Original Study

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Recording and Reconstructing the Sacred Landscapes of Sicilian Naxos

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Abstract: In recent years, an on-going project investigating the urban landscape of Naxos has surveyed and produced several new digital reconstructions of the settlement's simple non-peripteral temples, most with highly decorative roofs. Three Archaic sacred buildings of Sicilian Naxos are used to demonstrate different approaches to recording the remains and reconstructing their architectural features. This work reflects changes in digital strategies over the past ten years. Tempietto H is a small shrine located outside the city's boundaries and the site is currently inaccessible, so its reconstruction is based on excavation documentation and roof terracottas. The visible half of Tempietto C was documented using three-dimensional line-drawing with total stations and photogrammetry; the back-filled south-western part was surveyed with ground penetrating radar. Temple B is the largest sacred structure in Naxos. A geophysical survey gives new data on the eastern extent of the sanctuary. The area has been recorded with handheld and aerial photography to create a three-dimensional model of the sanctuary. A new orthogonal grid of the city was established circa 470 BCE and a rectangular base was placed in the south-east corner of every crossroad. These bases were the starting point for the plan, and their interpretation as altars converts the entire urban plan into a sacred landscape.

Keywords: Greek sanctuaries; Naxos in Sicily; digital reconstruction; 3D documentation; geophysical survey

1 Introduction

Naxos was the earliest Greek settlement on Sicily (founded 734/3; all dates in the paper are BCE) and it is located on the east coast, south of Messina. One of the first actions of the Greek settlers was to establish a new sacred focal point, the Altar of Apollo Archegetes. This sanctuary was respected by all Greek *apoikiai* of the island, even in subsequent periods. Traces of houses from the first settlement are evident in the eastern part of the Schisò peninsula, next to the bay and the harbour. Life in the colony was highly turbulent during the fifth century. Hippocrates of Gela captured it circa 492 and Hieron of Syracuse expelled Naxians to Leontinoi circa 475; after the death of the tyrant, they were allowed to return circa

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460. However, Naxos sided with Athens in the Peloponnesian War and the city met its final destruction by Dionysios of Syracuse in 403/2. The new foundation, Tauromenion, lies in the hills on the north side of the bay. The upheavals of the fifth century are also evident in archaeological material from the area, as Archaic buildings were systematically destroyed when the new orthogonal plan was established in the early Classical period (on the identification of the two superimposed urban layouts, see Pelagatti, 1981; for a recent review of the textual sources and archaeological evidence, see Lentini, Blackman, & Pakkanen, 2013). Its design is one of the best-preserved western Greek examples of town planning. In the recent excavations of the main east-west avenue, Plateia A, two road surfaces with stone-surfaced drainage channels related to the second could be detected. Considering the archaeological material and the historical dates, the first is best interpreted as the introduction of the new design by the Syracusan Deinomenid rulers circa 470 and the second as a result of changes that occurred when the Naxians exiles returned circa 460 (Lentini, Pakkanen, & Sarris, 2015).

A pictorial summary of the archaeological work conducted at the site since systematic work was started in 1953 is presented in Figure 1. The excavated sectors are concentrated in the northern half of the city, the southwest sanctuary and the Santa Venera sanctuary outside the city walls and to the west of the Venera stream. A high-accuracy total station survey of the excavated sectors currently located inside the archaeological park has been conducted as part of the project *Urban Landscape of Naxos in Sicily* in 2012–17 (Pakkanen, 2013, p. 56; on the project, see also the acknowledgments at the end). Geophysical work of all accessible areas has been carried out and several test trenches have been excavated as part of the new work at the site (Lentini et al., 2015). The background of the plan in Figure 1 is left grey to emphasise the extent of the 2017 aerial orthomosaic. The case studies discussed in detail in this paper are Tempietto C in the eastern part of the city (seventh century; marked C on the plan), Tempietto H in the Santa Venera area (early sixth century), Temple B in southwest sanctuary (late sixth century) and one typical example of the early Classical rectangular bases at the crossroads of the east–west avenues (*plateiai*) and north–south streets (*stenopoi*). This paper follows the Italian terminology of naming smaller shrines as ‘tempietti’. There is no clear convention for when a sacred structure should be named as a ‘tempietto’ or as a temple, so the excavators’ terminology is followed here.

The preservation of building foundations is very good in many parts of Naxos due to the city’s destruction in 403/2 and subsequent abandonment. However, the city’s buildings were constructed using mudbrick, and with their roofs no longer maintained and their tiles largely recycled, their walls dissolved quickly. This outcome occurred with both private houses and monumental architecture. Not a single temple of the city had stone columns and their sacred character was mainly emphasised by rich terracotta decoration and, in the case of Temple B in the southwest sanctuary, size. The process of monumentalisation of sacred spaces at Naxos is quite different than at other western Greek settlements (Lentini & Pakkanen, 2019). The most labour-intensive construction projects at Naxos were the Archaic city walls and the late Archaic and Classical shipshed complex, and like the residential buildings, their mudbrick walls soon melted away after the Syracusan victory. The size of the city and the building techniques used there have made it difficult to present the site to the visitors. The height of the stone socles of monumental constructions rarely exceeds a metre, so the third dimension of the architectural remains is lacking throughout the archaeological park. There are no ancient landmarks visible from a distance and the excavated sectors are quite far apart from each other. The digital reconstructions presented in this paper are one part of an effort in the past ten years to make a visit to the first Greek settlement on Sicily more informative.

2 Methodology

Three-dimensional documentation of archaeological features and architecture has seen very rapid developments in recent years due to changes both in hard- and software. Traditional methods of recording and draughtsmanship have been replaced in many fieldwork projects by various digital techniques. The cost of hardware for laser scanning is still too expensive for most research projects in archaeology, but

Figure 1. Archaeological Park of Naxos in Sicily. Survey data and reconstruction of the ancient city superimposed on an orthomosaic of the site. Red = Archaic; green = Classical; cyan = Byzantine; blue = ancient shoreline; light grey = modern features (Jari Pakkanen).

accurate recording can be accomplished using total stations and digital photography. Based on careful three-dimensional documentation it is possible to directly produce the required two-dimensional images of the plans, elevations and sections (Pakkanen, 2018). In total station surveys of large topographical areas it is important to minimise positional and directional grid errors when moving the instruments. Such errors were avoided here by systematically using four control points when moving the total station across the town (Pakkanen, 2009; 2013, p. 56). The combination of three-dimensional reflectorless-laser total station drawing with georeferenced photogrammetry has been recently discussed using case studies from fieldwork projects conducted by the Finnish Institute at Athens, including the shipshed complex at Naxos (Pakkanen, 2018). In this paper, realistic rendering of the walls in architectural reconstructions is in general avoided in order to emphasise the conjectural nature of reconstructing the height of mudbrick structures (cf. Lentini & Pakkanen, 2010, pp. 422–423). As will be seen in the case studies below, full three-dimensional recording of architecture makes possible construction of digital models that fit the data on the ground with high precision; also, the methods employed in this paper facilitate the writing of subsequent architectural descriptions and analyses.

Three seasons of geophysical work were carried out at Naxos in 2014–16, and three methods were applied at the site: magnetic gradiometry, electrical resistance and ground penetrating radar (for a review of these methodologies, see Sarris 2015). The magnetic survey was severely compromised by the shallow stone foundations built largely using local igneous rocks, and even more so by the bedrock of volcanic origin. In addition, frequent eruptions of Etna have created a magnetic lens covering the archaeological remains, and this lens affected also the soil resistance measurements. The volcanic material is porous, increasing background interference. Ground Penetrating Radar (GPR) proved best able to detect the architectural features of the subsoil. Removal of the background noise and band pass filtering of the data made it systematically possible to highlight interesting features over the whole archaeological park. Most of the identified linear anomalies are aligned in the same direction as the reconstructed layout of the Classical city. They are especially visible in the GPR slices at a depth of 0.6–1.0 m below the current surface (for further analysis of the geophysical survey at Naxos, see Lentini et al., 2015, pp. 27–28).

3 Tempietto C

Discovered in 1953, Tempietto C was one of the first buildings excavated at Naxos during a project led by P. Pelagatti and E. Lissi (Pelagatti, 1977, pp. 46–48; marked C in Figure 1). Considering the significance of constructing an Archaic temple over early colonial layers, it is surprising that the building does not feature more prominently in studies of Greek architecture in Sicily. Based on the new survey of its exposed north-eastern half, the width of the building between the exterior faces of the wall courses is 6.88–6.91 m. In the excavation plan, the length of the building measures 22.3 m, with its foundation blocks protruding 0.20–0.35 m from the wall alignment on all sides (Pelagatti, 1977, fig. 4). The width of the walls is substantial, measuring 0.75–0.82 m. The temple has an elongated rectangular plan with a width to length ratio of 1:3.2. Its orientation is north/north-east to south/south-west. The wall facing south-east is aligned with a road (Street Sg?) or possibly with a poorly preserved temenos wall (Figure 2). The foundations and the two lowest courses of the walls were mostly built from local dark-grey volcanic blocks of different sizes cut into approximately rectangular shapes and some rounded limestones collected from the riverbed, while the rest of the superstructure would have been constructed using mudbricks. The north-eastern half of the building was more thoroughly excavated than the south-eastern, and the area was backfilled in the 1960s when the expropriation of the area was still ongoing (Pelagatti, 1977, p. 46, n. 16). Only the north-eastern half of the building is currently visible (Figure 3). In the excavations, four symmetrically arranged bases for protruding pillars were discovered inside along the walls of the structure. At the centre of the space and in line with the central pillars a base with dimensions of 1.2 × 0.7 m was exposed, most likely intended for a cult statue as has also been suggested for the temple in the agora at Megara Hyblaea (Pelagatti, 1977, p. 46).

Figure 2. Area of Tempietto C. Excavated remains (solid lines), reconstructed features (dashed lines) and GPR grids superimposed on the aerial orthomosaic. Orange = Early Archaic; light green = Classical (Jari Pakkanen, Esko Tikkala, Apostolos Sarris, & Meropi Manataki).

The memory of the Archaic structure was completely erased when the new Classical city grid was established and the houses of insula A11 built over the temple. The remaining foundations of the Classical houses are at the same depth as the walls of the Archaic temple, but their orientation matches exactly the new city grid, confirming their identification as fifth-century features (Figure 2). During the 1953 excavations, the Classical walls built over the earlier temple were documented but partially removed to uncover the Archaic building. The positions of the walls drawn as solid green lines in Figure 2 are derived from both the excavation documentation and the exposed remains. Interestingly, the significant number of *kourotrophos* figurines discovered in the recent excavations of the dwellings of insula A10, which neighbour Tempietto C, shows that at least some ritual functions took place in the nearby fifth-century houses. However, such finds are entirely absent from the Classical houses of insula A11 that extend over the temple, so the material remains suggest that the change from a religious to residential function was total.

Figure 3. Eastern half of Tempio C. Textured photogrammetry model with 3D total station survey of blocks (Jari Pakkanen).

The most recent fieldwork at Tempio C and the surrounding area was carried out in 2015–16. The geophysical GPR survey conducted in 2015 detected the stones of the south-western part of Tempio C, as well as the remains of several unexcavated Classical houses lining Stenopos 10 and forming parts of city blocks A09 and A10 (Figure 2). No evidence of further pillar bases along the length of the temple was detected in the geophysics (these have been hypothesised in Pelagatti, 1977, p. 46). The exposed blocks of the temple were recorded stone-by-stone using precise three-dimensional line drawing with total stations, and photogrammetry was used to produce a textured model of the area of the temple. The two different types of three-dimensional documentation can be combined to accurately record the current state of the excavated area (Figure 3). In Figure 4, the dense point cloud produced in photogrammetry software is exported into CAD as a three-dimensional background. The site's two chronological phases were documented already in the field as two distinct CAD layers using the line-drawing method with reflectorless total stations; the Archaic phase is displayed in orange and the Classical in green.

In the brief report summarising the 1953 excavations, Pelagatti suggests that under Archaic Tempio C there would have been well-preserved layers with a Bronze Age hut of the Thapsos culture and a late eighth-century colonial predecessor built with the same orientation as the temple (Pelagatti, 1977, pp. 46–47). Based on the extensive excavations of the same layers 50 m to the north of Tempio C at the crossroads of Plateia A and Stenopos 11, it is possible to suggest an alternative explanation for the two superimposed structures (Lentini, 2012; in press). They are best interpreted as late Iron Age buildings from the period of initial Greek arrival and occupation at the end of the eighth century and their cohabitation with the local Siculi. One can tentatively suggest that the mid-seventh-century Building H, a dining room, at Plateia A and Stenopos 11 is connected with Tempio C. This interpretation would also be consistent with heroisation of the first *oikists* and the place where they settled.

Details of the two earlier structures or the archaeological material related to the Archaic temple have not yet been published, but a seventh-century date can be proposed for Tempio C based on comparative material and the lack of roof terracottas at the site. The size and proportions of the late seventh-century Temple 'h' built in the south-west corner of the agora at Megara Hyblaia are comparable to those of the Naxian building, though its conception of the interior space with a central colonnade is different (Vallet, Villard, & Auberson, 1976, pp. 227–228; Romeo, 1989; Mertens, 2006, pp. 90–91). The temple at Naxos is one of the rare Sicilian examples of an *oikos*-plan building with three or four rooms. The Megaron south of later

Temple C at Selinous, built probably in the early sixth century, is another notable case. It is very elongated in plan and has pillars along its central axis; the east room is in this case interpreted as the *adyton* (De Angelis, 2003, p. 134, fig. 42). Another comparable structure with multiple rooms is Temple B at Himera, though it is dated slightly later (Mertens, 2006, p. 91).

Figure 4. Eastern half of Tempietto C. Dense point cloud produced by photogrammetry exported to CAD; 3D reflectorless total station line drawing recorded as separate layers. Orange = Early Archaic; light green = Classical (Jari Pakkanen, Stuart Heath, & Martina Riedl).

It is not entirely clear whether the entrance to the building at Naxos was from the north-east or from the south-west, but based on the dimensions of the spaces, the north-east room could be interpreted as an entrance vestibule with a clear span of 2.8 m. Also, the excavated section of the short south-west wall is shown in the published plan to consist of substantial orthostate blocks facing both the exterior and interior of the building (Pelagatti, 1977, fig. 4; in Mertens, 2006, fig. 205, the entrance is drawn from the south-west side, but this is unlikely). The main cella would then be divided into two halves of approximately 6.8 m (central part) and 10.1 m (south-west room). Since no decorative roof terracottas were documented in the excavations, the most probable reconstruction for the temple would incorporate a flat clay roof, lending further credibility to a seventh-century date for Tempietto C. It is highly unlikely that the roof would have been completely recycled – the large tiles would have broken easily, and some fragments would have invariably been discarded at the site.

The complete disregard for the temple and construction of Classical houses on top of it changes radically the function of the area. This neglect could have been intentional or unintentional. If intentional, it would have been an act of erasure of the sacred memory of the earlier Greek settlement by the Syracusan Deinomenid rulers in circa 470. It could also have been unintentional as once the clay roof collapsed, wind and rain would have rapidly eroded the mudbricks of the wall into a soil heap. In both cases, the change in function highlights the absence of the expelled Naxians during the time when the new city grid was established. By the time they returned, the character of the previously sacred *temenos* would have already been residential.

4 Tempietto H

Tempietto H is a small shrine in the extramural sanctuary to the west of the town and the Santa Venera stream (marked H in Figure 1). The sanctuary is perhaps best known for the unique late seventh-century dedication to the goddess Enyō discovered in a *bothros* (Pelagatti, 1980–81, pp. 702–706; Guarducci, 1985). However, the range of architectural terracottas excavated from the sanctuary provides insights into the development of Archaic Greek revetments in Sicily (Ciurcina, 1980; Lentini, 1997; Lentini & Pakkanen, 2010). As the only excavated building in the sanctuary with preserved architectural terracottas, Tempietto H provides an ideal case study for digital reconstruction. Significant parts of the sima and geison revetments were excavated along the south and west sides of the temple. Based on the stylistic features of the revetments, the temple can be dated to the early sixth century (Lentini, 1997, pp. 127–131; Lentini & Pakkanen, 2010, pp. 421–423).

The excavations in the sanctuary took place in two principal phases in 1975–78 and 1985–1992 (Pelagatti, 1980–81, pp. 702–706; Lentini, 1993–94, pp. 1012–1025; 1998, pp. 87–96; Lentini & Pakkanen, 2010, p. 417). As part of the urban development plan of Giardini Naxos, the area was transformed into a civic piazza in early 1990s; thus, the archaeological remains are largely inaccessible today due to vegetation growth, so the reconstruction of Tempietto H is based solely on excavation records and the preserved roof terracottas (Lentini, 1997, pp. 127–131; Lentini & Pakkanen, 2010, pp. 422–423).

Tempietto H is a small temple with plan dimensions of approximately 15.5 × 6.8 m. Its orientation is west/south-west to east/north-east with the entrance on its eastern side. The building technique is similar to Tempietto C: the foundations are constructed of roughly shaped dark-grey volcanic rocks with some rounded riverbed stones; its best-preserved section is the south-eastern corner where the orthostate blocks facing the exterior are mostly cut into rectangular shapes. A cross wall separates the entrance vestibule from the cella of the temple. The stone foundations projecting from the short eastern side of the shrine were most likely intended to hold the steps leading into the temple in place. The rest of the superstructure would have most probably been constructed using mudbricks, in line with the general practice at Naxos. An alternative reconstruction model would incorporate rubble walls built on top of stone foundations, but in that case it is likely that the small stones would have been abandoned where the walls collapsed.

Figure 5 presents the wireframe model superimposed on top of the excavation plan of the temple. The digital reconstruction gives an idea of the relationship of the three-dimensional form of the temple with the walls extruded in CAD from the horizontal plane of the two-dimensional plan. The reconstruction is based on the minimum height of the building, as with an entrance ramp or stairs and a doorway, the height of the stone socle and the walls would have needed to be at least 3.5 m. If the 0.78–0.83 m high decorative plaques associated with the temple (Pflug, 2006, pp. 454–456) were to be reconstructed at the top of the exterior wall also above the door, the minimum wall height would be 4.0 m.

Figure 6 more accurately reflects the current preservation of the building and three-dimensionality of the excavated remains, apparent from the superposition of the reconstruction on an excavation photograph. Even though the exact location from which the photograph was taken is unknown, finding the right perspective projection for the three-dimensional reconstruction is a relatively simple task because the corners of the building are marked with ranging rods in the photograph. Keeping the reconstruction transparent rather than using a photorealistically rendered model emphasises the relationship between the process of excavation and the subsequent reconstruction.

Figure 5. Tempio H. Wireframe reconstruction superimposed on the excavation plan in CAD (Jari Pakkanen)

Figure 6. Tempio H. Perspective view of the reconstruction fitted on top of an excavation photograph of the site (Jari Pakkanen).

Looking at Figures 6 and 7, one can appreciate the overall effect of the highly decorative roof revetments and the simple exterior of the *oikos*-type temples of Naxos. The roof has an unusually low pitch of 10 degrees as indicated by the preserved corner geison cassette (Lentini, 1997, fig. 5; a more typical inclination of ancient tiled roofs is 15–25 degrees; Wikander, 1988, pp. 207–208). In the CAD reconstruction of the terracottas, the red and black slips of the decoration are implemented as three-dimensional solids and they project slightly from the face of the revetments. Thus, the model reflects the tangible relationship between the painted decoration and the plain clay surfaces.

Figure 7. Tempio H. CAD reconstruction of the roof corner (Jari Pakkanen).

5 Southwest Sanctuary and Temple B

Temple B, a late sixth-century structure located in the South-West Sanctuary, is the largest sacred building in Naxos. The temple's roof, with its unique anthemion sima, is the only structural feature in the city that clearly shows Ionic influences. Its links with the decorative features of the roof of the North Propylon of the sanctuary point towards a larger late-Achaic programme of monumentalisation in the area (Figure 8; for a review of the sanctuary, see Lentini & Pakkanen, 2019).

As with the other sacred structures of Naxos covered in this paper, the 1960s and early 1970s excavations conducted by P. Pelagatti are vital to discussion (Pelagatti, 1964, 1972). New examinations of the sanctuary were carried out in 2012, 2015 and 2017; during the latter two seasons, the emphasis of the work was on photogrammetry, and architectural revetments of Temple B were also documented in the site's storerooms. The residential areas adjoining the sanctuary were surveyed using GPR in 2016.

High, well-preserved stone foundations of the city walls separate the sanctuary from the outside on the west and south sides. On the north side, the wall marks the limit between the sacred area and the city, but it has not been possible to determine where the eastern boundary of the sanctuary lies. A reconstruction by D. Mertens depicts it extending all the way to Stenopos 6 (Mertens, 2006, fig. 616), but analysis of the GPR results shows that there are private houses on the south side of the Archaic Street Sc on the west side of Stenopos 4 (Figure 8); therefore, the boundary of the sanctuary must lie to the west of these houses. This study provisionally sets the boundary in alignment with Stenopos 3. Determining the exact location of the eastern boundary would require large-scale clearance of vegetation, a new geophysical survey of the area and test trenches.

House foundations are another significant feature visible in the GPR survey (Figure 8). They have been detected in all geophysics grids in the south-west sector of the city. Despite clear signals for walls, no obvious plot boundaries are visible in these areas, so it is likely that the foundation stones from these houses have been partially recycled. There are traces of reuse in other parts of the site (for a Roman limekiln, see Lentini et al., 2015, p. 25; later reuse of stones has also included the construction of 20th-century aqueducts).

Figure 8. South-west sector of Naxos. Excavated remains and GPR grids superimposed on the aerial orthomosaic. Red = Archaic; green = Classical (Jari Pakkanen, Apostolos Sarris, & Meropi Manataki).

During the sixth century BC, a devastating flood buried all contemporary structures at the sanctuary. The first temple, the altar, the stelai and the kilns were covered by a significant layer of sand. Temple B was built towards the end of sixth century BC, partially on top of Building A, but following a different orientation that only approximates the orthogonal Classical layout (according to the new survey, the north side of the temple has a compass direction of 64.0 degrees and Plateia B of 63.3 degrees). Only the foundations of Temple B,

constructed using irregular blocks, are preserved. The dimensions of the temple, 38.40×14.25 m, reflect a typical peripteral temple. The temple is the largest sacred building in Naxos and the largest *oikos* building discovered in Sicily (Pelagatti, 1972, p. 217; Romeo, 1989, p. 8). The sixth-century pottery discovered at the level of its foundations confirm its construction date (Pelagatti, 1964, pp. 160–161).

In the process of three-dimensional modelling of Temple B's roof terracottas, several fragments were placed in correct positions relative to one another and they were documented simultaneously. This procedure improved post-processing efficiency and facilitated comparisons with previous reconstructions. Figure 9 presents the textured photogrammetry model of the lateral geison revetment and sima fragments. The reconstruction of the temple revetments (Ciurcina, 1977, pl. 8) is superimposed on the top of the fragments, showing overall a good fit. Taking accurate measurements of the preserved fragments is difficult due to their small size, but possible with scaled photogrammetry documentation.

Figure 9. Temple B. Textured three-dimensional model of the geison revetment and lateral anthemion sima (Series A, B and C) fragments with reconstruction drawing superimposed on the model on the left (Jari Pakkanen).

Figure 10. South-West Sanctuary from west. Reconstruction of Temple B superimposed in CAD on the dense point cloud produced in photogrammetry (Jari Pakkanen).

The reconstruction of Temple B presented in Figure 10 gives an idea of the scale of the structure and its impact on any visitor to the sanctuary. The city wall would have blocked a direct sightline to the temple when observed from beyond the Santa Venera stream to the west of the city or from the sea to the south. In Figure 10 the temple reconstruction is superimposed in CAD on the dense point cloud generated from the aerial photos in photogrammetry.

6 Altars at the Crossroads of the Classical City

The Classical orthogonal grid plan of Naxos was first excavated by P. Pelagatti in 1973 (Pelagatti, 1976–77, pp. 537–542). The urban layout is defined by three main arterial streets – Plateiai A, B and C – running in an approximately east to west direction (Figure 1). At regular intervals, they are intersected by narrower streets orientated north to south, Stenopoi 1–14 (Pelagatti, 1993, pp. 275–276; 1998, p. 51). The city blocks have a uniform size of 39.2 x 156.7 metres. The crossroads are systematically marked by a series of square bases in the south-eastern corners.

New topographical fieldwork conducted at Naxos in 2012–2017 has provided data for a reassessment of the fifth-century grid design (Pakkanen, 2013, pp. 52–59; Lentini et al., 2015, p. 28). Statistical analysis of 48 direct measurements directly related to the features of the urban layout – dimensions of the city blocks, widths of the streets, and distances between the square bases – reveal a statistically highly significant design module of 1.633 m or, quite certainly, five feet of 0.327 m (the so-called ‘Doric-Pheidonic’ foot). Even though this particular length can be expressed in terms of a ‘standard’ Greek foot-unit, the importance of starting with statistical analysis rather than simply expressing the modern measurements in terms of conventional metrological units cannot be stressed enough (Pakkanen, 2013; for the example of an unexpected statistically significant unit of 0.340–0.341 m at Kyllene, see Pakkanen, 2018, pp. 128–129). The detection of the underlying unit makes possible further scrutiny of the grid design at Naxos (Figure 11). The size of an insula, 39.2 x 156.7 metres, equals 24 x 96 modules, so the ratio of width to length is exactly 1:4. The elongated proportions of the

Figure 11. Classical city grid of Naxos. Principal dimensions expressed in terms of design module. Based on cosine quantogram analysis of the topographical survey measurements (Jari Pakkanen).

block are typical of western Greek city layouts (cf. Hoepfner & Schwandner, 1994, pp. 1–10). The street network has varying design widths: Plateia A (about 9.5 metres) is six modules, Plateiai B (about 6.4 metres) and C (about 6.3 metres) and Stenopos 6 (about 6.4 metres) are all four modules; the width of a normal stenopos (4.94–5.19 metres) is three modules. The rectangular bases of the intersections are clearly an integral part of the city design and their positions possibly mark the starting points of the grid design. The north–south distance between the centres of the bases at Plateiai A and B is 100 modules and the typical east–west distance 27 modules. Even though the varying street widths create some variation in the modular distances across the whole design, is it just a coincidence that the two most commonly occurring dimensions are results of taking the square and the cube of a base number ($10 \times 10 = 100$; $3 \times 3 \times 3 = 27$)? The bases divide the city into intelligible units, so a closer look at their design and function is merited. Also, there is earlier evidence of structuring the plan of a city in reference to altars or comparable constructions at Megara Hyblaia, Himera and Selinous (Mertens, 2006, p. 179). At Selinous, to the east of the Agora, stone circles A–E are located under the boundary walls of sixth-century house plots, and animal bones most likely originating from sacrifices were discovered during the excavations (Mertens, 2006, pp. 177–181, figs. 308–317).

Currently the best-preserved rectangular base is at the crossroads of Plateia A and Stenopos 11 (Figure 12). The foundations on the north and south sides of the monument consist of irregular stones and on the façade facing Stenopos 11 of large rectangular slabs. The orthostate blocks made of volcanic stone are preserved on the north and south sides. The overall dimensions of the base are 1.38 (east–west) $\times$ 1.61 m (north–south), somewhat larger than the four well-preserved bases currently visible on Plateia B (Pl. B/St. 1: 1.36 $\times$ 1.39 m; Pl. B/St. 2: 1.18 $\times$ 1.41 m; Pl. B/St. 4: 1.24 $\times$ 1.40 m; Pl. B/St. 5: 1.36 $\times$ 1.40 m). The heights of the two orthostate blocks are 0.46–0.47 m. They have an interesting technical detail, possibly unique in Greek architecture. The blocks were attached to the next level, most likely a large horizontal slab, by stone dowels made of same volcanic stone as the orthostates (marked ‘sd’ in Figure 13) and they have horizontal pour channels for lead. On the southern orthostate, the corners of the dowel are rounded, giving it a nearly oval shape (8.3 $\times$ 6.2 cm), and on the northern block the dowel is rectangular (6.4 $\times$ 5.2 cm). On both blocks, pouring channels for lead are clearly visible on the top surfaces of the orthostates, and the lead surrounding the dowels is still preserved. Such use of wooden dowels is known from sixth-century Greek architecture, while round wooden *poloi* were used between column drums in the previous century (Martin, 1965, pp. 65, 291), but stone dowels in architecture are rare. However, attaching stone sculptures with lead to a stone base is a common practice (e.g. Adam, 1966, p. 14). A stone dowel in a votive column is reported from Samos (Gruben, 1957, p. 63; Martin, 1965, p. 291, n. 1). A second possible parallel to the dowels at Naxos is listed among the 19th-century acquisitions of the British Museum; it is a stone dowel from a column drum from Thasos with no further information given (Smith, 1888). Horizontal pour channels for lead were a relatively common feature of marble architecture in eastern Greece and Asia Minor from the mid-sixth century onwards (Ohnesorg, 2005, p. 131, n. 727; Herda, forthcoming, appendix A). They are also known from Athenian architecture of the second half of the fifth-century BCE, though this technical feature only becomes more common in the fourth century (Martin, 1965, p. 286). Since the bases at Naxos are original features of the early Classical layout of the town of circa 470, the Naxian orthostates with channels are the earliest known architectural example of this technique in the Greek west, earlier than the Attic examples in the Hephaisteion and the temple of Athena at Pallene (later re-consecrated as the temple of Ares in the Agora; Korres, 1992–98).

The location of the rectangular bases at crossroads gives an idea of their probable function. Street junctions were important liminal points and the Greek deities most often associated with crossroads were Hekate and Hermes. These were uncomfortable points of transition, but their effect on the passer-by could be controlled by rituals (Johnston, 1991). Identification of the rectangular bases as *hekataia*, altars at the road junctions for placing ritual meals for Hekate, is quite tempting though literary evidence specifically related to Naxos would be required to argue the case more conclusively (cf. e.g. Demosthenes, 54.39; Hesychius s.v. Ἑκάταια; for further ancient references, see Johnston, 1991, p. 219, nn. 9–11). However, these altars at Naxos had an even greater purpose than just appeasing Hekate or Hermes and making sure that she or he could lead the individual past the transitional crossroads safely: they made the city intelligible by structuring it into distinct zones, thus keeping chaos at bay. By monumentalising the starting points of the Classical layout with altars, all the territory inside the city walls was rendered sacred.

Figure 12. Rectangular altar base at the crossroads of Plateia A and Stenopos 11. Screenshot of the textured photogrammetry model (Iari Pakkanen).

Figure 13. Orthomosaic of the rectangular altar base. Stone dowels marked with 'sd' (Jari Pakkanen).

7 Conclusions

Even though a modern and rather technical approach to sacred space is at the heart of this paper, reconstructions of the physical space are important to our understanding of the material dimensions of rituals and sanctuaries at Naxos in Sicily. Construction of Tempietto C is quite likely linked with the heroisation of the first Greek settlers at Naxos, Tempietto H with the initial monumentalisation of the Santa Venera area outside the city walls, and Temple B with the full-scale rebuilding of the South-West Sanctuary after a devastating sixth-century flood. Finally, altars at crossroads were used to monumentalise the city design *and* give the liminal points a ritual dimension. Recent rapid developments in hard- and software have changed the ways in which architectural and archaeological features are recorded and reconstructed. The case studies presented in this paper reflect these changes over the past ten years.

Currently, the most popular method in archaeological field documentation of architectural remains is photogrammetry. The low cost of both hard- and software has made it possible to test which sets of photographs work best in different circumstances. The three-dimensional models and plans presented in this paper are more detailed than traditional types of fieldwork documentation based on photography and drawing, and they are also fast to produce. It is also possible to test the fit of the computer reconstructions with accurate documentation of the features. When more traditional-looking publication images are preferred, it is possible to combine photogrammetry documentation with three-dimensional line-drawings produced using reflectorless-laser total stations (Pakkanen, 2009, 2018). The required two-dimensional representations can easily be exported from CAD and GIS for editing in a drawing program if necessary. One key benefit of combining total station documentation with photogrammetry is it makes it easier to read the produced images, as the

lines can be used to separate the features and phases of the recorded target. It is often difficult to see subtle changes of texture and colour in the photogrammetry models and orthomosaics, but when the boundaries are recorded using reflectorless total stations, it is possible to conveniently highlight these characteristics in post-processing of the images. The benefit of using aerial photography in photogrammetry is fast recording of large areas and attaining better views of architectural features. Combining the documentation of excavated remains with a geophysical survey of the surrounding area, it is possible to detect the continuation of the Archaic and Classical features of the city and sanctuaries at Naxos.

When it comes to the sanctity of the entire urban space at Naxos, the importance of the Altar of Apollo Archegetes should not be forgotten. As is also emphasised in the writings of Thucydides from the late fifth century (6.3.1), the primacy of Naxos and its symbol, the altar, was respected by all later Greek settlements of Sicily. Murray emphasises the role of the Altar for claiming religious sacrosanctity for the city in the final years before the Syracusan sack (Murray, 2014, pp. 467–468). However, as the altars at the crossroads demonstrate, the sacred aspect of the re-foundation is present from the very beginning of the design process. Hieron, the new Syracusan ruler, certainly also saw the value of controlling Naxos and the Altar of Archegetes for political and propaganda purposes. The Naxians were never able to escape the political realities of Sicily. As an Ionian settlement it was a natural ally of Athens, and the disaster that struck Athens at the end of the Peloponnesian War was also felt in Sicily. The power of the altars at the crossroads was not enough to keep chaos away from the streets and houses of Naxos. In 403/2, chaos arrived again in the form of Syracusans, sacking the city for one final time.

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