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Developing a NeumeScribe for Sino-Japanese Buddhist Musical Notations

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Abstract

There is more to song than its text. And pre-modern Japanese manuscript collections of chant and song for Buddhist liturgy often write both text and musical notation for its vocal expression. Yet facsimile publications may be drastically undersized, and so coarsely-grained in grays as to remove meaningful color distinctions; edited typeset versions may give all textual information, including glosses to graphic "text" that constitutes musical notation, but completely omit any representation of the graphs themselves. The musicological researcher is left unaided. A solution is an analytically arrived at encoding scheme for Sino-Japanese musical graphs (*hakase* 博士, usually "neumes"), an encoding itself derived from Japanese "neume-maps" (*hakase*-zu 博士圖). Looking ahead, and for the musicologist, this encoding will enable transformations on representations of neumes through a computer-program (written in STklos-Scheme). Described here and now is one further product, originally devised to verify the accuracy of encoding, which demonstrates how neumes can be directly incorporated in printed text typeset with X_TIAT_FX for publication.

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Keywords:

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Lisp/Scheme, Musical Notation, Neumes, TikZ, XeLaTeX

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爲中國日本佛教樂譜創立纽姆记谱法

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摘要

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對於歌曲,文字之外還有更多的東西,日本傳統佛教歌曲和誦經的手稿集通常以文字和樂譜作為其聲樂的表述方式;其影印的出版物可能尺寸巨大,粗糙灰色的紙張往往抹去了原手稿中具有意義的顏色區分,而重新編輯打印的版本雖然保存了所有的文字信息,其甚至包括對於構成樂譜的曲線符號的註解,但其卻完全摒棄了其曲線符號,這讓音樂研究者處於一種無助的狀態。分析解決這種困境的方式,我們可以爲中國和日本的音樂的曲線符號(「博士」hakase)創立一個編碼方案,這種編碼本身源於日本的「博士圖」(hakase-zu)。長遠來說,尤其對於音樂學家,這種編碼能夠通過電腦程序□STk-los程序)來改變對「博士」像的再現。本文最初旨在證明編碼的準確性,不僅如此, 其進一步展示了「博士」如何能夠直接的融入以 XqBTFX 印刷的文本而出版。

關鍵字: Lisp/Scheme,樂譜,纽姆记谱法, TikZ, XeLaTeX

Why a NeumeScribe?

A musico-historical event and its systematic consideration stand behind the development of NeumeScribe.



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Figure 1: Manzairaku 万歳樂 (Shinma et al., eds. 1984, 194)

In 1984, the publication of Shinma Shinichi 新間 進一, et al. (eds.), *Kanazawa bunko shiryô zenshû 7: Kayô - Shômyô-hen* 金沢文庫書料全集 7:歌謡一声 明編, was hailed as one of the most important publications of early manuscript materials, many previously difficult of access or even inaccessible to the scholar, for the history of Japanese vocal music in general, and of Japanese Buddhist Chant *shômyô* 聲明 in particular. Sadly, however, the facsimile reproductions of texts-with-neumatic-vocal-notation (Figure 1), reduced to about a third of their original size and in shades-ofgrainy-gray, turned out to be barely workable-with – for musicological study (Hirano 1984; Markham 1990) – and were not clarified in the extensive, accompanying *Kama* 范白和士

contributions by Fukushima Kazuo 福島和夫.

Although edited, typeset versions of the texts in the manuscripts were provided (Figure 2b), including of texts to be sung, surprisingly (from a musicologist editor), no visual representations were offered for the graphic vocal notations, or neumes, attached to the texts of songs (Figure 2a) — for the one aspect that makes these treasures so valuable for the musicological researcher.



Figure 2: Editing kada 伽陀 (Shinma, Inui, Fukushima, and Takahashi 1984)

The practice in a "scholarly edition" of completely omitting major information,

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namely, the musical settings of religious texts which are to be sung, became inexplicable to us when an original treatise explaining musical information expressed in a vocal neumatic notation around square boxes as placeholders for Sino-Japanese lexigraphs (as shown in Figure 3a) was represented in the edition (Figure 3b) with just the placeholder-boxes and their glosses in Japanese writing. Dropped from the edition completely were the semantic content and theoretical argumentation in these diagrams – the musical notation. Focusing on this particular edition highlights an approach we found common in the literature on *shômyô* 聲明. Such "editions" are simply useless for the scholar/musicologist.



Figure 3: Placeholders with (a) and without (b) their neumes (Shinma, Inui, Fukushima, and Takahashi 1984)

The need for digitized facsimile and electronic editions of Japanese musical notations (with or without texts — to revert the usual bias) becomes even more obvious when we consider the importance of color in these notations. The case for digitized color images as facsimiles is obvious: photographic film dyes change over time, but we hope that the 0s and 1s in a digitized format stay in the same places, and that they can be re-read over long archival time-spans. It was the lack of a color reproduction of a 14th-century score for mouthorgan $shô \cong$ that led the outstanding scholar of early Chinese and Japanese music Laurence Picken to miss an ingenious dual-notation (Wolpert 1985). Returning to our neumatic notations, and to another comparison of reproductions, we are faced with the same problem again. Comparing the example of *kada* (mix) shown in Figure 2 with the excellent reproduction of the excerpt from the same manuscript in the catalogue for a special exhibition at the Nara National Museum (Iwata, T. Nojiri, and N. Kitazawa 2005) in Figure 4, we recognise the absolute need for color. Unfortunately – a beautiful catalogue excerpt in color is all we get from the manuscript for our research.

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Figure 4: Reproduction of kada 1984 and 2005

The omission of musical notation and of color references in serious publications gave the external prompt to begin developing NeumeScribe, based on a previously developed encoding scheme for Japanese neumatic notations, a code which was designed to be humanly readable and, for musicologists, also understandable as a musical notation. This earlier code could drive an automated re-synthesis of the neumes; and a partner transnotation program NeumeWriter¹ could put them into Western staffnotation.

Any systematic computer-assisted investigation of a large corpus of musical notation requires some form of encoding that reflects and analyses the original notation, and that describes rather than prescribes. Already in 1992 Richard Widdess pointed out (Markham 2006, 67) that a notation may also provide an indigenous analysis of music: "...the original notation involves an act of analysis on the part of members of the musical culture concerned, for notation preserves those aspects of the music which the *notator* considers essential for its transmission or recall." (Widdess 1992, 225-226) Original non-Western notations may differ in many aspects from Western staff-notation, the now standard (*globalized*) system of musical notation (Wolpert and Markham 2008). Devising encoding schemes for such notations requires throughout

¹ These programs were eventually presented in the context of a research colloquium at the University of Amsterdam in 1996 (Markham and Wolpert 1996). NeumeScribe and NeumeWriter were fused into one program between 1997 and 2000 at the Department of Computer Science, University of Otago (Wolpert 2000, 113). The rendering of the neumatic notations and of Western staff-notation was performed through PostScript via a "Notation-compiler" written in C. Output from this more recent version of NeumeScribe has since found its way into several publications (Markham 2005; Markham 2006; Markham 2009; Wolpert 2001). NeumeScribe is at present in a third phase of development, departing from the previous stand-alone approach by using modular building blocks. The component providing automated transnotation into Western staff-notation (not discussed here) is driven by an integratable program written in Scheme (Gallesio 2009a; Gallesio 2009b; Kelsey, Clinger, and Rees 1998).

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development repeated checking against the originals (or their reproductions) to make sure that encoding represents the original notations (without (mis-)informed interpretation). This process of repeatedly checking an evolving system is most reliably undertaken through automated re-synthesis of the original format: if the re-synthesis doesn't look like a printed (hence stylised) version of the original, the encoding system needs to be refined. Encoding schemes are evolving processes, not final products. The analyses (and interpretations) possible on encoded material are only reliable if they are based on a provably faithful and re-confirmable representation of an original (Wolpert 2001; Wolpert 2007a).

Additional, perhaps surprising, considerations for developing a musicologist-userfriendly encoding system on which we then based NeumeScribe were:

- 1. The reluctance of many monastic and private libraries to make their manuscript resources available in a generally accessible (digitized) format. Often, however, these holdings can be viewed and even quite thoroughly examined after establishing personal contact with the monk or librarian in charge — examined means often that we may gain permission to "hand-copy" relevant passages (however long these may be), and that we may come back to check whether we "got it right".
- 2. Facsimile resources that have been made generally available once seem to have an uncanny tendency of disappearing, and of subsequently being claimed to have been "lost" when there is, for example, a change in the policy of an institution. We are not speaking as theorists of accessibility here.
- 3. Preservation of our present-day research our thinking about and understanding of historical resources — must be another aspect that requires reproducibility in a lasting format. As already indicated, the analysis of an original notation as itself an original analysis in encoding and/or transnotating a source is a step in the ladder of historical documents, a step which also needs equal preservation. Personal and institutional websites are often closed when a member of faculty departs: work which has had only an electronic life is lost for ever. A humanly readable and printable code allows reconstruction when the electronic format has been lost.

Japanese Neumes

Early Japanese vocal notations identified as *hakase* $!!!\pm$ are usually described in musicological writings for Western readers as *neumes* (or *neums*), and from there, as neumatic notation, neumations, neumated texts, and so on. Such description places Japanese *hakase* systems among other vocal notations — for the medieval repertory of Gregorian Chant, for Byzantine Chant, Ethiopian Chant, Tibetan Chant — "formed primarily by neumes, that is, by graphic signs that represent essentially the movement

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in pitch of a melody." ("Neumatic notation" in Macy 2008) These systems of signs, supplied to guide how a text is to be "read" in melody, typically notate the note or group of notes to which each individual syllable is sung. The graphic signs employed in a neumatic notation may be contour orientated to "look the way they sound", or they may be conventional abstract symbols, perhaps requiring extraneous support for their reading.



Figure 5: Sôfuren 想佛戀 from Raigô-in 来迎院, Ôhara

For its graphic representation of changing pitches, our member in this category of musical notation uses strokes of changing angles, their starting points orientated on the Sino-Japanese or Japanese character to be intoned according to the neume they constitute (Figure 5). Neumes can be single strokes or combinations of several strokes, and they can be placed on either side of a textual character (or even above or below it), with different starting positions (usually top, center, or bottom) on an imagined square around the character (Figure 6). So called "neume-maps" (*hakase-zu* 博士圖), written versions of mental maps of strokes for pitch space, such as that in Figure 6, show stroke positions and directions labelled with relative pitch names, and may also include further pitch indications, via the finger-holes on the Japanese flute *ryûteki* 龍笛, for example. For an early explanation of the operation of the "square" and associated neume-strokes see Markham (1985); Sawada (2000) is a more general account.

Not all neumes associated with characters are uninterrupted lines (in Figure 5, the last neume in column 2 is an interrupted, or "gapped" neume). Another neume-type features "offsets" between neumes of the same direction. And, finally, a tightly

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curved neume, which we term here a "bulge", can occur in certain positions as part of a complex neume-shape (but never just on its own).



Figure 6: Neume-map hakase-zu 博士圖, re-presented from a manuscript in Raigô-in, Ôhara

In search for an ultimate precision he deemed certain hakase systems seemed to demand, Walter Giesen undertook a complicated, well-known research project in which he measured with a protractor the precise angles on neumes in early Japanese manuscripts (Giesen 1986). However, research in visual cognition has since shown that (through what is known now as overshadowing) such "over-exactness" would have been more of a hindrance than a help to the medieval cantor as he labored over memorizing, remembering, and reconstructing visual information (Brandimonte and Collina 2008; Lloyd-Jones, Brandimonte, and Bäuml 2008). Our approach of giving a visually perceived correct angle to encoded (and from there to re-synthesized) neumes takes this caveat of "overshadowing" into account. Distinct angles need to be preserved, but minor differences of a few degrees are more likely to be resolved in an analytical (and, in the musicological sense, systematic) stage of (re-)interpreting the neumes: for those who understand musical mode and form, neumes would be performance aids rather than geometrically precise instructions for micro-tonal inflection or for modally "impossible" progressions² (Figure 7). We suggest that this is why the original neume-maps could be kept so simple by medieval scribes — and why we can apply the same principle of simplicity to our encoding, to what we term our TikZ-maps (see later), and ultimately to the re-synthesis of Japanese manuscript sources in neumatic notation.

Visually comparable to the Penrose stairs (Figure 7) which, although they can be drawn, nevertheless depict an impossible reality. For a wider discussion of "verbalisation" of shapes see the discussion of verbal descriptions of possible and impossible shapes in Walker, Dixon, and Smith (2000).

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Figure 7: Penrose stairs, or M.C. Escher's Ascending and descending lithograph of 1960

Why X_HIJF_EX?

The temptation to make computer re-synthesis of a manuscript-notation an exercise in creating a look-alike is considerable — and must be resisted under all circumstances. The problematic of "re-production" of artifacts, and in particular of East Asian musical artifacts (which include musical notations), has been laid out in detail in Wolpert (2007a). Our argumentation for keeping re-synthesis distinct in appearance from the original has also been presented, at the PNC conference in Hong Kong (2001). We have always subscribed to the spirit of the Athens (1931) and Venice (1964) Charters of the International Council on Monuments in that re-synthesis "must be distinguishable from the original" and "...not falsify the artistic or historic evidence." (Venice Charter 1964, Article 12). We have always tried to keep computer-generated transnotations looking "scholarly", and not like performance scores; and we have aimed to have computer-generated re-syntheses of encoded original notations looking "computerized", and not like imitations of hand-written materials (Wolpert 2007b). Our implementation offered here is part of a larger "toolkit" to enable seamless integration of re-synthesized notations, transnotated notations, and multi-script texts³.

The choice of freely available, pre-existing, extensible building blocks is deliberate, and a step away from the proprietary BiwaWriter⁴ introduced in 2001 at the PNC

A toolkit providing an integrated environment for editing (Emacs, http://www.gnu.org/software/emacs/), programming (based on the Scheme implementation STklos (Gallesio 2009b), http://www.stklos.org), and compiling the printed output (X_IIIT_EX http://scripts.sil.org/xetex, with TikZ and LilyPond (Nienhuys and Nieuwenhuizen. 2010), http://lilypond.org/web/). This toolkit will also provide the environment for the next stage of the *Táng Music Project* (from volume 8 of *Music from the Tang Court* onwards) with its instrumental Sino-Japanese gagaku 雅樂 notations.
For Sino-Japanese lute- (琵琶) tablatures.

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conference in Hong Kong. Our tool has to satisfy the possibility of integrating:

- 1. text in more than one script (Chinese, Japanese, Sanskrit, extended Western);
- 2. graphical images (e.g., "facsimile" reproductions);
- 3. non-Western and Western musical notations.

In addition, all standard editing tools must be available, and both our source-files and the generated output must be in portable formats.

These pre-requisites are all met by various packages and editing tools that work together in the T_EX environment:

- X_AI^aT_EX provides a user-friendly system for multi-lingual and multi-script texts.
- NeumeScribe is configured as a set of X_HIIF_EX-macros⁵ which allow seamless integration in text, but which can also be used to produce stand-alone editions using that environment. NeumeScribe relies on pre-existing IIF_EX-packages, especially on TikZ, a graphics package developed by Till Tantau.
- The notation-program LilyPond developed by Han-Wen Nienhuys and Jan Nieuwenhuizen is also seamlessly integratable into XAIBTEX.
- Any Unicode-capable text-editor can be used.

TikZ, a graphical package developed by Till Tantau (2007) for the T_EX typesetting environment allows integration of "textual" graphics (such as neumatic notation) within an historical ethnomusicological, academic typesetting environment focused on East Asia, an environment based for its non-European and musicological tools on a combination of X_HIgT_EX and LilyPond (for the unavoidable crutches of transnotation into Western staff-notation).⁶ Within this framework, TikZ provides portable graphics, ease of implementation, and the desired, distinct character of the visual outcome for original East Asian notations, as well as the visually required tool for checking encodings to attain the necessary confidence in the precision of these encodings for analytical purposes. Indeed, building a systematic encoding tool is in itself an important aspect of analysis.

The Hakase Environment: Combining Character and Neume

Following the Japanese lead, and placing each lexigraph in a box, actually into an invisible box, we can align the neumes on this box radiating out right or left, from the top, from the middle, or from the bottom. Choosing a simple compass-rose as

 $[\]frac{1}{5}$ To be reformulated as a X-JIM-X-specific package.

⁶ Encoding and Scheme-based processing (Gallesio 2009b) will be described elsewhere.

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our basis for directions provides more than enough of the angles we might need to represent the direction(s) of individual neumes. Stringing directions together, we can re-represent the shapes of complex neumes.



Figure 8: A compass rose with thirty-two directions

The number of possible strokes (the good Buddhist number of thirty-two marks) gives enough options to distinguish closer and wider spacing of direction in rendering Japanese neumes in a printed version of a manuscript. In actual fact, only a (small) selection of the mnemonic directional names will be necessary for each neumatic system, manuscript, or manuscript-family.

The format for writing neumated text in NeumeScribe requires three arguments (and one optional argument): $hakase \{<1>\}\{<2>\}\{<3>\}[<4>]$

1. The lexigraph.

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- 2. The starting position, right or left top, center, or bottom of the (invisible) square into which the lexigraph has been entered.
- 3. Neume directions (including markers such as dots or glosses in various colors) indicated by compass-directions.
- 4. Optional glossing of the neumes (e.g., flute tablature-signs).

But let us return to Figure 1. There are 14 distinct stroke directions in this neumatic notation for the opening of *Manzairaku* 万歲樂, six pointing "westwards", six pointing "eastwards", and two more pointing "north" and "south", respectively. The directions are quite clear. Transplanting the directions from this neumatic notation into our "compass rose", we can extract the 14 macros needed for a printed representation of the strokes. Furthermore, (in our new compass) we can label the flute

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glosses associated in the manuscripts with stroke directions, and arrive in that way at a "hypothetical" neume-map in Figure 9, a neume-map extracted from an actual notation.



Figure 9: A hypothetical neume-map for Manzairaku

In this map, the directions are clearly "mirrored" (as the signs for flute corroborate) in that the left-hand upper part is reflected in the right-hand lower part, and the left-hand lower part in the right-hand upper part. This fits well into the pattern of other (non-hypothetical) neume-maps of this type.

When we now apply our neume-map and associate the macros for encoding Figure 1 we arrive at a printed verification version in Figure 10b. Perhaps, through the *hakase* environment we have come to how to avoid "editions" as in Figure 10a, and how to do full justice in a printed volume or PDF-based digitized version pertaining to a present treasure-house of early Japanese neumatic notation. Perhaps we have a solution which could offer a "modern edition" as useful for the historical musicologist as for the historical liturgist: unashamedly a print, but showing the principles of the neumes as used in an original manuscript as clearly as can be shown the printed versions of the textual characters in the hand-written song-texts to which those neumes refer.

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Figure 10: First lines from Manzairaku 万歲樂: Two editions of the original facsimileexample in Figure 1

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