The Arch Meets the Line – Geometries of Innovation and Conveyance

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Abstract:

Teaching mathematical and geometric concepts through art forms that are a part of indigenous knowledge systems (IKSs) has become a key aspect of pedagogical transformation in many national arts and sciences curricula. This article delves into the nuances of artistic innovation, marketing, and mathematical process in contemporary Zulu, South Sotho, and Venda ceramic practices in both individual studio and workshop settings. The work of Azolina MaMncube Ngema, Lenky Nhlapo, and the Mukondeni Pottery Village are discussed in relation to expanding fields of ceramic consumption. Ceramic artists' first-hand engagement in classroom workshops, portrayal in pedagogical writings, and strategic engagement with touristic venues are framed in the context of geometric reasoning, visual innovation, and potential classroom innovation.

Keywords: art | ceramics | pedagogy | Zulu | Venda | Sotho | geometry | mathematics | South Africa

Article:

Introduction

The implementation of South African mathematics curricula based on indigenous knowledge systems (IKSs) has increased significantly since the early 2000s. The transformation of science and mathematics knowledge production into an experience that draws on learners' social environments is the outcome of multiple efforts by the Department of Basic Education (formerly a part of the Department of Education), textbook producers, researchers, and instructors. Recontextualising schooling and learning goals is both a challenge and a goal for mathematics and science teachers in the 21st century.

This pedagogical stance can both empower students and bring a sense of enjoyment and ownership to the classroom (Gerdes 1998; Van Heerden, Smuts, and Getz 2006; Van Wyk 2002;

Vithal, Adler, and Keitel 2005). Fortunately, pedagogical innovators have realised that mathematics and geometry can be approached through conceptual components already found in many South African art forms: beadwork, weaving, and wall painting, as well as ceramics. These art forms provide multiple means of approaching concepts, particularly types of symmetry and patterning: reflective and rotational/radial symmetry, translational symmetry and frieze patterning, periodic patterning, and tessellations.

In this article, I do not provide a full historical or contemporary inventory of geometries used in southern African ceramics. Rather, I discuss several moments when artists, authors, and instructors have engaged with complex geometric thinking as a part of ceramic art forms and histories, with a focus on vessels. I advocate the further decolonisation of educational systems and I present case studies that educators could reference: examples of local expert artists being brought into the classroom, texts that reference indigenous geometries, and local community-based projects that may not yet be a part of educational curricula but that dovetail perfectly with the objectives of highlighting geometry in ceramic practices. To facilitate radical decolonisation, more is needed than mere changes in curricula; this can be achieved by bringing in IKS experts and opening hierarchical structures of education (Meda, Swart, and Mashiyi 2019; Vandeyar 2019).

I discuss several cases in which IKSs and geometry have intersected, both inside and outside of the classroom. The three examples I focus on highlight individual artists and a group deeply invested in IKS practices: Azolina MaMncube Ngema, Lenky Nhlapo, and the Mukondeni Pottery Village. As I highlight the creativity of these Zulu, South Sotho, and Venda women working in rural studio and small-scale workshop settings, I also draw upon and accentuate texts that bring to the fore the geometric sophistication of each artist's or group's cultural knowledge base, and I refer to fieldwork documenting their expanding art practices. It is my hope that this article will bring to light new research on pedagogical innovation and demonstrate how textbooks and handbooks that are currently used in South African classrooms could be developed in ways that show the parallels between or strengths within these three cultural regions.

Azolina MaMncube Ngema: Potting and Teaching Innovation

Azolina MaMncube[1] Ngema's *ukhamba* beer vessels were featured as anonymous Zulu works in the foundational exhibition *Africa: The Art of a Continent* in 1999; she was later acknowledged as an important master potter and culture bearer in KwaZulu-Natal (Jolles 2005; Perrill 2011; Van Heerden, Smuts, and Getz 2006). Between 2001 and 2007, arts instructor Reeves Gumede, with the guidance of the then deputy chief education specialist in the KwaZulu-Natal Department of Education, Jannie van Heerden, brought MaMncube to the King Bhekuzulu College in Nongoma, KwaZulu-Natal. At this college, MaMncube was extremely popular with students and the styles she taught encouraged their understanding of ceramic construction, radial symmetry,

[1] Married women are referred to as "Ma-maiden name", for example "MaMncube", as an honorific that acknowledges their family of origin. This convention follows Zulu *hlonipha* (politeness) norms between women and is the way that I addressed interviewees. Because I refer to artists in Zulu-speaking areas by these honorifics, I also use these titles to refer to them in this text as older women who are culturally embedded artists.

and colour symbolism. Simultaneously, learners acquired a pride in local art forms, particularly those created by rural women.

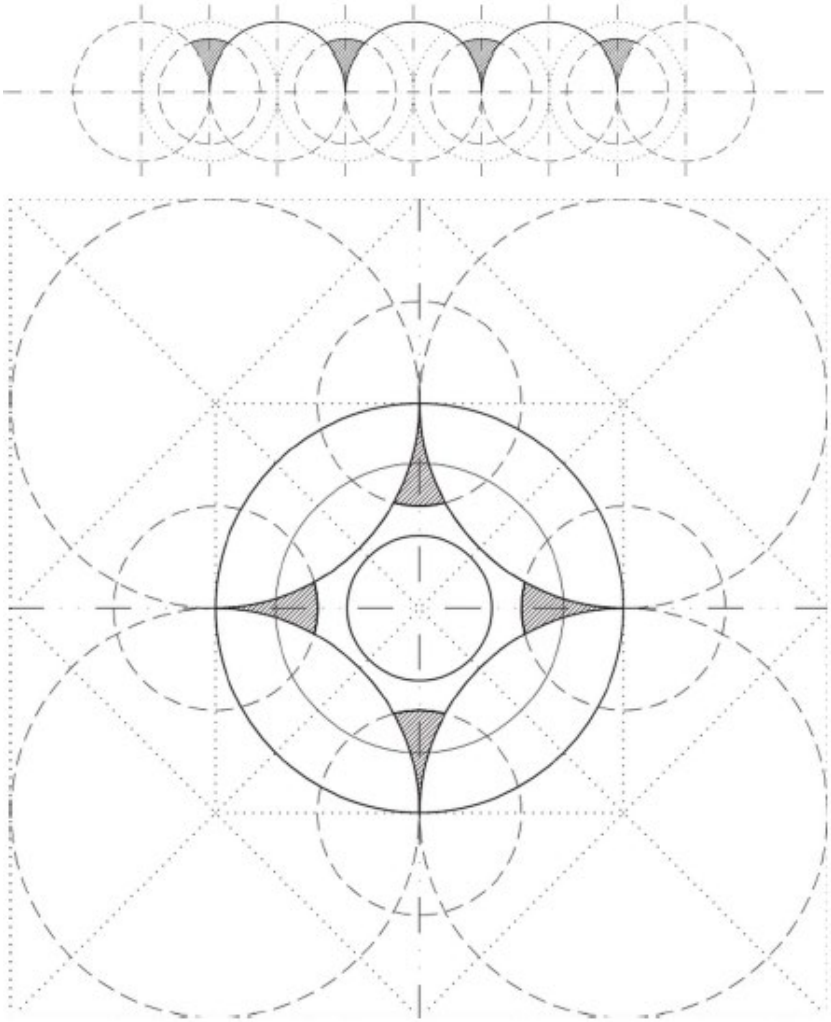
During her workshops, MaMncube first instructed students in Zulu coil building. She demonstrated the ways in which potters utilise between two and five clay sources and then dig, grind, sieve, and mix the clay into the proper consistencies for various vessels. She and her students created *izinkamba* (singular *ukhamba*) beer pots using coiling techniques. Each student visited MaMncube's home in the Ekubuseni district of Nongoma and created pots constructed by smoothing coils onto a small round base as the pot was turned, often on a piece of cardboard or dish. MaMnucbe then assisted in trimming the openings, or mouths, of each pot to ensure that they were circular and fired the pots at her homestead. For a subsequent lesson, MaMncube travelled to the King Bhekuzulu College with the fired works so that students could focus on colour theory and discussions of cultural colour symbolism during the vessels' completion.

When demonstrating her decorative methods, MaMncube utilised design principles based upon the demarcation of the pot's diameter and subsequent division and subdivision of the pot surface into three, four, six, eight, or more radially symmetrical portions (see Figures 1a and 1b). In Figure 1 the radial symmetry of this subdivision is clearly shown in MaMncube's monochromatic work.

The radial symmetry technique can also be seen in the working methods of Khulumaleni MaMbambo Magwaza (see Figure 2). MaMbambo, originally from the Ntolwane area of KwaZulu-Natal, now lives in Mpabalana as part of a large ceramics-producing family. MaMbambo often marks a horizontal diameter mark around the circumference of her vessels and then divides the pot utilising arches emanating upward from this horizontal baseline. These arches may delineate a 180-degree rotational symmetry for a pot divided in half, 120-degree rotational symmetry for a pot divided into three units, or 90-degree rotational symmetry for a pot divided into four units. Angles of radial symmetry become more acute as the artist creates further subdivided units.

Figures 1a and 1b: An *ukhamba*, by Azolina MaMncube Ngema (2006). Six-lobed ridge design, side view and top view. (Photo by Dhanraj Emanuel Photography).

Figure 2a: Unfired vessels by Khulumaleni MaMbambo Magwaza, Mpabalana, KwaZulu-Natal, 2011. (Photo by Laurent Estoppey).



Figures 2b and 2c: Elevation and plan diagrams for a vessel by Khulumaleni MaMbambo Magwaza, shown in Figure 2a (Geometric diagrams by William Clifton Woods).

On a pot shown in Figure 2a drying in the sun prior to firing, MaMbambo has created large arched designs that establish a 90-degree rotational symmetry (see Figures 2b and 2c). In other words, the vessel has four major arches engraved on the surface. Further subdivided units are created by smaller arches, a triangular banded design utilising sixteen upper and sixteen lower sections, and multiple subdivisions within the large arch motifs. It is by this accumulation of subdivisions and textural patterns that largely monochromatic Zulu vessels may be decorated. Radial symmetry is not a hard-and-fast rule in Zulu aesthetics, but it is a technique that is quite common in contemporary production and can be seen in historical works.

The principles of radial symmetry are even more apparent from above, the angle from which many potters see their work during construction and decoration. Both historically and in the contemporary moment, Zulu-speaking women living in rural areas sit on the floor when creating pottery. The bodily mechanics of sitting at floor level with a vessel between one's legs makes it easy to hold up a pot to see it from the side and to see it directly from above. Sitting on the floor is also an important aspect of a Zulu IKS, as part of an architectural system in which rooms are repurposed during the course of the day. Mats are the major form of furnishing and are rotated in and out of historically circular and now sometimes rectilinear dwellings. Sleeping mats are rolled up in the morning and mats are rolled out during the day for women to work or socialise, alongside low benches or stools for men who visit women's dwellings.

Additionally, in the context of both gatherings and private domestic moments when pots are used for drinking, they would be placed on the floor and seen from above. Whether the individual is on a mat or low bench, the pot is placed on the floor in front of the person about to drink and then lifted by each individual in a communal drinking circle. Thus, the side and "birds-eye" views of many traditional South African drinking pots are equally important when considering their geometries and aesthetics. Thus, the use of one's body and space is integral to ceramic design.

Potters often subdivide vessels into halves or quadrants. This tendency is seen even in works that utilise grouped patterns that stand alone on a pot surface (see Figures 3a and 3b). The Nala family is well known for their use of bilateral symmetry that counterbalances two large motifs on opposite sides of a vessel, balanced by two smaller images in the remaining two quadrants. Since the 1980s the Nala family has been creating pots for external audiences who do not drink from these works; nevertheless, they often emphasise the historical use of *izinkamba*. Someone drinking from or observing a vessel with two major and two minor motifs will likely grasp the pot over the minor themes and view the major, highly elaborated motifs frontally.

Figures 3a and 3b: An *ukhamba*, by Zanele Nala (2006). 28.7 cm x 30 cm, side view and top view. (Photos by Michael Cavanagh and Kevin Montague, courtesy Indiana University, Eskenazi Museum of Art).

However, one must not box in or constrain one's perceptions of Zulu ceramics, or any of the other cultural traditions discussed in this article. Asymmetry and symmetry have both been important stylistic tools in ceramists' vocabularies, and regional styles vary. During apartheid, Zulu ceramics were portrayed as "most" typical when they bore *amasumpa* patterns. J. W. Grossert, the Natal "Organizer of Art and Crafts for Native Schools", was appointed in 1948, the year the National Party took power in South Africa, and he later became the national inspector for art education in teachers' colleges for all of South Africa. His widely distributed book, *Zulu Crafts* (1978), was used in classrooms, museums, and galleries as a reference well into the 1990s, which led to an over-emphasis on *amasumpa* and discouraged diversity in creation and collecting (Perrill 2014). Art historians have now acknowledged that *amasumpa* raised bumps are just one motif in complex networks of regional styles (Armstrong 1995; Armstrong, Whitelaw, and Reusch 2008; Jolles 2005; Perrill 2008).

A striking feature of the incised motifs and patterning MaMncube taught to learners at King Bhekuzulu College is that they did *not* obey normatively defined Zulu potting decoration styles. They were innovative improvisations combining principles of radial symmetry that are a part of Zulu ceramic traditions with well-known patterning styles found in Zulu beadwork (see Figures 4a and 4b). This cross-media fertilisation was created by MaMncube decades earlier. The first component of her improvisation was based upon a sophisticated knowledge of radial symmetry. The addition of paints was inspired by illicit trips MaMncube undertook to visit her husband near Johannesburg during the height of apartheid. During the 1970s and 1980s, MaMncube's husband travelled back and forth to the Witwatersrand mines as a migrant labourer, as did many men from KwaZulu-Natal. And, just as migrant labour inspired transformations in Zulu weaving, styles of dress, and other forms of self-representation (Klopper 2011), MaMncube's ceramic art was impacted by this labour structure and her observations.

While travelling, MaMncube saw pots decorated with enamel paint that could have been Sotho or Venda in origin (interview, November 18, 2006). Upon her return home, she began painting on pots utilising patterns and colours suited to the aesthetics of her region, Nongoma. Utilising the complimentary colour schemes of red and green, black and white, with occasional additions

of yellow, MaMncube implied connections to royal Zulu beadwork patterns that are common to Nongoma (Boram-Hays 2015) (see Figure 5). These colour combinations, as well as the translational symmetry often found on beadwork, in which patterns can be repeated by sliding them in a straight line, are seen in her painted pots (see Figure 4), as well as on those of her students at King Bhekuzulu College (see Figure 6).

Figure 4a: An *ukhamba*, by Azolina MaMncube Ngema (2006). 21.4 cm x 23.4 cm. (Photo by Michael Cavanagh and Kevin Montague, courtesy Indiana University, Eskenazi Museum of Art).

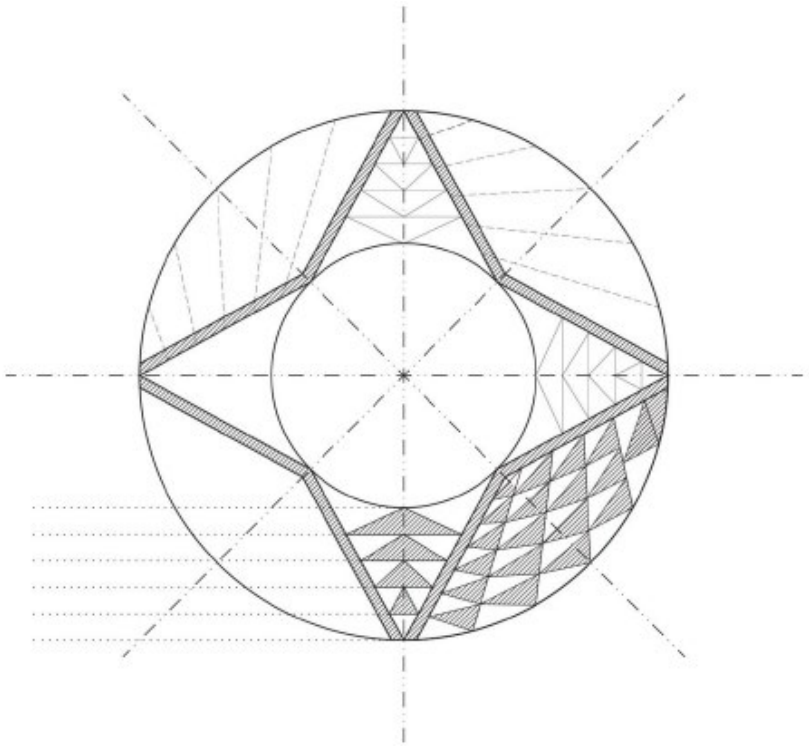


Figure 4b: Plan diagram for the vessel by Azolina MaMncube Ngema shown in Figure 4a. (Geometric diagrams by William Clifton Woods).

Figure 5: An apron, *ubheshwana wezangoma* (worn by young women and old men), by an unidentified artist, Zulu, South Africa (1960s). 12 x 15 inches, glass seed beads, cotton thread, string, fishing wire, "Job's tears" seed beads. Design: shield. (Photo courtesy Axis Gallery, New York and New Jersey).

Figure 6: Azolina MaMncube Ngema displaying student work at King Bhekuzulu College, Nongoma, South Africa. October 2, 2006. (Photo by Elizabeth Perrill).

From the 1980s to the early 2000s, MaMncube did not show the style of painted pots she used for student instruction to external audiences. When selling work to gallery dealers, scholars, and exporters who would stop by her homestead several times a year, this savvy businesswoman sold her blackened *amasumpa* works, which were seen as "typical" of a Zulu potter. All the while, MaMncube was making painted pots on commission for local weddings, funerals, and other

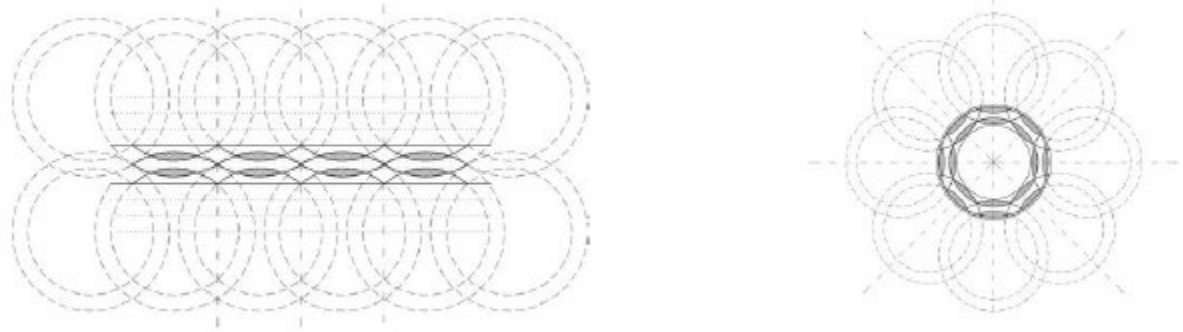
household functions where pots were used to serve guests and to present ancestors with Zulu homebrewed beer. It was this contemporary IKS innovation that was given precedence in Nongoma's schools, rather than the blackened works popular with external buyers.

Lenky Nhlapo: South Sotho Potting at the Doorstep of Tourism

Lenky Nhlapo lives just a short drive from the Golden Gate Highlands National Park, the QwaQwa Nature Park, and the Basotho Cultural Village. Nhlapo's work features the geometric and organic forms linked to *litema* and *marêlla* home decoration patterns (see Figure 7) and is sold at the cultural village near her home. Her work speaks of a complex history with historical transformation and preservation. Nhlapo remembers the use of store-bought paints from her youth, though the range of colours was more limited (Riep 2008). She and her family continue this tradition and are also innovating upon tradition (see Figure 8).

Figure 7: A South Sotho *marêlla* mural near Warden, South Africa, 2009. (Photo courtesy David M. M. Riep).

Figure 8a: The Nhlapo family potters (from left): Selina Nhlapo, Lenky Nhlapo, and Semakaleng Nhlapo. QwaQwa, South Africa, 2009. (Photo courtesy David M. M. Riep).



Figures 8b and 8c: Elevation and plan diagrams for the vessel held by Lenky Nhlapo in Figure 8a. (Geometric diagrams by William Clifton Woods).

A pedagogically innovative school textbook, *Africa Meets Africa: Pathways through the Interior* (Ousman et al. 2011), engages with some nuances of Nhlapo's experience. In this book the concept of a road trip to explore one's own country is integrated with questions of what tourism is in South Africa today and how intellectual growth can be a part of this experience. The *Africa Meets Africa* series of textbooks and instructional materials bring southern African indigenous knowledge into classrooms and is one of several texts integrating mathematics and arts that have been produced both in South Africa and beyond (see, for example, Gerdes 1998; Van Heerden, Smuts, and Getz 2006; Zaslavsky 1999).

Africa Meets Africa: Pathways through the Interior (Ousman et al. 2011) follows two young people, Sandy and Lerato, on a journey in which history, mapping, and politics, as well as mathematics and geometry, are explored first-hand. The textbook that accompanies this narrative provides grade-level exercises. The QwaQwa "stop" in the textbook covers the historical settlement of this region in the 15th to 17th centuries, as well as the establishment of the region as an apartheid-era homeland in 1969 and its achievement of self-governance in 1974. The struggles of contemporary QwaQwa leaders with unemployment are touched upon, as is the importance of the tourist trade as a key to prosperity for this agriculturally poor region.

Mogege Mosimege (2008) and Luckson Muganyizi Kaino (2013) have suggested that the use of cultural villages originally designed for tourists might provide a further source of economic enrichment and retention of mathematics through a connection to social life. Multi-layered re-enactments, renewals, or transformations of local art forms and cultural expressions take place across South Africa in cultural villages. However, the complex portrayals of history at these sites may pose their own problems. Tourist sights often adopt models of self-representation that hover between historical re-enactments and displays of cultural continuity and preservation in the present, and these styles of representing history and culture are often poorly defined and mixed into a problematic anthropological present—a mode of discussing cultures as if they exist outside of time. Tourists and learners alike can become confused. What is a construction of the past? What is a cultural tradition utilised and innovated upon by living artists? Whose vision of history or cultural continuity is being portrayed?

The *Africa Meets Africa: Pathways through the Interior* text points out this slippery boundary between the continuity of traditions and their transformation. This book highlights the conundrum of contemporary South Sotho women who maintain *litema* or *marêlla* wall designs for tourists to view, even though they would prefer to live in brick houses. The Basotho Cultural Village, which sells Nhlapo's work, attempts to historicise this tradition by recreating various Sotho architectural and design changes decade by decade, an approach that allows for the fact that cultures are not static (Ousman et al. 2011, 62).

It is within this framework that one can approach contemporary continuations of pottery traditions with a more sophisticated historical perspective. Enriched by the extensive documentation on the career of Lenky Nhlapo conducted by art historian David Riep (2008; 2014), research conducted by art historian Gary van Wyk (1998) on *litema*, and earlier work of various pottery managers and professionals such as Thaba Bosigu and Peter Hayes (Gers 2015, 302–305), connections between Nhlapo's ceramics and the broader cultural significance of the earth and of *litema* or *marêlla* decorative motifs are made clear: "Women mark their homes with *litema* patterns to celebrate and recall the earth and the abundant crops, plants and flowers that spring from it. Of course, women are themselves linked to the productivity of the earth in fundamental ways as they plant, till and care for the soil, feeding their families with produce from it" (Ousman et al. 2011, 58). *Litema* and *marêlla* may thus evoke both the rain and the earth, where familial ancestors reside. They may also re-create this symbolism in the context of contemporary tourism to satisfy both themselves and touristic expectations. The symbolic connection to water and land and its re-creation is similarly a part of ceramic creativity in the contemporary period. Ceramics utilise raw materials dug from the earth and are decorated using

a similar set of geometric and organic designs that are intellectually tied to a parallel set of connotations.

Amidst this continuation of overarching conceptual categories, contemporary ceramicists in the South Sotho region, such as Lenky Nhlapo, are capable of and interested in subtle decorative innovations. Nhlapo notes that her design work, which is created with the help of her daughter and granddaughter, is created for aesthetic purposes, rather than for conveying specific symbolic meanings (Riep 2008). She and her family improvise upon themes that have been passed down and transformed over generations. They also work in a collaborative manner found in many indigenous ceramics traditions; thus, the output of their homestead has a combined authorship.

When incising decorations in her pots, Nhlapo utilises a starting point similar to that employed by the Magwaza family, described above. She moves along the circumference of the pot, creating distinct bands or registers. Next, she demarcates subdivisions within the radial symmetry of the pot. As mentioned in *Africa Meets Africa: Making a Living Through the Mathematics of Zulu Design*, what makes working in ceramics particularly challenging is how to determine the length of each subdivision in geometric and mathematical terms (Van Heerden, Smuts, and Getz 2006, 32). The length of the radial section is often determined by creating opposing marks on each half of a pot along the circumference and further subdividing these portions in half and half again.

Within each radial division, patterns are created, often utilising repetition and areas of reflective symmetry within the band. The upper and lower divisions of the banded portion are identical when seen along a central, horizontal dividing line, whether implied or delineated through a mark (see Figures 8a and 9). In one vessel decorated by Nhlapo, documented by David Riep, the artist has created elongated rectangular subdivisions with bands above and below this focal design space. This blackened vessel can be seen in Figure 8a (held by Lenky Nhlapo), with geometric sketches provided in Figures 8b and 8c. In the second step of the incising process, Nhlapo drew four arches that intersected within the rectangular areas on this pot. One arch begins at the top corners of the rectangle and the other at the bottom corners of the rectangle, but they do not meet. The two final arches were added beginning from the central points in the left and right sides of the rectangular subdivisions. This technique creates two leaf-shaped spaces, which are decorated with the same small diagonal impressions as those in the bands above and below the rectangular design spaces. Principles of overlap and exclusion, often taught using Venn diagrams, are illustrated quite eloquently by this design process. Readers can see the geometric complexity of this design work in the extrapolated elevation and plans provided (Figures 8b and 8c). These are examples of diagrams that could be used for mathematical instruction.

Figure 9: Selina Nhlapo painting the fine details of a *lefiso*. QwaQwa, South Africa, 2009. (Photo courtesy David M. M. Riep).

The reflective symmetry created during the incising process, which is completed during the leather-hard stage, is emphasised or enriched by Nhlapo's granddaughter Semakaleng and daughter Selina, who paint these vessels after firing. The application of paint can establish colour patterns that maintain the reflective motifs and glide symmetry, a technique in which patterns are inverted and then moved laterally or vertically to create movement in a pattern. A painter may also subdivide a repeated band further by shifting colour repetitions. Thus, a pot with eight identical subdivisions during the unfired stage may become a pot with two sets of four identical subdivisions in its final painted form.

The mathematical and geometric principles that are integral to these South Sotho decorative patterning styles have been transposed easily into mathematical teaching: fractions, angles, Pythagorean calculations. This illustrates one of the key principles in the *Africa Meets Africa* series, which is that South African pedagogical writing and instruction can be integrated with the promotion of cultural pride. I would also suggest that, rather than promoting this type of culturally embedded teaching and learning only within its region of origin, intercultural education and appreciation of both continuity and innovation should be disseminated at a national level. The dissemination of books such as *Africa Meets Africa: Pathways through the Interior* (Ousman et al. 2011) and *Making a Living Through the Mathematics of Zulu Design* (Van Heerden, Smuts, and Getz 2006) needs to continue at the national level to increase intercultural literacies.

Mukondeni Pottery Village: Design, Identity, and Economics in Venda

There are also ceramic traditions that would benefit from further research and pedagogical writing. The Venda potter Sarah Munyai is known for having established a group of potters in 1980. This group, now known as the Mukondeni Pottery Village, is not only a hub for the creation of pottery decorated using the traditional Venda surface treatments of graphite and red ochre, but a focal point of community organising and a location where development organisations are building upon Munyai's legacy.

There is a decided density of Venda ceramic production and coverage in craft and art publications. Noria Mabasa, a ceramicist who was deeply impacted by histories of migration (Harber 1992; Nolte 2005), and Rebecca Matibe have both found a place in histories of South African ceramics as artists who incorporated figural sculpting into their work (Harber 1992; Sellschop, Goldblatt, and Hemp 2002). Phopi Maligana, Ma Thomas, and Mushekwa Litshira have been acknowledged as prominent artists within the genre of Venda potting (Cruise 1991, 130–33; Krause 1998). However, it is in the work of Sarah Munyai and the Mukondeni Pottery Village that the continuity of geometric thinking can be traced most readily. In many ways, the exceptional status of figural sculpture has received more scholarly attention than the masterful geometry of Venda pottery that predominates in contemporary markets.

When Sarah Munyai founded the Mukondeni Pottery Village in 1980, the group was operating in the Venda "homeland", in what is today the north-western region of the Limpopo province. The creation of workshops and small spaces for sales and trade in self-ruling "homelands" was a practice encouraged by the apartheid-era Department of Arts and Crafts and taken up by the Venda Development Corporation. As Anitra Nettleton has noted, "[w]hile there had undoubtedly been some form of ethnic consciousness in Venda in earlier years, there was, from the late 1930s onwards, an increasing emphasis on a cohesive or monolithic Venda ethnic consciousness, cultivated in various ways" (Nettleton and Hammond-Tooke 1989, 81; cited in Carmen 2011, 77).

The maintenance of strong geometric patterns, delineated using graphite and ochre, has continued as a strong form for Venda self-identification and self-promotion (see Figure 10). The traditional eye-catching contrasts of graphite and ochre have made ceramics a widely disseminated icon of Venda identity. Vessels decorated with oil-based paints are far less prominent in both scholarly literature and in contemporary marketing sites (Coetsee 2002; Cruise 1991; Madi a Thavha Mountain Lodge 2015; Sellschop, Goldblatt, and Hemp 2002; South African Tourism 2015). This points to a value that is placed on the unique materiality of the Venda ceramic tradition.

Figure 10: Sarah Munyai outside her home, n.d. (Photo courtesy Susan Sellschop).

During the late 1980s and early 1990s, when Noria Mabasa and Rebecca Matibe were gaining widespread acknowledgement from the South African "fine art" world (Nettleton 1988; Rankin 1990, 38), several artists focusing on vessels—Phophi Maligana, Sarah Munyai, and others—were also realising that emerging craft art audiences required modified aesthetic choices in the domestic vessel genre (Cruise 1991, 132). To highlight the geometric mastery of Venda aesthetics, Maligana and others began decorating the interiors of flat *ndongwana* meat or food bowls, which would have historically been embellished only on the exterior (see Figures 11a and 11b).

Figures 11a and 11b: Venda *ndongwana* bowl, artist unknown (2004). 8.5 cm x 26 cm, side view and top view. (Photo credit Dhanraj Emanuel Photography).

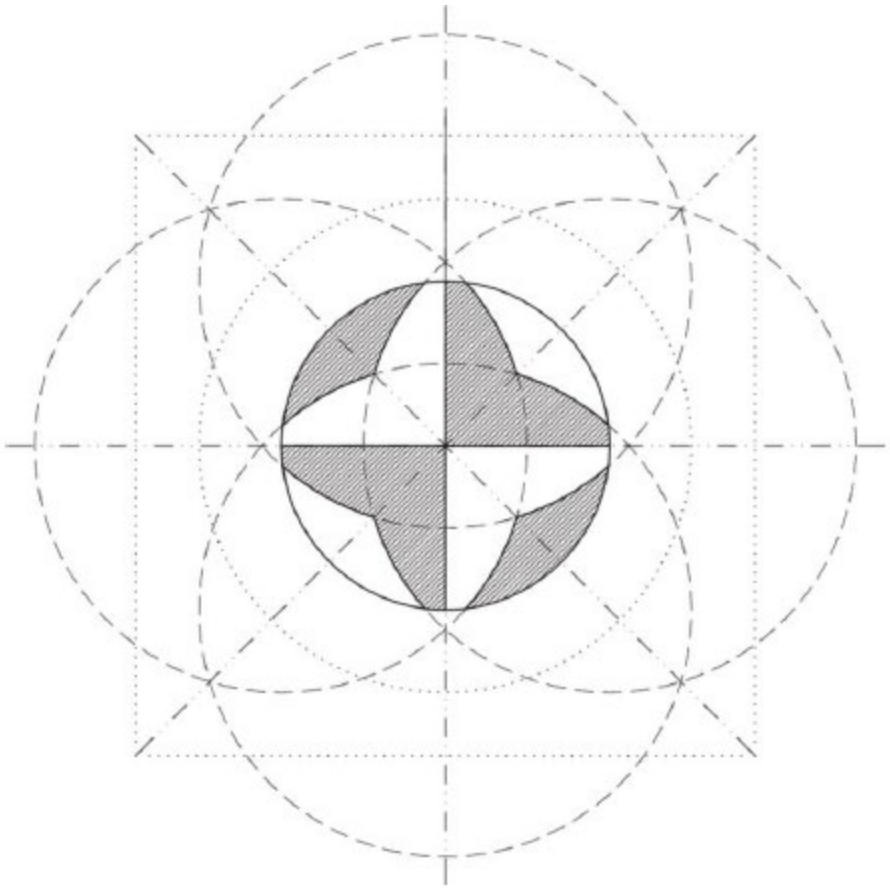


Figure 11c: Plan diagram for the unsigned Venda vessel shown in Figures 11a and 11b. (Geometric diagrams by William Clifton Woods).

When viewed from above, as they would be in both the sale venues and eventually on the side tables or coffee tables implied by the tourist market, these designs often emphasise bilateral or 90-degree radial symmetry. Like the Zulu and Sotho beer vessels discussed above, *mvuvhelo*, Venda beer pots, often include further radial subdivisions, utilising a system of banding and the demarcation of curves discussed. The breadth of Venda geometric improvisation does not end here. Concentric circles, spirals, or figurative decoration can be found on the expanded range of vases, jugs, plates, and vessels that appear in publications, at roadside markets, in art centres, and in online sales venues (see Figure 12). Despite a very strong and historically reinforced identity, Venda potters improvise and expand to meet market demands. The use of geometric systems of subdivision that are part of the historical tradition of Venda ceramics means that permutations of subdivisions, mirror symmetries, or glide symmetries are par for the course in any artist's improvisational tool kit.

When speaking of her lineage, Sarah Munyai emphasises the importance of her female ancestors as a source of her knowledge and work ethic: "My mother taught me how to make pots when I was a girl, and her mother taught her before that … All our mothers and grandmothers and great-grandmothers made pots. My mother sold her pots for five cents. I remember how we used blankets to keep the clay wet before there was even plastic. For over 80 years I have made pots" (in Hilton-Barber 2012).

Figure 12: Large-scale vase forms, Mukondeni Pottery Village. (Photo courtesy Susan Sellschop).

The above quotation highlights the broad realisation on the part of dozens of rural women that the undervaluing of their work has been going on for generations. Munyai notes that she remembers the time when her mother's work was sold for a mere five cents. Jabulile Nala from KwaZulu-Natal has also noted how her mother's labour and expertise was not sufficiently valued, as she sold work for five or ten cents a vessel during the 1970s or 1980s (interview, July 4, 2019). Engagement with external economies and adjustments in working methods require concomitant adjustments in compensation, a topic of continual discussion and negotiation for Zulu, South Sotho, and Venda artists. Artists and development initiatives throughout South Africa have worked to ensure that rural craft is now generally highly valued and that these works command higher prices.

The potters of Mukondeni Pottery Village have embraced diversification of ceramic production in a way that has created greater stability for both those living in the village and others working at the Mukondeni pottery factory. Scientific analysis has been conducted on the three different ceramic materials at Mukondeni to ensure that this raw material can be used for ceramic water filter production (Amponsah-Dacosta, Muzerengi, and Mhlongo 2013). Unsurprisingly, the scientific analysis concluded what Venda potters have known for years: mixing the red, green, and black clay types in the region results in optimal levels of plasticity and reduces cracking.

Conclusion

The potters of the Zulu, South Sotho, and Venda cultural regions of South Africa have, for generations, understood that the geometric principles of radial symmetry and patterning must be mastered when decorating circular and spherical forms. When we take part in acts of codification, labelling methods of decoration and design in different knowledge systems, we are translating this pre-existing knowledge. Speaking of radial symmetries, degrees, or radii allows a broader public to access the visual expression of South African potters and provides a point of access for students familiar with these forms into a new vocabulary.

The progressive pedagogical approaches being employed in South African schools that seek to bring mathematics and art curricula together form a unique lens through which one can view this diverse nation and its artistic output. Bringing masters of IKSs into the classroom, publishing new textbooks or materials that integrate mathematics and art, and identifying rural traditions still practised that can be incorporated into classroom units are all mechanisms that can be leveraged to decolonise classrooms. It is clear that by foregrounding rural women's projects that demonstrate mathematical reasoning, pedagogues are seeking to challenge stereotypes of supposed rural "ignorance" and to bring IKSs to the fore. This article has presented three ceramic regions and three examples of radical change that could help promote South African ceramics and engage with the instruction of geometries.

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