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Chains, Ladders, Ciphers, and Glyphs: The Development and Standardization of Central Javanese Gamelan Notation

A number of authors have discussed the circumstances and motivations underlying the initial creation of notation for Central Javanese gamelan in the late 19th century, as well as the ways in which notation has potentially altered musical practice. Among these are Becker (1980), Sumarsam (1995), Ishida (2008), Sutton (2001), and most recently Hand (2018) and Rizzo (2020). This paper takes a different approach in that it compares the underlying features of many different notational systems and ultimately aligns them into a single historical narrative. Of particular interest is the role that print technology—first the typewriter, later the personal computer—had in shaping the development of notation.

For sake of clarity, the overview of notational systems is divided into three sections: *gendhing*, vocal, and kendhang. The first section concerns notation used for recording the composition i.e. gendhing itself. All forms of gendhing notation are ultimately based on the *balunganning gendhing* (literally "skeleton of the gendhing"), a slow-moving, abstract melody spanning up to two-and-a-half octaves. In practice, the balunganning gendhing is played by instruments such as the saron, demung, and slenthem but in a reduced, one-octave form. This is then referred to simply as the *balungan*.[1] As will be discussed, gendhing notation was eventually adapted to notating the parts of individual instruments. The second, shorter section concerns vocal notation. The third section concerns notation for the drum or kendhang, especially the mid-sized *kendhang ciblon*. Finally, there is a section ("The digital era") that discusses computer fonts designed for notating Javanese gamelan. This paper assumes a basic familiarity on the part of the

[1] For more on the distinction between *gendhing*, *balungan(ning) gendhing*, and *balungan*, see Supanggah (2009, 7-20), Sumarsam (1975b), and Perlman (2004).

reader regarding the names and functions of the gamelan's instruments, as well as the slendro and pelog tuning systems.

Gendhing notation

1. Pakulaman notation. Purbodiningrat (1956, 256) states that the hereditary ruler of Pakualaman,[2] Sri Paduka Paku Alam V, developed a notational system prior to 1878. This would make it the oldest system under consideration. Kunst (1949, 349-50) states that both it and *nut åndhå* (discussed in the following section) represent the earliest systems, but does not specify a year of origin for the former. He does, however, provide an image of the notation (Figure 1) as well as a brief description. The Pakualaman system is a notation of the single-octave balungan written on a horizontal, seven-line staff. Rather than ciphers or noteheads, characters from Javanese script that correspond to the solmization of tones are placed on the underside of each staff line.[3] These characters are then linked by vertical lines, with those falling on gong circled. Based on a description by Buys (1940, 26), it appears that a number placed underneath a character indicates a held tone; there are no other rhythmic markings or divisions. Notably, lines lower on the staff correspond to higher tones, and vice versa.

2. *Nut åndhå*. Commonly translated as "ladder notation," nut åndhå (Figure 2) was developed within the Yogyakarta court and made its first appearance in 1889 in manuscript titled *Serat Pakem Wiråmå* (Sumarsam 1995, 111). It has also been referred to as "graph" (Sindoesawarno 1955, 339) or "chequered" notation, from the Dutch *ruitjesschrift* (Kunst 1949,

[2] There are two major and two minor courts in Central Java. The Keraton Yogyakarta and Pakualaman are the major and minor courts of Yogyakarta, respectively. The Keraton Surakarta and Mangkunegaran are the major and minor courts of Surakarta, respectively.

[3] In this now-obsolete system, tone 1 = *bem*, which is then abbreviated as *be* when solmized; 2 = *gulu* = *gi*; 3 = *dhadha* = *dha*; 4 = *pelog* = *pe*; 5 = *lima* = *ma/me*; 6 = *nem* = *ni*; 7 = *barang* = *ba*. Today, the common method of solmization is based on the numbering of tones in low or *ngoko* Javanese: 1 = *siji* = *ji*; 2 = *loro* = *ro*, 3 = *telu* = *lu*, 4 = *papat* = *pat*, 5 = *lima* = *ma*, 6 = *nem* = *nem*, 7 = *pitu* = *pi*. See Kunst (1949: 443) and Ishida (2010: 282).

349). Nut åndhå resembles a vertical staff read from top to bottom, with regularly spaced horizontal lines indicating division of time. Noteheads placed at the intersections of these lines represent the saron part i.e. the single-octave balungan. Additional symbols on the left-hand side refer to colotomic instruments (gong, kethuk, kenong, kempul), and those on the right-hand side refer to a limited variety of kendhang strokes.

3. *Nut ranté*. This "chain notation" (Dutch: *kettingschrift*) was first developed by an official of Mangkunegara IV (r. 1853-1881) (Sumarsam 1995, 108). It was later given to the court musician Gunasentika, who in turn presented it to his *papatih dalem*—the prime minister Sasradiningrat IV—as "an expression of his esteem, his obedience, and the joy in his heart" (Warsadiningrat 1972, 165; Sumarsam 1995, 108). Thus from its inception, nut ranté had the quality of being a symbolic offering rather than a practical tool for day-to-day use by musicians (Ishida 2010, 281). Be that as it may, nut ranté served as a necessary predecessor to nut ångkå or *kepatihan* notation, which will be discussed in a following section.

In nut ranté, noteheads are placed on a six-line staff. Read from bottom-to-top, these lines represent the pitches 1/7, 2, 3, 5, 6, and high 1/7. Note 4 of the pelog tuning is indicated by placing a notehead in the space between the lines for 3 and 5 (Ishida 2010, 275). These noteheads are then linked together by curved line segments, as if forming a chain. Beneath the staff, indications for gong and kenong are written in Javanese script. Similar to the Pakualaman notation, nut ranté is not organized into metrical units. However, there are some ways to indicate changes in note duration, such as omitting a curved line segment to indicate a single beat rest.

Beyond this, it becomes more difficult to generalize about nut ranté's features. Between Ishida (2010, 281) and Perlman (1991, 48-51), three distinct forms of nut ranté are identified. Two of the three are capable of expressing the multi-octave course of the balunganning gendhing, one

by modifying the shape/position of the noteheads (Figure 3), and the other by incorporating both dashed and solid line segments (Figure 4).

There are two main takeaways regarding nut ranté. First, it was likely not used to any significant extent. As Ishida notes (2010: 281), there was little demand for the notation among experienced musicians. Nor does it seem that nut ranté was ever effective as a teaching aide. Purbodiningrat comments that nut ranté "was taught to the king's children and relatives in the kepatihan [the *patih*'s residence]," but also that "it was somewhat difficult to understand" (1965: 165). Gitosaprojodo is even more direct, stating "The old system of notation [nut ranté]...is no longer popular because it is felt to be old-fashioned and difficult" (1970, 357). The second takeaway is that musicians of that era (particularly those of Mangkunegaran and Keraton Surakarta) were very much cognizant of the multi-octave melodic structure of gendhing, and were grappling with how to express this and other previously unwritten information in notational form. This is evidenced by two different approaches to marking register in nut ranté, an innovation that was absent from nut åndhå and the Pakualaman notation but would reappear in nut ångkå/kepatihan.[4]

4. Staff notation and *trappenschrift*. Kunst (1949, 354) makes passing mention of two systems based on Western staff notation. The first, developed by R.M. Suryaputra, places noteheads on a four- or five-line staff, depending on whether the gendhing is in slendro or pelog. The second, developed by Jayadipura-Linda Bandara, places noteheads on a single seven-line staff for both tuning systems. For lack of additional explanation or example, one would assume that other aspects of these systems take after Western staff notation. Kunst is of the opinion that "both

[4] Kunst (1949, 351-4) explains that nut åndhå is capable of expressing register with the addition of small slanted strokes to the noteheads. It is not clear from the passage whether Kunst is describing something already in practice or personally advocating for its adoption. The nut åndhå in the *Serat Pakem Wir*åmå (Figure 2) does not utilize these markings.

may be used…for complete orchestral scores" (1949, 354), language that further attests to their Western roots. In any case, there is little evidence for either ever have been utilized.

There is a system of notation described by Kunst as "wave-line-degree script." (1949, 355). This seems to be what is erroneously called ladder notation (i.e. nut åndhå) by Purbodiningrat[5] (1956, 256). While the two authors' descriptions are only cursory and differ substantially from one another, the evidence that they are referring to the variants of the same system is that both mention the use of black, red, blue, and possibly green inks for different symbols. No other system is known to have made functional use of color. This may possibly be connected to what Buys (1940, 15) describes as the *trappenschrift*[6] ("staircase notation") of 1910, which simultaneously notates the balungan and the kendhang part by way of "colourful drum notation." It is unknown whether "colourful" in this context can be taken literally to mean different colors of ink, as Buys's example (Figure 5) is reproduced in black and white. However, other parts of Kunst's ("dots and figures...on imaginary staves...connected by more or less wavy, vertical lines") and Purbodiningrat's ("a system [that] indicates the course of the *irama*" [tempo/metrical subdivision]) statements support this connection.

5. *Nut ångkå/kepatihan* notation. Nut ångkå ("cipher notation") "was devised in 1893, by Wreksadiningrat, a prominent nobleman and musician" (Hastanto 1985, 36). Nut ångkå eventually became known as kepatihan notation, taken from name of the prime minister or *patih*'s complex

[5] Confusingly, the actual nut åndhå is then dubbed New Yogyakarta Kraton Notation. This is verified by Purbodiningrat's description: "It differs from the others in that it is read from top to bottom. All of the gendhing in the book *Pakem wiromo-wilet gendhing berdongga naliko amurwani ing* tahun Alip 1819 [AD 1897]...are written in this notation" (1956: 256). It is unknown whether this is the result of a mistranslation or Purbodiningrat's own error.

[6] Similar to the naming error in Purbodiningrat's manuscript, Buys's *trappenschrift* is translated as "ladder notation." The Dutch word for ladder is, in fact, *ladder*. This means that ladder notation would be reverse translated as *ladderschrift*, a term which was apparently never used. *Trappen*, on the other hand, means staircase. Therefore, *trappenschrift* must refer to a notation that resembles a staircase, rather than a ladder. Misuse of the term ladder notation likely stems from the fact that unlike in Dutch or English, stairs and ladders are not differentiated in Javanese and Indonesian.

in Surakarta where Wreksadiningrat (also known as Jayasudirja) resided at that time. Evidently, kepatihan notation was developed in response to the deficiencies of nut ranté, namely the difficulty by which it is both written and read. In kepatihan notation, the keys of the saron are simply assigned a number 1–7 (Warsadningrat 1943, 164-5), and the sequence of numbers corresponding to the balungan written down. In this way, beginning musicians could essentially "play by the numbers." While visually levels of magnitude simpler than nut ranté, kepatihan notation in fact conveyed exactly the same musical information (Ishida 2008, 486).

According to Sindoesawarno, Wreksadiningrat "compiled a notational system using numbers (ångkå), similar to the Galin-Paris-Chevé system, which he already knew" (1955, 339). The Chevé system is a form of cipher notation developed in 19th century France for purposes of teaching sight-singing, and which was based on an earlier system of Rousseau's. By the time nut ångkå was introduced by Wreksadningrat, the Chevé system had already been in use in the Netherlands for a number of years (Rainbow 2001). In describing the "special notational symbols" of kepatihan notation, Gitosaprodjo (1970, 358) explicitly attributes register dots, dots for rests, below-cipher phrasing arcs (used for vocal melismas), vertical bar markers, and single or double above-cipher lines for marking rhythmic subdivisions "to the Chevé (1804-1864) system of notation." Today, only the vertical bar markers are no longer used, having been replaced by spaces.

Indeed, the only things that truly differentiate modern-day kepatihan notation from the Chevé system are its specific application and its inclusion of additional symbols, such as those for representing the colotomic instruments. Combined with the above statements by Sindoesawarno and Gitosaprodjo, it might be assumed that Wreksadiningrat simply took the Chevé system from Dutch informants and applied it to the gamelan. However, this assumption does not hold up when looking at historical examples of kepatihan notation. Aside from the use of ciphers, early versions

of kepatihan do not closely resemble the Chevé system. It seems rather that features of the Chevé system were integrated into kepatihan notation over time as an indirect result of the Dutch using it for teaching Western music starting in the early 20th century (Sumarsam 1995, 302).

The earliest example of kepatihan notation appears in an untitled manuscript dated 1894 or 1895 (Ishida 2010, 284). This notation (Figure 6) does not employ bar lines, spacing, or other metrical organization. The ciphers representing balungan tones are simply written one after the other, with commas indicating rests. There are, however, symbols for kenong (N) and gong (g) written following the cipher on which they fall. Underlines indicate rhythmic subdivision.

A somewhat later example (Figure 7) appears in a book of notation authored by Gondopangrawit, presumably around the year 1910 (Ishida 2010, 283). It is mostly similar to the previous example, except that each *kenongan*[7] is written on a separate line. These lines are also numbered in the margins for easy reference. A broken circle enclosing a cipher marks the point or departure or arrival for transitioning from one section of a gendhing to another, not unlike a *del segno* in Western music. The same approach (minus the line numbering) is used in a 1913 instructional manual by Djakoeb and Wignjaroemeksa.

In Buys's example from 1924 (Figure 8), we can see the beginning of true metrical organization; that is, the grouping of the balungan into regular four-beat units. This was initially accomplished with bar lines (or if typed, with slashes) in the manner of the Chevé system. As a result, the bar lines are placed before the strong beat, in effect treating notes in that position as the downbeat of a new measure (Sumarsam 1995, 113). This misrepresents the end-weighted nature of gamelan music, in which the strong beat marks the close, rather than the beginning, of a bar or

[7] *Kenongan* refers to a musical phrase which spans the length from one strike of the kenong to another. In this particular example, one kenongan contains 16 balungan pulses.

measure. Over time, these bar lines were shifted to the correct position, and then dropped entirely in favor of spaces.

According to Sindoesawarno (1955, 342-343), it was in the 1950s with the establishment of the Konservatori Karawitan Indonesia (KOKAR) in Surakarta that kepatihan notation was applied to the task of notating individual instruments. The instructor Wirowijogo developed notation for the gender and gambang. As these instruments are played with two hands, their notation is written on two lines, the upper for the right hand and the lower for the left. This method was subsequently applied to the siter/celempung[8] as well as the bonang, in which the two lines correspond to the upper and lower rows of kettle gongs. Wirowijogo also developed notation for the rebab, in which the symbols < and > indicate bowing direction and the letters *a* through *d* indicate left hand fingering. Gitosaprodjo (1970, 358) is of the opinion that the now-standard symbols for gong (a circle around a cipher), kenong (a downward curve or semicircle over a cipher), and kempul (an upward curve or semicircle over a cipher) also originated at KOKAR.[9]

The form of kepatihan developed at KOKAR was subsequently adopted by Akademi Seni Karawitan Indonesia (today ISI Solo) and Akademi Seni Tari Indonesia (today ISI Yogyakarta) starting with their founding in the 1960s. No doubt it also spread outside of conservatory circles, as instructors at such institutions are characteristically also freelance performers/teachers, associated with one or more of the courts, or both. Aside from minor stylistic changes, the kepatihan notation commonly used today is fundamentally the same as it was in the 1950s, both for notating gendhing as well as individual instrumental or vocal parts.

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[8] For example, a 1983 instructional book from ASTI Yogyakarta titled *Cengkok-cengkok Clempungan/Siteran.*

[9] In practice, because these symbols are not easy to reproduce on a typewriter, there are many publications post-1950s that use) for kenong and ( ) for gong. For example, Djumadi's *Titilaras Rebaban* (1975), Martopangrawit's *Catatan Pengetahuan Karawitan* (1975), or Sukardi and Sukidjo's *Gending-gending Jawa Gaya Yogyakarta* (1976). Other colotomic instruments are generally not notated.

Vocal notation

There are few examples of vocal notation that are not derived from *kepatihan*. Generally, the syllables of the song text are written under the notated melody. A bracket or arc spanning beneath multiple ciphers indicates a melisma. Sometimes, the song text is written separately, especially if it consist of multiple verses.

Ishida (2010, 276-8) describes a system of vocal notation called *widyåswårå* that has more in relation to (or possibly even gave birth to) nut ranté. It is written on a 13-line staff, corresponding to the range of vocal melodies. Two types of widyåswårå are known. In the first (Figure 9), the song text is written underneath the staff. Instead of noteheads, Arabic numerals are placed on the staff that refer to the numbering of syllables within a line of song text. These numerals are then connected by curved lines in the manner of nut ranté. In the second type (Figure 10), the song text is written directly on the staff and connected by a variety of curves which carry information about vocal ornamentation.

Next is Warsapradonggo's notation for *santiswårå* (Figure 11), a genre of worship song originally accompanied by the rebana/terbang or frame drum (Darusuprapta 1989, 24-6). It appears in Warsapradonggo's 1915 book simply titled *Santiswara*, but is belived by Buys (1940, 35) to go back to 1907. It is a cipher notation, but unlike typical kepatihan vocal notation has additional ciphers written above and below the main melody, connected by either solid or dotted lines. Buys does not go into detail about the meaning of these lines, but comments that they relate to the practice of singing instructors "indicating the text as well as sketching the contours of the melody with his stick" (1940, 36), implying some form of conducting. Not incidentally, in the preface of Warsapradonggo's book there is a sketch (Figure 12) of what appears to be like a conductor.

Neither widyåswårå nor Warsapradonggo's santiswårå notation seem to have had much of an impact, as there are few extant examples of either. However, they both point toward a shortcoming of kepatihan notation; that is, its inability to fully capture the nuances of vocal ornamentation. Be that as it may, these two systems were rendered obsolete once kepatihan notation became commonplace.

Kendhang notation

Drumming or kendhang notation is addressed separately for two reasons. First, when used in conjunction with kepatihan notation, the kendhang is the only instrument in the gamelan to receive with its own distinct set of symbols which may be used for no other application. Second, its historical development was parallel to, but not quite concurrent with, that of kepatihan notation. Whereas the advent of kepatihan notation proved to be paradigm-shifting, there was no comparable revolution in kendhang notation. Rather, it was developed piecemeal in response to the demands of teaching kendhang in institutional settings.

As far back as the 1950s, there was the sense that kendhang notation suffered from lack of standardization. Writing from his post at the then recently established KOKAR in Surakarta, the instructor Sindoesawarno lamented, "At this time kendhang notation is the least systematized notation. It can be said to be out of control. Everyone does as he pleases" (1955, 344). The same perception was echoed by Sumarsam some twenty years later: "However, even today drumming notation is not uniform. Notation may vary from group to group and even from teacher to teacher" (1975, 175). While the various methods for notating gendhing and even specific instrumental/vocal parts more or less converged into a single model during the early years of KOKAR, notation for kendhang has—and to some degree, continues to—defy standardization.

Perhaps the main obstacle is simply that the kendhang (in particular the mid-sized kendhang ciblon or *batangan*[10]) produces a greater number of distinct sounds than any other instrument in the gamelan. Whereas the individual keys, gongs, and strings of other instruments can simply be assigned an octave-repeating solfege syllable or numeral 1 through 7, each head of the kendhang can produce a multitude of different sounds depending on both the position of the hand (rim, edge, or center) and the stroke technique (open, closed, sliding, tapping, etc.). The situation becomes yet again more complex for sounds that are produced through a combination of left- and right-hand strokes, either rendered simultaneously or slightly offset in time.

The sounds of the kendhang can be vocalized using onomatopoeic syllables in a form of rhythmic solfege referred to as *kendhang cangkem* (Javanese: mouth drum), *kendhang mulut*, or *kendhang secara lisan* (Indonesian: mouth drum, spoken drum). This practice serves as a pedagogical/mnemonic tool, as is even a feature of certain a capella performance styles like *wayang jemblung*.[11] Kendhang cangkem exists prior to, and ultimately independently of, notation. Therefore, an ideal system of kendhang notation would directly reflect this vocalization, with as many unique symbols as there are rhythmic solfege syllables.

According to Sumarsam (1995, 112-113), the earliest known kendhang notation appears in a manuscript attributed to Gondapangrawit, a musician of the Keraton Surakarta. It was likely written around 1910 (see Ishida 2010, 283 for clarification of dates). A handful of patterns are notated using Javanese script to literally spell out the *kendhang ageng* strokes *dhang* and *dhung*, with dots in-between serving as rests.

[10] There are three basic kendhang configurations. The first, known as *kendhang satunggal*, uses the large kendhang *ageng*, optionally with a second person playing a repeating pattern on the small kendhang *penunthung/ketipung*. The second, known as *kendhang kalih*, combines the kendhang ageng with the kendhang ketipung. The third is the mid-sized kendhang ciblon/batangan played alone.

[11] For information on *wayang jemblung*, see Lysloff (1990).

Another early example of kendhang notation is found in the 1913 instructional manual by Djakoeb and Wignjaroemeksa mentioned previously. The entire manuscript is typed. The main text is in Javanese script, produced by means of a special typewriter.[12] The few examples of kendang notation (Figure 13) use upper-case Latin characters for the drumstrokes *dhang/dhah* (B) and *dhung* (D), the position of kenong (N) and gong (G), as well as section headings (W., A., AC., etc.). The subscript 1 is used for rests, whereas subscripts 1-4 placed adjacent to an N refer to the sequence of kenong strokes within a gong cycle. Similar to other early forms of notation, there was no attempt to organize the material into metrical units.

A quite different approach to kendhang notation appears in the 1924 text *Boekoe piwoelang naboeh gamellan* by Djatiswara and Lebdapradangga. This notation for kendhang ciblon places the left- and right-hand parts on separate lines. Buys (1940, 17) provides an example (Figure 14), but does not comment on what drumstrokes the symbols represent. However, it can at least be deduced that the lower "B" line corresponds to the larger drumhead known as *bem*, and upper "Pg" line to the smaller drumhead known as *kempyang*.

As evidenced by the previous two examples, even by the early 20th century it was important that notation could not only be written but also typed. It was also becoming increasingly common to print Javanese in Latin script based on Dutch orthography (see discussion in Robson 2011), meaning that the main device used in the production of manuscripts became the standard European typewriter. For that reason, kendhang notation became restricted to the symbols available on such machines. In Figure 15, it can be seen that Sindoesawarno (1955), Martopangrawit (1972),

[12] It is unclear when such typewriters (Javanese: *mesin tik huruf Jawa*) were first developed or how common they were. The Museum Penerangan in Jakarta has one in its collection, a modified Royal "Bar-lock" model purportedly used by the the Keraton Surakarta as early as 1917. (See: https://muspen.kominfo.go.id/koleksi/single?id=228). This particular machine has keys for Arabic numerals, but no Latin characters.

Sumarsam (1975), and Romo Kawindro/Sri Atmojo's[13] kendhang notations all reflect this reliance on typewriters. In the latter two cases, there are a number of novel symbols produced via overtyping.

The digital era

With the 1980s came the age of the personal computer, and with it word processing programs that would rapidly supplant typewriters. This technological transition brought with it new opportunities, namely the ability to design kepatihan-based fonts for notating gamelan music. While the impact of these fonts can be clearly seen today both in Java and among the international gamelan community, virtually nothing has been said about them in the literature. For example, a recent graduate thesis as well as an article by Institut Seni Indonesia (ISI) Solo author Rusdiyantoro (2011; 2018), both devoted entirely to the subject of kepatihan notation's development, make no mention of such fonts and only passing reference to the role of digital technology. Yet, current Indonesian authors such as Rusdiyantoro will more often than not utilize these fonts in their writing. From my experience living in Yogyakarta from 2015 to 2020, I have also noticed the frequency with which they are used by contemporary gamelan composers for generating musical scores. While still largely unacknowledged, the actual importance of such fonts to current musical practice and scholarship is substantiated by the Keraton Yogyakarta releasing their own font in 2020 called Kridhamardawa.

The first computer font made specifically for the purpose of notating Javanese gamelan was the creation of Carter Scholz, an American composer. Dubbed Kepatihan (not to be confused

[13] This notation is still used for instructional purposes at Institut Seni Indonesia, Yogyakarta. I first saw it in handwritten form, but based on its character set and parallels with the other systems, it was clearly intended to be compatible with typing. Nowadays it is commonly reproduced using the KepatihanPro font, as the two have a high degree of compatability. Unfortunately, I have been unable to ascertain what year this notation was developed.

with the lower-case kepatihan, which refers to cipher notation more generally), this font was designed for Macintosh computer in 1986-1987 using the recently released Fontographer program. According to Scholz, he initially developed Kepatihan for his own use, combining his dual interests in typography and gamelan to "organize and make more legible the handwritten gamelan notation...that I was amassing as I learned" (Scholz, email message to author, 24 November 2020). Word of Kepatihan got out among gamelan players in the Bay Area—figures like Jody Diamond, Ben Brinner, and Alex Dea—and Scholz used their feedback to further refine the notation. The first published use of Kepatihan was in the journal *Balungan*, of which Scholz served as Art Director.

There were two main advantages to using Kepatihan over standard fonts. First, it made it possible to type ciphers and their upper/lower register dots at the same time, as opposed to having to manually insert dots after the fact. Second, it allowed for the addition of various symbols to ciphers without affecting character spacing. For example, a passage[14] formerly typed as...

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 t    t N  t    t N
2123 2126 33.. 6532
5653 2126 2123 2126G
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...could now be easily outfitted with register dots and the full range of symbols for colotomic instruments:

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-+-  -+-⁀ -+-⌣ -+-⁀
2123 2126̇ 33.. 6532̂

-+-⌣ -+-⁀ -+-⌣ -+-
5653 2126̇ 2123 212(6̇)
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According to Scholz, "The various symbols for kethuk, kempyang, kenong, kempul, gong, et cetera were our common practice, following Pak Cokro most likely." Pak Cokrowasito (also

[14] This particular style of notation, with Latin characters placed either above or next to ciphers to represent the colotomic instruments, is used throughout Volume 3, Appendix 2 of *Karawitan: Source Readings in Javanese Gamelan and Vocal Music* (Becker, 1984).

known as K.R.T. Wasitodipuro/Wasitodiningrat or K.P.H. Notoprojo) was a hugely influential figure in the growth of gamelan in the USA, having taught at CalArts from 1971 until 1992 in addition to a number of other programs. For the most part, the symbols passed down through Pak Cokro to Scholz and others are the same as those popularized at KOKAR and ISI Solo/Yogyakarta.[15]

While conducting research in 1994 for a master's thesis, Matthew Arciniega developed a new font for Macintosh based on Scholz's model, but with greatly expanded capabilities. What would come to be known as KepatihanPro (to avoid a naming conflict) contained all the symbols necessary for notating rebab, vocals, and kendhang. Like Scholz, he developed the font for his personal use. However, according to Arciniega, "By the later 1990s I was no longer pursuing my gamelan studies, so it languished" (Arciniega, electronic message to author, 3 December 2020). Fortunately, fellow friend and gamelan player Raymond Weisling stepped in and generated both Adobe PostScript and Windows TrueType[16] versions. This enabled the font to be used on—and sent between—any current Apple or Microsoft machine. KepatihanPro was publically released in 2000, and is hosted on the American Gamelan Institute website (gamelan.org).

For lack of documentation, it would be difficult to accurately trace the spread of KepatihanPro in Java. But having lived in Yogyakarta from 2015 to 2020, my own observation is that KepatihanPro is now not only commonplace, but even serves as a kind of common standard between students, instructors, scholars, and composers. It must have been readily adopted by

[15] According to Gitosaprodjo (1970: 358), practitioners at KOKAR originally used an upward caret for kethuk and a downward one for kempyang. Over time, these changed to a plus (+) and minus (-) symbol, respectively. As can be seen in his collection of handwritten notation, *The Vocal Notation of K.R.T. Wasitodiningrat* (1995), Pak Cokro favored the latter style.

[16] First released in 1984 by Adobe, PostScript is a programming language used for print formatting (see: https://www.adobe.com/products/postscript.html). TrueType is both a collection of fonts as well as software (a "rasterizer") that controls the appearance of font characters. It was originally developed by Apple but was later incorporated into the Windows operating system in1992. See: https://docs.microsoft.com/en-us/typography/truetype/

schools for the arts, because Arciniega based its symbols on his own studies at ISI Solo (Arciniega, electronic message to author, 3 December 2020). At a minimum, it is now used in the majority of gamelan-related publications out of ISI Yogyakarta and Solo.[17] The previously mentioned *Serat Pakem Wiråmå*, an 1889 collection of nut åndhå notation from the Keraton Yogyakarta, was converted to cipher notation using KepatihanPro and published in 2005 by the Cultural Office of Yogyakarta.

In July of 2020, the Keraton Yogyakarta released its own font called Kridhamardawa. The press release[18] specifies two main reasons for its creation. First, the characters of KepatihanPro are too thin/light and can be hard to read, especially for older musicians. Second, the default line spacing of KepatihanPro is too large, leading to inefficient use of page space. Kridhamardawa boasts a number of other features, such as additional symbols for kendhang (see Figure 15), the introduction of a grace note symbol for vocal ornamentation, and register dots and colotomic symbols that are automatically positioned closer to ciphers. But in large part, the difference between KepatihanPro and Kridhamardawa is mostly a matter of style rather than practical capability. Time will tell whether Kridhamardawa becomes the successor of KepatihanPro, or an alternative favored only by musicians within the Keraton Yogyakarta's sphere of influence. See below for a comparison between KepatihanPro and Kridhamardawa produced using the same key input:

[17] See, for example, gamelan-related articles in the open-access journals *Resital* (ISI Yogyakarta), *Gelar*, and *Keteg* (ISI Solo).

[18] https://www.kratonjogja.id/peristiwa/110/keraton-yogyakarta-luncurkan-font-baru-untuk-notasi-gendhing-gamelan

Raw key input	KepatihanPro	Kridhamardawa
2=u-23 -2=u-tny -3=3-.p. -6=5-3n2	2̣723 2̣5̣6̣ 33.. 6532	2̣723 2̣5̣6̣ 33•• 6532
5=6-5p3 -2=u-tny -2=u-2p3 -2=u-tgy	5653 2̣5̣6̣ 2̣723 2̣5⑥	5653 2̣5̣6̣ 2̣723 2̣5⑥

Conclusion

Since its advent in the late 19th century, notation used for Central Javanese gamelan has passed through a number of developmental stages. Parallel to a mutual process of stylistic differentiation in the arts, the four courts of Central Java each lay claim to a different notational system. The unnamed notation from Pakualaman; nut åndhå from the Keraton Yogyakarta; nut ranté from Mangkunegaran; and finally nut ångkå or kepatihan from the *patih*'s residence, which was under the jurisdiction of the Keraton Surakarta. Along the way, other systems were suggested, such as Suryaputra and Bandara's staff notations and *trappenschrift.* But ultimately, kepatihan became the favored system throughout Central Java, and underwent further standardization with its use in arts conservatories starting in the latter half of the 20th century.

Kendhang notation followed a somewhat different trajectory. Like kepatihan, it seems that the ability to reproduce it via typewriter was a major consideration. The role of technology in shaping the form and use of notation was reaffirmed with the creation of the Kepatihan font in the late 1980s. Its successor, KepatihanPro, brought together gendhing, kendhang, rebab, vocal etc. notation into a single standardized package. While developed in the US, today KepatihanPro is a nearly ubiquitous tool among students, instructors, composers, and scholars in Java. Most recently, the Keraton Yogyakarta released their own font, based on KepatihanPro but with a number of additions and stylistic changes.

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APPENDIX

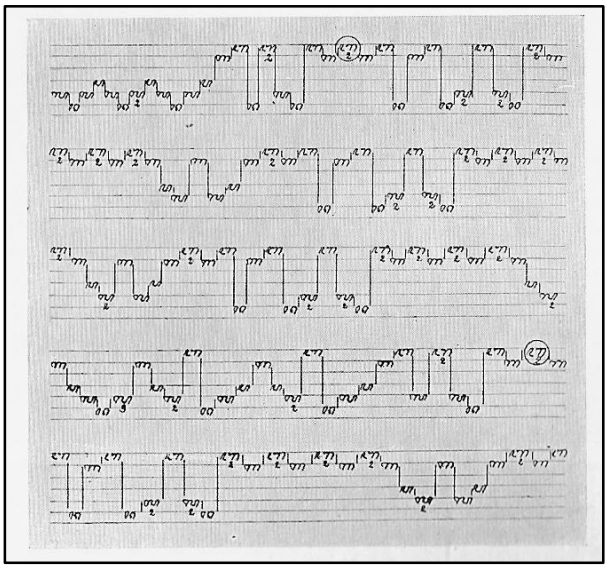

Figure 1. Pakualaman notation. From Kunst (1949, 442).

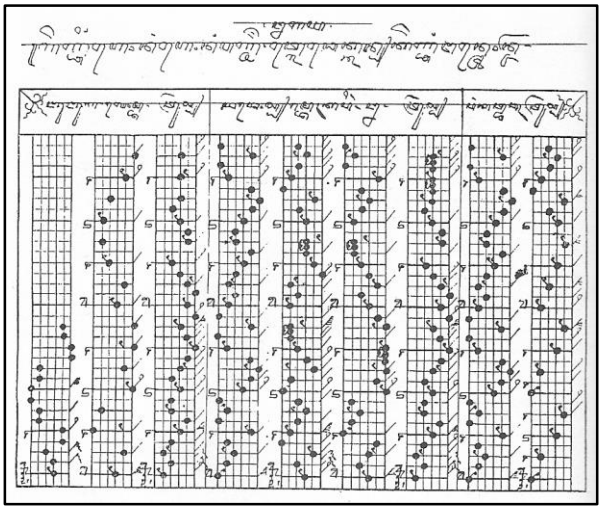

Figure 2. Nut åndhå in the *Serat Pakem Wirama*. From Sumarsam (1995, 110).

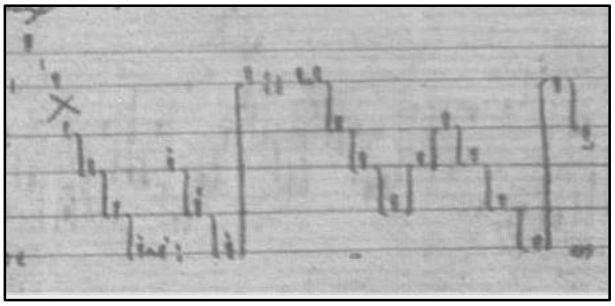

Figure 3. Nut ranté type 2. Dotted noteheads indicate high register; plain noteheads on upper side of staff line indicate middle register; plain noteheads on lower side of staff line incidate low register. From Isida (2010, 280).

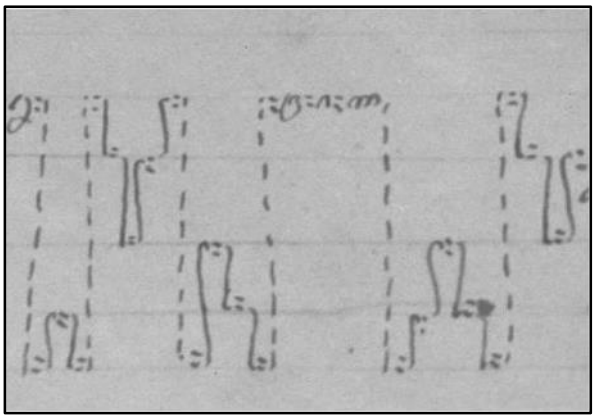

Figure 4. Nut ranté type 3. Dashed lines indicate a break in register.From Ishida (2010, 281).

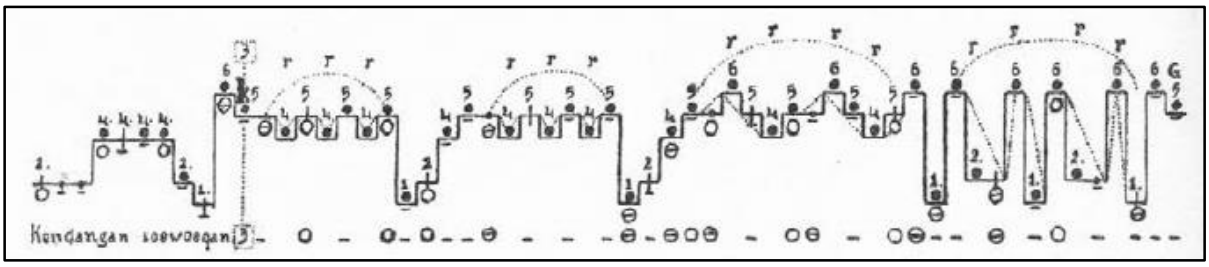

Figure 5. Trappenschrift. From Buys (1940, 26).

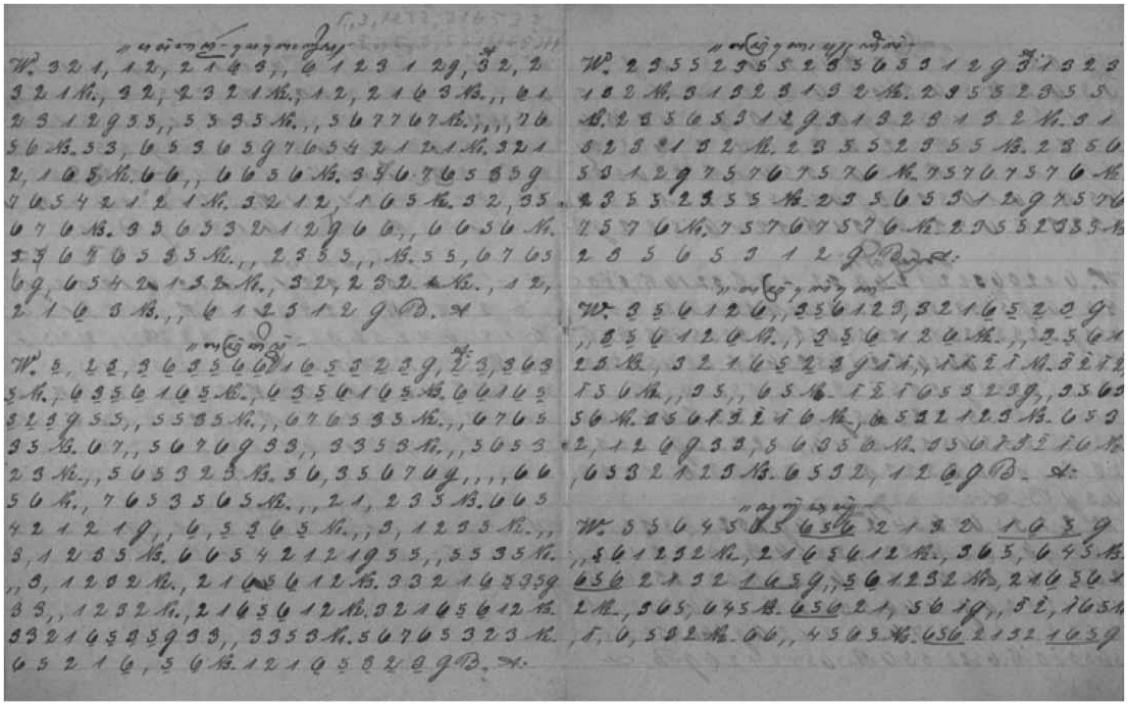

Figure 6. Early kepatihan notation. From Ishida (2010, 284).

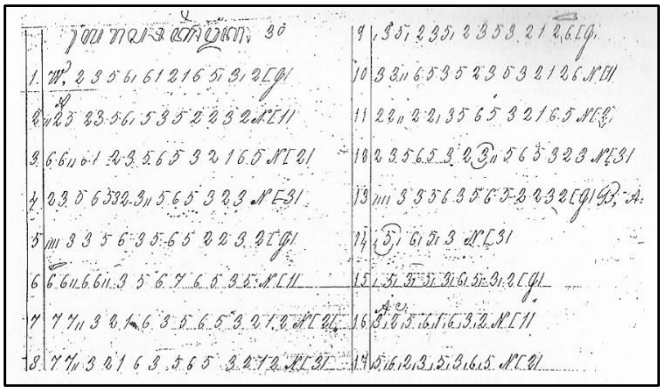

Figure 7. Gondopangrawit's kepatihan notation for gendhing Larasati, circa 1910. From Sumarsam (1995, 112)

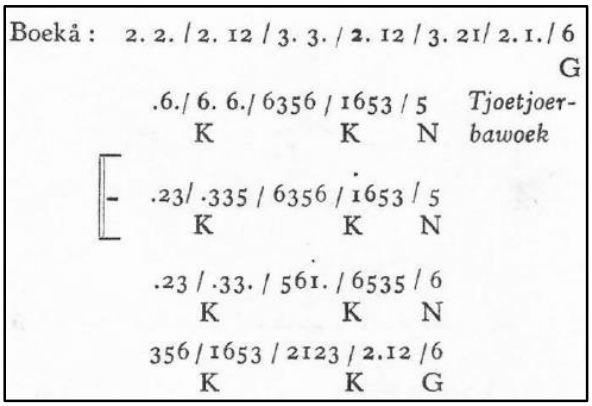

Figure 8. Kepatihan notation for gendhing Cucur Bawuk, circa 1924. From Buys (1940, 27).

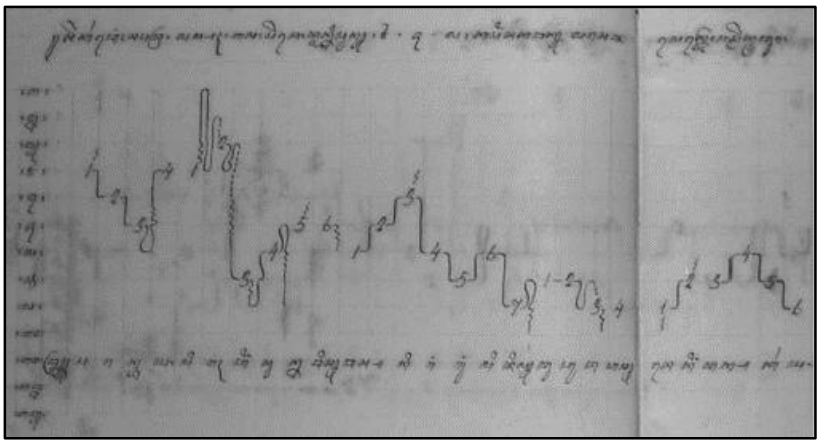

Figure 9. Widyåswårå type 1. From Ishida (2010, 277).

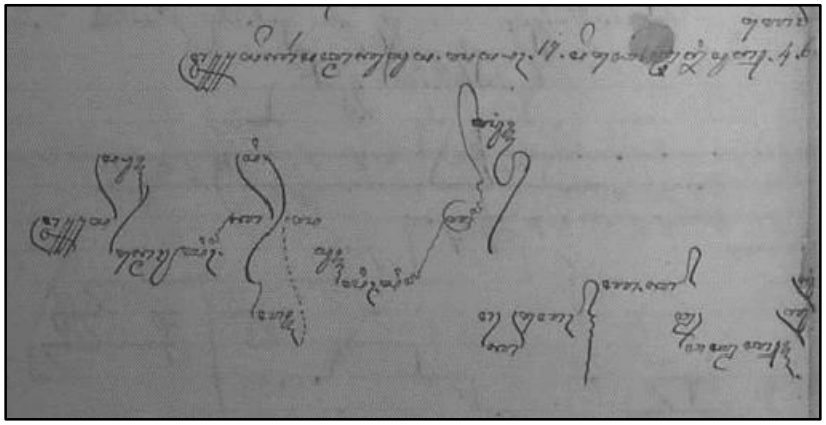

Figure 10. Widyåswårå type 2. From Ishida (2020, 277).

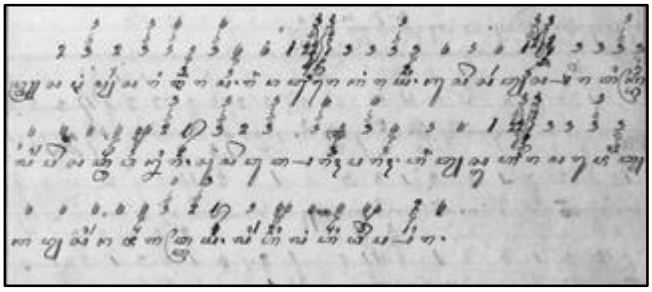

Figure 11. Warsapradonggo's santiswåra notation. From Warsapradonggo (1915).

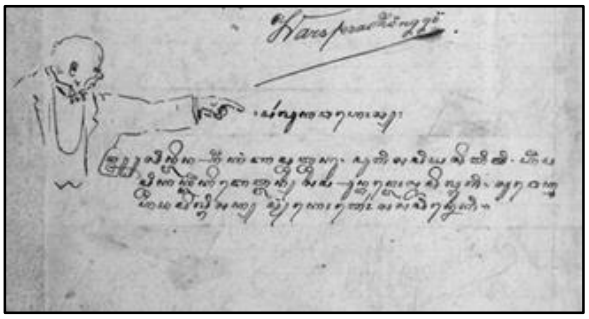

Figure 12. Warsapradonggo's "conductor." From Warsapradonggo (1915).

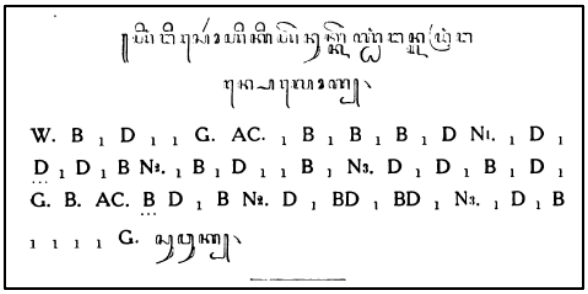

Figure 13. Djakoeb and Wignjaroemeksa's kendhang notation for the drum pattern *ladrang kendhang satunggal*. From Djakoeb and Wignjaroemeksa (1913, 57).

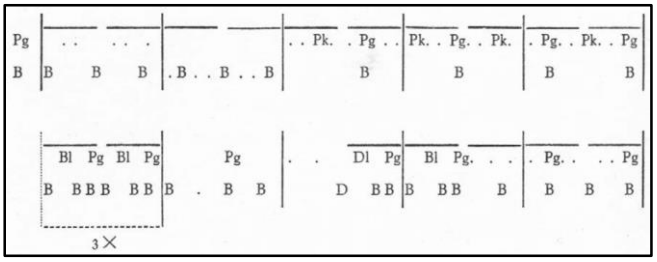

Figure 14. Djatiswara and Lebdapradangga's kendhang ciblon notation, circa 1924. From Buys (1940, 17).

Figure 15. Comparison of kendhang stroke symbols.

	Sindoesawarno (1955)	Martopangrawit (1972)	Sumarsam (1975b)	Romo Kawindro/Bambang Sri Atmojo (?)	KepatihanPro (2000)	Kridhamardawa (2020)
RIGHT DRUMHEAD (*BEM*) STROKES						
Den/dhen/bem		b	O	b	ɓ	ɓ
Dhet		b̲	Θ	ḅ	ɓ	ɓ
Hen			o		h	h
Hut				ƀ	ɓ	ɓ
Thung/dhung	d	p	l	p	ρ	ρ
Ket		l	-	k	k	k
Dhah (*kd. ageng*)	D			b	B	ß
Theg					ƒ	
Ret					r	
LEFT DRUMHEAD (*KEMPYANG*) STROKES						
Tak	t	t	+	t	t	t
Lang		L	!	L	L	L
Lung		L	i	l	ℓ	ℓ
Tong/thong	+	º	,	’	∘	o
Thok				’	.	●
COMBINATION STROKES						
Dang/ndang		d	Θ	ƀ	d	ɗ
Dlang/dhelang		ƀ	Θ	bL	ɓL	ɓ

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Dlong		ƀ	Ǫ	b’	ɓ̇	ɓ̊
Tlong/trong			ȷ̧	p’	ρ°	ρ̥
Tlung/thelung					tℓ	tℓ
Trang/tlang				ꝑ		tᵖ
Kret					k̇	k̃
Sut				p̸		[illegible]
Tlok						k•
Ndak/ndag						[illegible]
Ndong						b̊
Ndout/ndot						[illegible]
Plak				ꝑ̣		[illegible]
Dlok/ndlok				ḅ’		ɓ•
Dlak				ƀ̣		

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