DE GRUYTER OPEN

MUZEUM 55 / 2 / 2017 / s. 27–35

DOI: 10.1515/mmvp-2017-0043

Paperless Archaeology on Castrum Novum

Klára Paclíková, Michal Preusz

archeologie

Paperless Archaeology on Castrum Novum

Abstract: ***Modern technology affects the development of the humanities, including the most traditional of the disciplines such as classical archaeology. We are looking for an answer to the question of whether high-tech could completely replace the basic tools without which we would not even imagine archaeology. Could pencil and paper completely disappear from the trench? We tested the principles regarding paperless archaeology on the exemplary research of the deserted Castrum Novum Roman Colony located in central Italy. The colony was founded in the 3rd century BC and disappeared in the 5th century AD. The discovery of the city occurred in the 18th century when the Pope decided to support the first excavations. Especially unique findings of sculptures became a feature of the Vatican Museums. After that the city was again forgotten. Only in the second half of the 20th century, have we managed to re-locate Castrum Novum. This resulted in the need for modern systematic archaeological research. Currently an extraordinary collaboration is bringing interesting discoveries and new perspectives for the Italian, the French and the Czech archaeologists.***

Keywords: ***Paperless archaeology, classical archaeology, Castrum Novum, Roman Colony, Santa Marinella***

Introduction

Archaeologists commonly use relational databases, laptops, digital photography and 3D-modelling techniques, etc. The term "paperless archaeology" expresses archaeological field workflow that connects these tools to mobile tablet computers to produce clear, comprehensive and long-term accessible documentation.[1] It was born from a need for efficient digital data management that corresponds to the "need-for-speed" required by different factors. Some of them could be institutional pressures in combination with the increasing impact of development, salvage archaeology, permit limitations and political instability in archaeologically significant regions. One pioneer of Paperless Archaeology is the American archaeologist Steve J.R. Ellis. He started to practice it during his research in Pompeii in Italy in 2010.[2] Another systematic research that implements tablet computers in its documentation is Davidson College's Athienou Archaeological Project, which has been excavating on Cyprus since 1990.[3] These researchers have long-term experience with the application of modern, especially mobile, technologies to archaeological documentation and they offer good examples of the utilisation of paperless methodology. From a methodological point of view, important publications emanate from Maurizio Forte and Thomas Levy. These entities responded to the recent intensification of the use of digital methods in archaeological research by introducing the concept of "cyber archaeology".[4] They defined four interrelated components of process: i.e. acquisition, curation, analysis and dissemination. More recently, Christopher Roosevelt and his team operating at the Kaymakçı Archaeological Project suggested the integration of additional new digital tools. This team itself developed an innovative system of a paperless workflow that improves the quality of the recording and the interactions between the excavator and the material culture.[5]

1 *AVERETT, Erin. W., GORDON, Jody M., COUNTS, Derek, B. et al. Mobilizing the Past for a Digital Future: The Potential of Digital Archaeology. Grand Forks, 2016.*
2 *ELLIS, Steve J. R. Are We Ready for New (Digital) Ways to Record Archaeological Fieldwork? A Case Study from Pompeii. In: AVERETT, Erin. W., GORDON, Jody M., COUNTS, Derek. B. eds. Mobilizing the Past for a Digital Future: The Potential of Digital Archaeology. Grand Forks 2016, pp. 51–75.*
3 *TOUMAZOU, Michael K., KARDULIAS, Nick P. and COUNTS, Derek B. Crossroads and Boundaries: The Archaeology of Past and Present in the Malloura Valley, Cyprus. Boston 2011.*
4 *FORTE, Maurizio: Introduction to Cyber-Archaeology. In: FORTE, Maurizio et al. Cyber-Archaeology. Oxford: British Archaeological Reports International Series 2177, 2010, pp. 9–14; LEVY, Thomas E. From the Guest Editor. Near Eastern Archaeology, September 2014, vol. 77, no. 3, pp. 187–191.*

Dott.ssa Klára Paclíková
Faculty of Philosophy and Arts University of West Bohemia in Pilsen - Department of Archaeology
klara.paclikova@gmail.com

Mgr. et Mgr. Michal Preusz, Ph.D.
Faculty of Philosophy and Arts University of West Bohemia in Pilsen - Department of Archaeology
preusz@kar.zcu.cz

Paperless Archaeology in regard to Castrum Novum

The Castrum Novum archaeological site is located 64.4 km from Via Aurelia in the municipality of Santa Marinella, in central Italy (**Fig. 1**). This Roman colony was founded in the 3rd century BC at the location that was the original Etruscan settlement. The reasons for and the exact period of its abandonment are so far unknown. The available archaeological evidence confirms that the settlement disappeared during the 5th century AD.[6] The site became the object of archaeological research during the second half of the eighteenth century. Pope Pius VI financed the research of valuable artefacts that were intended to increase the collections of the Vatican Museums. Some of them have comprised a part of the collections up till now. After various stages of rescue excavations that alternated with the activities of illegal treasure hunters during the last century, systematic research returned to this site in 2010. Currently research is being conducted by Flavio Enei from Museo del mare e della navigazione antica. It involves researchers from Italy, France, the Czech Republic and also university students and volunteers, especially the Gruppo Archaeologico del territorio Cerite. The systematic work results are published each year not only in scientific articles, but also in the journal "Castrum Novum. Storia ed Archaeologia di una colonia romana nel territorio di Santa Marinella".

In September 2015 the methods of paperless archaeology were tested. This case study describes the advantages and the disadvantages of the usage of the iPad combined with other applications during the archaeological research directly in the field.

The methodology of the examination

The research was conducted in zone D / sectors I, II and III and in zone B (**Fig. 2**).[7]

The method was tested in the field (in zone D, sector II; zone B) and in the museum laboratory and at the base camp. Regularly team members circulated between the workplaces. All the team members worked together at the base camp. The team that was involved in the testing consisted of students, researchers and volunteers. The age representation can be

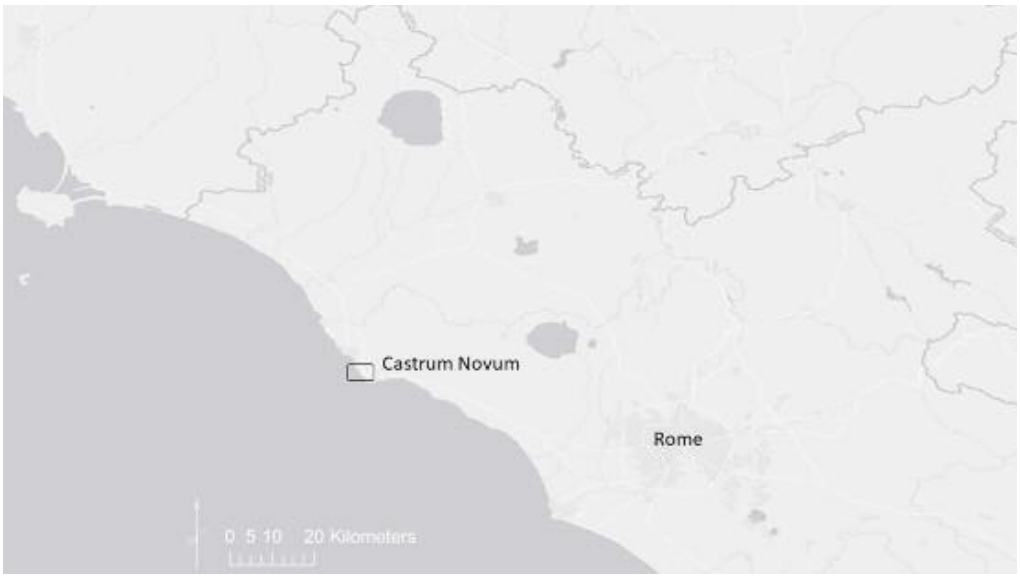

Fig. 1: The location of the Castrum Novum Site in Lazio, Italy. Author: Klára Paclíková; Esri data source, HERE.

5 *ROOSEVELT, Christopher H. et al. Excavation is Destruction Digitization: Advances in Archaeological Practice. Journal of Field Archaeology, 2015, vol. 40, n. p. 325–346.*
6 *ENEI, Flavio et al. Castrum Novum. Storia e archeologia di una colonia romana nel teritorio di Santa Marinella. Quaderno 1. Santa Marinella, 2011.*
7 *ENEI, Flavio, at al. Castrum Novum (Santa Marinella, prov. de Rome) [online]. Chronique des activités archéologiques de l'École française de Rome [En ligne], Italie centrale, mis en ligne le 24 juin 2015, consulté le 24 novembre, November 2016 [visited 11/07/2017]. Available online: http://cefr.revues.org/1364.*

divided into three groups: 20-25 years old (4 persons), 25-30 (3 persons) and over 50 years of age (3 persons). Every participating member had previous experience with different brands of smartphones and tablets. Basic familiarisation with chosen equipment preceded the testing.

The field workers worked with one iPad Air Wi-Fi 16G, one Jot Pro stylus and a 3G-modem Wi-Fi ONDA PN51T using TIM, the local operator's connection. The Mediacom M-PBS78L power bank was utilised as an energy source. The standard applications for the iPad did not correspond to the needs of the research. We therefore added the following applications: the File Maker Go client for the File Maker database. This is one of the relation database solutions that is available on the market. Sara Nardi Combeccure, the leader of the French team, created the database sheets for iDraw graphic application which, together with the Pages, were used for drawing the archaeological situation. iDraw is a graphic application for creating vector graphics and for working with vectors, which lead through the locations that are referred to as the control points or the nodes. Each of these points has a definite position on the x- and the

Fig. 2: A planimetry of the site. Author: Flavio Enei. In 2015 this research was conducted in zones D and B.

y-axes of the work-plane and thereby determines the direction of the path. Every path has various attributes, including such values as stroke colour, shape, curve, thickness and fill.[8] The vectors graphics, contrary to the bitmaps graphics, enable exporting images in different resolutions or qualities. The Pages programme functions as a word processor for the creating of documents. This makes it possible to write texts and also to add images and tables. The communication between field sectors and the laboratory was via such applications for on-line communication as Skype. Due to the limited memory of the device it became necessary to use the external cloud storage. We chose Google Disc, which is freely accessible to the users of Gmail and has sufficient capacity for our case study. In the case of larger excavations or long-term activities it would be necessary to choose a more sophisticated storage-place with a larger capacity. Laboratory workers used one notebook with the Microsoft Windows 7 operating system and Microsoft Office 2013 without Internet because of the absence of an available connection. At the base camp, the team worked with the equipment that has been described above and with another notebook also operating with Microsoft Windows 7.

Tab. 1: Tested activities.

Database record	
Used software/hardware:	File Maker
Tested action:	Researched objects were recorded directly at the site in the File Maker client database via File Maker Go. Photographic documentation, the GPS position and the description were added.
Disadvantage:	The price
Advantage:	Immediate registration and the assignment of the identification, an illustrative photo and the GPS localisation facilitate the orientation. Data are ready prepared for the statistics and for other work. There is immediate access available to all the data, with the possibility of the personalisation of the database and also of its interface.
Web and product information:	**https://www.filemaker.com/cz/**

Planimetry creation	
Used software/ hardware:	iDraw, Stylus
Tested action:	The ground-plan of the site was continuously plotted using the Jot Pro stylus and the iDraw graphics programme. This programme offers a choice of backgrounds (e.g. using graph paper) and also enables drawing to scale. The stratigraphy layer corresponds to one layer of the document. The site boundary has been set as the template for all of the individual layers. Once the illustration was completed, we exported it to JPG and uploaded it to the File Maker database.
Disadvantage:	The necessity for prowess in the use of the application.
Advantage:	A uniform style that is independent of handwriting and the rapid export of outputs in a variety of different formats.
Web and product information:	**http://www.indeeo.com/; http://www.adonit.net/jot/pro/**

Drawing of findings	
Used software/ hardware:	iDraw, Stylus
Tested action:	Individual findings were plotted using this programme. Their sketches and photos together with their GPS coordinates have been uploaded to the database.
Disadvantage:	The necessity for prowess in the use of the application.
Advantage:	A uniform style that is independent of handwriting and the rapid export of outputs in a variety of different formats.
Web and product information:	**http://www.indeeo.com/; http://www.adonit.net/jot/pro/**

8 *KAUFMAN, Arie. Rendering, Visualization and Rasterization Hardware. New York, 1993.*

Vectorisation of hand-drawn layouts	
Used software/ hardware:	iDraw, Stylus
Tested action:	In this programme the floor plans and the other drawings were redrawn for being associated with the new digital records.
Disadvantage:	The necessity for prowess in the use of the application.
Advantage:	A uniform style that is independent of handwriting, easy manipulation of data, the rapid creation of outputs and sharing data with colleagues. Easy viewing of all the already existing layouts.
Web and product information:	**http://www.indeeo.com/; http://www.adonit.net/jot/pro/**

Documentary photography	
Used software/ hardware:	iPad camera
Tested action:	Illustrative images of lower quality were taken during the excavation, which helps to document the individual phases of the research findings and their exact position.
Disadvantage:	A low image quality
Advantage:	The immediate assignment of photos to the objects that are included in the database and the quick sharing or connection to the site diary.
Web and product information:	**https://www.apple.com/**

Writing notes	
Used software/ hardware:	Pages; File Maker Go
Tested action:	Notes mapping the excavation process and the actual number of samples, with a description of the archaeological situations, etc. were also recorded during the course of the research.
Disadvantage:	None
Advantage:	Rapid export and sharing
Web and product information:	**http://www.apple.com/mac/pages/; https://www.filemaker.com/cz/**

GPS location	
Used software/ hardware:	GPS
Tested action:	Localisation of objects and artefacts, capturing GPS information on the photos facilitates information sorting.
Disadvantage:	Inaccuracy
Advantage:	Facilitating information sorting
Web and product information:	**https://www.apple.com/**

Communication	
Used software/ hardware:	Skype
Tested action:	Organisation and coordination of the working groups
Disadvantage:	None
Advantage:	Available and free communication between colleagues working at distant sites
Web and product information:	**https://web.skype.com/**

Examined activities

The following table (tab. 1) describes the tested steps of the documentations, tested actions, the software (mobile applications) and the hardware utilised and the conclusions obtained.

The first task involved the digitisation of the documents from previous years of research and making them available online. For this purpose cloud storage was used, thereby enabling browsing through the records and their expansion to include the new state of the research. We access the File Maker database via the File Maker Go client that was interconnected via the File Maker server. With this combination, it was possible to work with the database using both IPad and the computers simultaneously.

All the findings were drawn on the site plan. The overlay of the site was created in a graphics programme that enables working with vectors as has already been said above. iDraw enables the selection of the background, e.g. graph paper, and drawing to scale. iDraw in combination with the passive Jot Pro stylus that does not require batteries enable the worker to feel natural. In this manner the traditional pen, paper and the ruler are replaced. However, the considerable prowess and the worker's experience with the programme are needed to ensure that the drawing is accurate. With the capability of immediately being able to export outputs, data could be categorised continuously in a database or shared with colleagues. The application also enables drawing the sketches directly onto photographs or in downloaded photogrammetric plans, which greatly simplifies both the description and the interpretation of the archaeological situations.

We also took photos that included the GPS coordinates in the metadata before picking out the individual findings. Thanks to georeferencing it is possible to identify and to relocate findings even in the event that the item in question has lost its labelling. At the end of the day, all the data were uploaded to cloud storage and updated.

Evaluation methods

The team members alternated with each task and recorded the evaluation of their performance. For every tested action, 10 ratings from 1 (worst) to 10 (best) were obtained. The sum of the ratings was expressed as a percentage of the level of the user's positive attitude (tab. 2). The second manner of evaluation was a statement of the advantages and the disadvantages of every action tested. Their relative ratio is expressed in fig. 3. The evaluation of the positives and the negatives was provided at the conclusion of the test period during the joint discussion of all the team members.

Discussion

The involvement of electronic devices in documenting concurrently with traditional tools were tested. The biggest obstacle was represented by the acquisition of skills with the device, although all of the members of the team had previous experience with smart devices. For example, the first task – i.e. drawing – lasted considerably longer than it would to experienced archaeologists using paper and pencil. After gaining the necessary skills, the times shortened. Archaeologists who were using traditional drawing had to invest more time in digitising the drawings for the research report and their publication. They found this additional time useful for reflection and interpretation of the not-so-clear archaeological situations. The members of the team rated the "Creation of planimetry" and the "Drawing of findings" under 70% from the maximum of 100%. It was significantly more easy to vectorise the sketches from the previous seasons (100%). The possibility to add notes to the photos of the situations that are being currently examined helped us in regard to the overall interpretation, which was confirmed by the 100% rating that was received. Photographs taken by iPad had limited quality. For this reasons the rating is 88%. Testing was carried out in a location in which there was no problem with the Internet connection, as is evidenced by the 100% rating of the communication. The GPS location was specifically precise only in the cases of large open spaces and there were errors made during surveying on a small scale. For this reason it received a minimal rating (40%).

Tab. 2: The percentage expression of the level of the user's positive attitude to the application of modern tools to the actions tested.

Tested action	Final rating
Database record	100 %
Planimetry creation	63 %
Drawing of findings	69 %
Vectorization of hand-drawn layouts	95 %
Documentary photography	88 %
Writing notes	100 %
GPS location	40 %
Communication	100 %

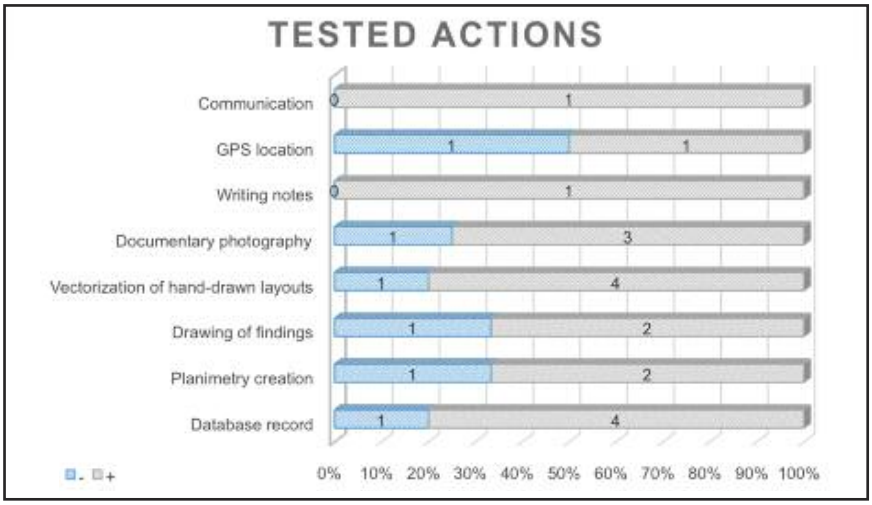

Fig. 3: The percentage expression of both the negative and the positive impact of the application of IPad in regard to archaeological documentation; single steps.

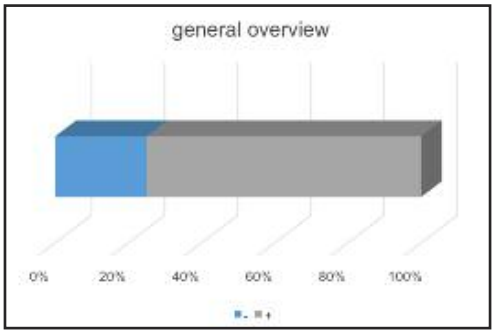

Fig. 4: The percentage expression of both the negative and the positive impact of the application of IPad in regard to archaeological documentation; general overview.

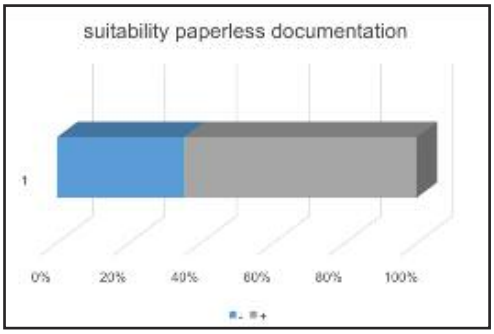

Fig. 5: The perceptual expression of suitability of paperless documentation in regard to archaeological documentation. Based on the steps that were examined during the excavation of Castrum Novum in Italy.

Disadvantage	Advantage
The purchase price for the equipment	Automatic data backup to the external storage
The necessary experience	Long battery life
The purchase prices for the applications	Speeding up the documentation processing
The need for an Internet connection	Clarity
The poor visibility of the screen in sunlight	Access to all the documentation in regard to research
Low resistance against dust and moisture	Communications between far distant sectors
	The readability of any notes
	The clarity of the drawings
	Suitable for long-term research and also for one-time events
	Access to data from different devices in different locations
	Space-saving for the archiving of documents

Tab. 3: A summary of the advantages and the disadvantages of using IPads in regard to archaeological documentation.

Fig. 6: The vectorisation of the handmade planimetry of the site (author: Flavio Enei). An example of the process that is carried out in IDraw. The superposition of the layer with the original planimetry and the vectorised layer (author: Klára Paclíková).

Additionally, we found it difficult to read the screen in direct sunlight. This could easily be resolved by shading, however. The device itself looks quite fragile in archaeological environment. Therefore, it was necessary to pay attention to such factors as dust, moisture and potential mechanical damage. Since our data was backed up continuously, breaking the device would not constitute a significant problem.

There was a certain degree of antipathy to devices which emanated mainly from the traditionally minded colleagues. On the contrary, colleagues with previous experience approached them favourably. Fig. 3 and fig. 4 show both the negative and the positive impacts of the application of IPad in regard to archaeological documentation.

Conclusion

After four weeks of the intensive testing of the instruments mentioned above, their benefit for scientific work is patently evident (**Fig. 5** and **Tab. 3**). After familiarisation, the device becomes an invaluable tool, especially during the post-excavation phases. Continuous digital documentation shortens the time needed for creating outputs for both the publications and the research reports. We have found this solution suitable for large-scale systematic surveys over many years and also for smaller one-time events that require rapid implementation and even more rapid processing. On the other hand, it is necessary to take in consideration the high costs of the equipment and its fragility. On the other hand a researcher practising with digital tools could became "de-skilled" and lose his/her corresponding intellectual

Fig. 7: An example of the documentary photo taken using IPad, whereas IDraw software enabled making various notes. In this instance notes about the positions of the taken samples and about the division of the layer into individual sections. Author: Klára Paclíková.

understanding. The cognitive freedom of a blank page of a paper notebook is in opposition to the rigidly organised database fields.[9]

Acknowledgement

The examination of the paperless methods on Castrum Novum was applied during The School of Interdisciplinary Studies that was organised by Klára Paclíková and Michal Preusz. The School was financed by IP 2015 of the University of South Bohemia in České Budějovice.

This contribution represents a partial result of the project of the Student grant competition at the University of West Bohemia in Pilsen SGS-2017-003 "Archaeology of the evolution and changes of the seascape in the area of Santa Marinella (Lazio, Italy)".

Bibliography

AVERETT, Erin. W., GORDON, Jody M., COUNTS, Derek, B. et al. *Mobilizing the Past for a Digital Future: The Potential of Digital Archaeology*. Grand Forks, 2016.

ELLIS, Steve J. R. Are We Ready for New (Digital) Ways to Record Archaeological Fieldwork? A Case Study from Pompeii. In: AVERETT, Erin. W., GORDON, Jody M., COUNTS, Derek. B. eds. *Mobilizing the Past for a Digital Future: The Potential of Digital Archaeology*. Grand Forks 2016, p. 51–75.

ENEI, Flavio, at al. *Castrum Novum (Santa Marinella, prov. de Rome)* [online]. Chronique des activités archéologiques de l'École française de Rome [En ligne], Italie centrale, mis en ligne le 24 juin 2015, consulté le 24 novembre, November 2016 [visited 11/07/2017]. Available online: http://cefr.revues.org/1364.

ENEI, Flavio et al. *Castrum Novum. Storia e archeologia di una colonia romana nel teritorio di Santa Marinella*. Quaderno 1. Santa Marinella 2011.

FORTE, Maurizio. Introduction to Cyber-Archaeology. In: FORTE, Maurizio et al. *Cyber-Archaeology*. Oxford: British Archaeological Reports International Series 2177, 2010, p. 9–14.

KAUFMAN, Arie. *Rendering, Visualization and Rasterization Hardware*. New York, 1993.

LEVY, Thomas E. From the Guest Editor. *Near Eastern Archaeology*, September 2014, vol. 77, no. 3, p. 187–191.

ROOSEVELT, Christopher H. et al. Excavation is Destruction Digitization: Advances in Archaeological Practice. *Journal of Field Archaeology*, 2015, vol. 40, n. p. 325–346.

TOUMAZOU, Michael K., KARDULIAS, Nick P. and COUNTS, Derek B. *Crossroads and Boundaries: The Archaeology of Past and Present in the Malloura Valley, Cyprus*. Boston, 2011.

9 *ELLIS, Steve J. R. Are We Ready for New (Digital) Ways to Record Archaeological Fieldwork? A Case Study from Pompeii. In: AVERETT, Erin. W., GORDON, Jody M., COUNTS, Derek. B. eds. Mobilizing the Past for a Digital Future: The Potential of Digital Archaeology. Grand Forks 2016, p. 51–75.*