a fraction of second give the visitor the sensation of absolute and unquestionable validity: in current 3D models, with few exceptions, there is no room for disclaimers as "probably", "as far as we know" and so on: thus a virtual reconstruction may be more deceptive than explanatory. This consideration in no way means that good models have to be ugly, but simply that viewers have to be aware of the fact that they are not looking at a photo or movie or the past, an exact replica of reality, but only to a representation of what scholars consider a reasonable interpretation of remaining evidence, with a variable degree of reliability.

So what is lacking in current 3D archaeological reconstructions is a philological approach, as noted in (Frischer, Niccolucci, Ryan and Barcelo 2002): there does not exist a conventional and intuitive code that allows to distinguish what remains from what is reasonably inferred and what is simply guessed. Possibly, this code should allow different degrees of representation, according to the intended audience: from the scholarly possibility of footnotes (in this case, foot-hyper-notes) and cross-references (in this case cross-hyper-references), to the simple trick of using different rendering in models aimed at a vast audience to express different reliability, a code as intuitive as the usual habit of refitting the pieces of coloured broken vases substituting the missing parts with plain clay, in order to give an idea of the whole and differentiate refit from integration.

There has been an increasing protest against this misuse of technology, carried on by computer experts working with

archaeologists and computer-receptive archaeologists (both categories being represented by the authors of this paper), eventually leading to the foundation of an association as CVRO (Cultural Virtual Reality Organization, but also the Latin world for "I care", of archaeological requirements of course), which proposes to develop and establish standards and best practices for such a philological correctness in archaeological computer reconstruction.

Although (Ross 1996) already enounced some of the above summarized principles other authors have also contributed to the debate (Miller and Richards 1995; Ryan 1996; Roberts and Ryan 1997; Goodrick and Gillings 2000) eventually leading to consider the concept of "Augmented Reality" or "Enhanced Reality" (Barcelo 2001) as closer to archaeological purposes. Many of the more recent contributions may be found in (Barcelo, Forte and Saunders 2000) and (Niccolucci 2002).

However, the magic of technology *per se* still fascinates some archaeologist, producing useless reconstructions of Stonehenge and Pompeii or proclaiming the power of some pretended new technology, with the naive enthusiasm of the amateur scientist. On the other side, the fascination of the Past (and maybe some commercial interest, too) inspires lots of engineers to produce new models with no attention to archaeological principles.

To conclude this review of the archaeological use of virtual reality, there are few more considerations that call for our attention. Present 3D modelling often requires powerful software, which keeps archaeologists away and increase their feeling alien to what is perceived by them as mere computer processing. Archaeological concepts and results dissolve in the fog of computer code.

Therefore, only a handful of high technology virtual reality labs has as yet succeeded in creating integrated teams and in achieving real co-operation: among others, we may quote the Archave project at Brown University (http://www.lems.brown.edu/~vote/; see also Vote *et al.* 2002), UCLA Cultural Virtual Reality Lab (http://www.cvrlab.org; see also Frischer et al 2000) in the US; the Foundation for Hellenic World (http://www.fhw.gr; see also Roussou 2002) and the CINECA VIS.I.T. Theatre (http://www.cineca.it/HPSystems/Vis.I.T/VirtualTheatre/ see also Guidazzoli 2002) in Europe for having archaeology has a central theme of their research. The same feature is present in the recent work by the virtual lab created by remote cooperation between the University of Tübingen and the software house Art+Com to produce the "Virtual Troy" reconstruction (Jablonka, Kirchner and Serangeli this volume).

A second unsatisfactory feature of present 3D models is the lack of integration with other data: modern archaeology manages a huge amount of data, since every information is recorded and managed by efficient database systems. There is little utility, however, in being able to rotate a colourful virtual model of an amphora if one must open another window to access data on that item: 3D models do not integrate in databases (but see Clark *et al.* 2002 for a remarkable example of customized solution to this problem) and fit in them only as a blob.

An even more frustrating feature is the general difficulty to merge different virtual models, due to different software and/or their complication, possibly related to the bad habit of programmers (and format creators) of mixing data with processing directives to improve performance.

Another aspect is related to the complicate procedure required to create a VR model: have an idea; say it to the modeler; have them create the model; process the result; play with the VR model; change the original idea… The complexity of each step of this process in practice makes feedback impracticable and prevents archaeologists to use virtual reality as a creative tool: pencil and paper are still the most effective tools to exert "creative imagination", which is, as quoted before, one of the components of archaeological research.

2 Virtual Archaeology and X3D: Great Expectations.

From the considerations summarily sketched above, it results that there are some basic needs that virtual archaeology asks to computer 3D graphics and virtual reality tools:

- allow philology, e.g. variants, reliability and other attributes of each item, and possibly make them visible somehow
- be transparent and avoid the "code fog" effect
- allow easy modification
- allow the creation of "archaeological libraries" where pre-prepared standard components can be stored and re-used
- be integrable with other, similar models
- be integrable with other – mainly alphanumeric - archives
- have a simple graphical editor and viewer.

Tools with such requisites may be eligible for being the starting point to develop a virtual archaeology, detailing codes of practice to create correct reconstructions as well as building repositories of archaeological current virtual material, from marble textures to standard amphora shapes.

So, this is why X3D looks so promising:

- using element attributes, it may allow for philology
- it can be read directly, as any XML-compliant language; if desired, the archaeologist can see what is going on behind the scene and convince that there is no black magic
- data can be accessed directly, and modified by means of ordinarily available tools
- modularity and componentization allow to create libraries of anything whatever, in particular of archaeologically relevant items
- integration of different models is easily obtained just merging their description
- different XML documents not only may be integrated in the same database if needed, but can even be searched! So, querying a database of 3D models of finds for "heart-shaped decoration of enamel", having defined appropriate components, is no more a dream, but a concrete possibility. In the same way, a digital caliper is at hand to measure what seems more appropriate, without depending on decisions taken once for all at design time.

There is still some way to go and what is more needed is something to create, transform and manipulate easily and intuitively 3D objects. Some steps on this way, as far as

archaeological applications are concerned, are a paper at the Virtual Reality Session of the CAA2001 Conference (Cantone 2001), the interest of the audience for a lecture by the authors at EAA2001 (Cantone and Niccolucci 2001), and the paper by one of the most authoritative scholars in the field (Ryan 2001). At present, however, drawbacks still prevent a diffuse use of X3D. They concern visualization of X3D models (no software is still available and VRML conversion is still required) and performance. Both are engineering problems, hopefully to be solved soon with appropriate software technology. There is, finally, a tendency to re-introduce hard-coding of spatial features into 3D models, perhaps aimed at solving performance issues. Also the theoretical considerations expressed in Vatanen 2002 (this volume) on the different intrinsic nature of spatial models and textual annotations show that more research is required to reach a satisfactory solution, but do not exclude that this may be X3D-based.

3 Archaeological X3D: an Experiment

As previously stated, good arguments often result in logical conclusions that have no real counterpart. So we did not content ourselves with logic, but wanted to test it the hard way. For this we chose a case-study that seemed to be created purposely, that is Porsenna's mausoleum.

Roman historians tell that Porsenna, king of the Etruscan state-city of Clusium (the modern Chiusi), besieged and occupied Rome in the early beginning of its republican history; he is told to have been stuck by several valorous deeds (notably those by Horatius Coclites, Mutius Scaevola and Claelia) that convinced him of the strength and love for liberty of the Roman people, so he withdraw and returned to his home town.

Modern historians are prone to think that the Roman version is patriotically romanced to exalt the origins of their republic, even if there was some real Etruscan king (possibly the one named Mastarna from Clusium) who occupied Rome for some time. Exalting the value and importance of this admirer of early Roman virtues is thus also an expedient to exalt those virtues. Consequently all the reported deeds of Porsenna (also named Porsina) may be part of this legend, and there is no evidence that the part that concerns us, Porsenna's mausoleum, refers to a real building.

The relevant part of Porsenna's legend is stated in the following passage by Pliny the Elder (Nat. Hist XXXVI, 91-93), where the author discusses notable buildings of the past:

Namque et Italicum dici convenit quem fecit sibi Porsina rex Etruriae sepulcri causa, simul ut externorum regum vanitas quoque Italia superetur. Sed cum excedat omnia fabulositas, utemur ipsius M. Varronis in expositione eius verbis: "sepultus sub urbe Clusio, in quo loco monimentum reliquit lapide quadrato quadratum, singula latera pedum tricenum, alta quinquagenum. In qua basi quadrata intus labyrinthum inextricabile; quo si quis introierit sine glomere lini exitum invenire nequeat.

Supra id quadratum pyramides stant quinque, quattuor in angulis et in medio una, imae latae pedu quinum septuagenum, altae centenum quinquagenum; ita fastigatae ut in summo orbis aeneus et petasus unus omnibus sit impositus, ex quo pendeant exapta catenis tintinnabula, quae vento agitata longe sonitu referant, ut Dodonae olim factum.

Supra quem orbem quattuor pyramides insuper singulae stant alta pedum centenum. Supra quas uno solo quinqe pyramides", quarum altitudinem Varronem puduit adicere; fabulae Etruscae tradunt eandem fuisse quam totius operis ad eas. Vesana dementia quaesisse gloriam impendio nulli profuturo, praeterea fatigasse regni vires, ut tamen laus maior artificis esset.

Here is the English translation:

It is now necessary to deal with the Italic one, that Porsenna, king of Etruria, built as a sepulchre, and also in order that the vanity of foreign kings be overcome by Italy. But since in this case the fabulous is beyond any limit, let us use the words by M. Varro himself in his description "He was buried under the town of Clusium, where he had built a square monument with square stones, every side measuring three hundred feet and five hundred in height. In this square base there is an inextricable labyrinth, in which if anybody enters without a clew of flax yarn he will not be able to find the exit.

Over that square base, there are five pyramids, four in the corners and one in the centre, each one seventy-five feet wide and one hundred and fifty feet high; they narrow in such a way that on top there is a bronze disk and one petasus, from which some bells hang by means of chains. These, moved by the wind, issue a sound that can be heard from far away, as it happened in Dodona.

On this disk there are four more pyramids, one hundred feet high, and above another platform and five more pyramids" whose height Varro is ashamed of reporting. Etruscan legends tell that it was the same as the building up to them. It is foolish madness to search glory with an expense of which no one will profit and moreover weakening the strength of the reign, so that the greatest praise would be only for the architect.

To make the quotation clearer, we remind that the *petasus* was an ancient Greek hat with a low crown and broad rim, especially the one worn by Hermes, similar to the helmets worn by English soldiers in the World War, and that a Roman foot (*pes*) was 29.57 cm (Dilke 1987: 26). So approximately the basement of the monument was a parallelepiped with a square base of 90 x 90 metres and 15 metres high. The first order pyramids had a base side measuring 22.5 metres and a height of 45 metres, while the second order ones were 30 metres high. The top ones were reported to be more than 90 metres high, since there is no information on the thickness of the bronze disk. The overall height of the entire monument so reached about 190 metres, one half of the Empire State Building!

It must be added that there remains absolutely no archaeological evidence of the above: only a labyrinth still exists under the modern city of Chiusi, but its extension is much wider than the reported one and it is dug directly in the hill, so that it is uncertain if the quoted labyrinth and the real one may be identified as the same. So the question of where the monument was placed and which shape and size it had is still open; it cannot be even stated with sufficient certainty that it ever existed.

4 Past Reconstructions of Porsenna's Mausoleum

Several scholars attempted to place the monument in the surroundings of Chiusi, but nobody in a conclusive way

(Vasori 1979; De Luynes 1829; Inghirami 1846; Messerschmidt 1942; Myres 1951).

The latest attempt appeared in a recent book (Gaugler *et al.* 2002) where the authors discuss different hypotheses and conclude choosing a hill near Chiusi. This location does not contradict Pliny's description, in the authors' interpretation, and the soil presents a concentration of some chemical substances that proves, in the authors' opinion, the ancient existence of a large mass of bronze. Unfortunately the top of the hill was removed years ago for building purposes so no direct archaeological evidence can be searched. So this book is an extended review of the archaeological debate about Porsenna and his funerary monument and it introduces chemical and archaeometric methods in the quest for its location and shape.

In the past there has been many attempts at drawing a reconstruction of Porsenna's mausoleum. The first ones date to the 16th century, and the modern ones began to be discussed at the end of the 18th. Comparisons have been made with other similar, but smaller, constructions and to iconographic evidence of similar buildings. The overall height of the monument has been argued as impossible to reach for static reasons, but such a precise description should refer to something real, even if possibly not referred to Porsenna and not placed in Clusium: for more information see the above papers and two popularizing books published on the matter (Fabrizi 1987 and Fabrizi 2001), or Gaugler's book.

It must be added that Porsenna is a popular character in the area of Chiusi (the main road of the town is maned after him) and the position and shape of his monument are the subject of discussion and interpretation debated at a local level by newspapers (for instance the article appeared on the local newspaper *La Nazione* concerning a new hypothesis on the Mausoleum). The popularity of the question is shown also by a comics story on the Italian edition of Mickey Mouse in which appears a reconstruction of Porsenna's Mausoleum.

This example appears as a perfect lab to use X3D for several reasons. First of all, interpreting Plinius' passage is much easier if one can sketch the shape of the mausoleum. Second, the monument is described in terms of "building blocks" as the square base, the pyramids and the bronze disk, that can be created as modules and repeated as necessary. Third, modifying dimensions and above all playing with height, the apparently most inconsistent parameter, can give better insight into the shape that Plinius had in mind. Fourth, investigation concerns only the overall shape as it may be based only on a general description as the above one, so photo-realism is fortunately out of question. Fifth, the representation of materials is rather simple: bronze and "stone". The latter may be assumed to be a yellow limestone widely used in the region, so a yellow texture represents faithfully enough the presumable appearance of the building.

On such assumptions the creation of an X3D model is straightforward. It is based on a few modules (the pyramid, in all the variants described by Pliny, the parallelepiped base, the disk and the petasus and the bell) repeated and varied as necessary. Even if complete interaction with the user cannot be obtained, changing one model into another is a quick matter and requires only few minutes. Being made by the same blocks, the comparison between different models is easier and

they can be examined one by the other regarding all of them from different point of views.
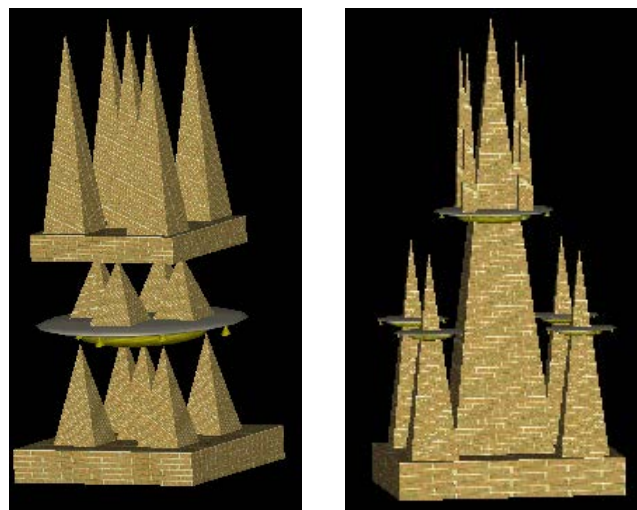
Fig. 1*. Two alternative X3D reconstructions of Porsenna's Mausoleum.*

The XML coding of the model is a very easy to understand, but for space reasons cannot be included here. It is available, however, at the web site

http://www.vast-lab.it/prisma/porsenna

together with the virtual models.

5 Conclusions

The experiment had a satisfactory outcome, since it was possible to test all the work hypotheses and X3D proved to be up to the expectations. In particular it allowed a quick representation of the different models and thus might have helped an archaeologist trying to examine alternate hypotheses for the mausoleum shape and appearance.

Further work may include model post-processing based on volumes and density of building material to allow examining the model from the point of view of physics and statics. Some engineering considerations developed in the appendix of (Gaugler *et al.* 2002) might be included in such an enlarged model to allow interactivity and add this perspective to archaeological investigation.

So, in the end, Pliny's judgement on this construction as being "*impendio nulli profuturo* (an expense of which no one will profit)" turned out to be pessimistic, since somebody – the authors of this paper at least and hopefully those working on Virtual Archaeology – now benefits of the existence of the mausoleum, even if in a way far different from Porsenna's original intent.

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References

BARCELÓ, J. A., 2001. Virtual Reality for Archaeological Explanation. Beyond "picturesque" reconstruction". *Archeologia e Calcolatori* 12.

BARCELÓ, J. A., FORTE, M. and SANDERS, D.H., 2000 (eds). *Virtual Reality in Archaeology*, Oxford: Archaeopress BAR International Series 843.

CANTONE, F., 2002. 3D Standards for Scientific Communication. In *Archaeological Informatics: Pushing the envelope CAA2001 Proceedings of the 29th Conference,* Gotland, April 2001, Oxford Archaeopress, BAR International Series 1016.

CANTONE, F. and NICCOLUCCI, F., 2001. New Tools for Virtual Archaeology. Paper presented at the 7th annual meeting of EAA, Esslingen, 19-23 September 2001.

CLARK, J. T., BERGSTROM, A, LANDRUM, J. E. III, LARSON, F. and SLATOR, B., 2002. Digital Archive Network for Anthropology (DANA): Three-Dimensional Modeling and Database Development for Internet Access, in NICCOLUCCI 2002.

DE LUYNES, D., 1829. Sur la restitution du tombeau de Porsenna., *Ann. Inst.* 1.

DILKE, O.A.W., 1987. *Mathematics and Measurement* London: British Museum Press.

FABRIZI, F., 1987. *Chiusi, il labirinto di Porsenna, leggenda e realtà*, Cortona: Calosci.

FABRIZI, F., 2001. *Il labirinto di Chiusi. Storia - scavi - esplorazioni*, Cortona: Calosci.

FRISCHER, B., ABERNATHY, D, FAVRO, D., LIVERANI, P. and DE BLAUUW, S. Virtual Reality and ancient Rome: the UCLA cultural VR Lab's Santa Maria Maggiore Project in Barcelo *et al.* 2000.

FRISCHER, B., NICCOLUCCI, F., RYAN, N. S. and BARCELÓ, J. A., 2002. From CVR to CVRO: the Past, Present and Future of Cultural Virtual Reality in Niccolucci 2002.

GAUGLER W. M., et al, 2002. *The tomb of Lars Porsenna at Clusium and its religious and political implications* – appendices with technical data by W. J. Venuti and P. A. J. Englert. Bangor: Laureate Press.

GOODRICK G. and GILLINGS, M., 2000. Construct, simulations and hyperreal worlds: the role of Virtual Reality (VR) in archaeological research. In G. Lock and K. Brown (eds.) *On the Theory and Practice of Archaeological Computing*, Oxford University Committee for Archaeology monograph 51. Oxford: Oxbow Books.

GUIDAZZOLI, A., 2002. Experiences of immersive graphics for Cultural Heritage,. in Niccolucci 2002.

HIGGINS, T., MAIN, P. and LANG, J., 1996 (eds.). *Imaging the Past: Electronic Imaging and Computer Graphics in Museums and Archaeology*, London: British Museum Press (British Museum occasional paper 144).

INGHIRAMI, F., 1832. Di alcuni toli sepolcrali,. *Ann. Inst.* 4.

JABLONKA, P., KIRCHNER, S. and SERANGELI, J. *TroiaVR: A Virtual Reality Model of Troy and the Troad*, this volume.

MESSERSCHMIDT, F., 1942., Das Grabmal des Porsenna, *Das neue Bild der Antike* 2.

MILLER, P. and RICHARDS J., 1995. The good, the bad and the downright misleading: archaeological adoption of computer visualization. In Hugget, J. and Ryan, N., *CAA94 Proceedings of the 22nd CAA conference,* Glasgow, 1994, Oxford: Tempus Reparatum BAR International Series 600).

MYRES, J., 1951. The Tomb of Porsena at Clusium, In BSA 46.

NICCOLUCCI, F., 2002 (ed.). *Virtual Archaeology*. Oxford: Archaeopress BAR International Series 1575.

NICCOLUCCI, F. et al, 2002. The PRISMA project: an Integrated Network for Local Archaeological Museums, this volume..

REILLY, P., 1991. Towards a Virtual Archaeology. In K. Lockyear and S. Rahtz, (eds.) *CAA90, Proceedings of the 18th conference,* Southampton, UK, March, 1990, Oxford: Tempvs Reparatvm BAR International Series 565.

RENFREW, C. and BAHN, C., 1991. *Archaeology. Theories, Methods and Practice* London: Thames and Hudson.

ROBERTS, J. C. and RYAN, N. S., 1997. Alternative Archaeological Representations within Virtual Worlds, Available at: www.cs.ukc.ac.uk/people/staff/nsr/arch/vrsig97/vrsig.html

ROSS, S., 1996. Archaeology's new language: Multimedia. In Higgins, Main and Lang 1996.

ROUSSOU, M., 2002. Virtual Heritage: from the research lab to the broad public. In Niccolucci 2002.

RYAN, N. S., 1996. Computer based visualisation of the past: technical 'realism' and historical credibility. In Higgins, Main and Lang 1996.

RYAN, N. S., 2001. Documenting and Validating Virtual Archaeology. *Archeologia e Calcolatori* 12

VASORI, O., 1979. Disegni d'antichità etrusche agli Uffizi., *St. Etr.* 47.

VATANEN, I., 2002. Deconstructing the reconstructed – issues in conceptualising the annotation of virtual realities, this volume

VOTE, E., ACEVEDO, D., LAIDLAW, D. and JOUKOWSKY, M. 2002. What is Virtual reality good for? The ARCHAVE system: problems and possibilities, in Niccolucci 2002.

Topolino e la leggenda di Re Porsenna, text and drawings by P. Gorlero, *TOPOLINO* (Italian edition of the Mickey Mouse Journal) n. 1764, 17/9/1989.

Porsenna e l'enigma del mausoleo, *La Nazione*, 14/4/1996.