SYMMETRY in ARROW DESIGNS, SONGS and LEGENDS OF CENTRAL NEW GUINEA and the UPPER SEPIK[1]

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Abstract
In this paper we recount results of symmetry analysis of designs on the fore-shafts of arrows from the upper Sepik and central New Guinea and suggest how symmetry in graphic designs may be correlated with symmetry in other aspects of culture, in particular, in songs and oral traditions.

1. STRUCTURE ACROSS 'AFFECTING WORKS' OF CULTURE

In 1971, Robert Armstrong published *The Affecting Presence*, in which he sought to analyse the properties of the various 'arts', what he termed 'affecting works of culture' ie. works intended to express feeling. 'What we face is the necessity of exploring the space and time in which the affecting presence exists, with the objective of ascertaining the "logic" of relationships'. Regarding the physical properties of works, 'it is of the greatest urgency to establish a highly generalized language capable of identifying and describing constituent physical units and of stating their relationships' (1971:42), ie. their structure.

Armstrong asserts that different cultures may structure these physical units in different ways and that within a culture, there is often to be discerned a similarity in the structures across the variety of affecting forms (ibid.:15, Table 1). Thus sculpture, graphic arts, music, folk narratives and so forth within a particular culture partake of a common structure. Using a methodology he developed, Armstrong attempted to demonstrate this for the Yoruba (Nigeria) and Jogjanese (Java).

The methodology he uses in his book entails an analysis of the metaphorical bases of the affecting forms (ibid.:57, Table 2). At the level of Trope, he distinguishes between spatial and temporal characteristics. Thus, for example, sculpture, architecture and the graphic arts rely upon an axis of space, and music and

[1] This is an expanded version of a paper presented at **SymmAdelaide 2016**, the 10th International Congress-Festival, Symmetry: Art and Science; Special Theme: Symmetry and Social Harmony, Adelaide, 1-6 December 2016, organised by the International Society for the Interdisciplinary Study of Symmetry. Their invitation to present the paper is gratefully acknowledged.

narrative rely upon an axis of time (ibid.:64).[2] On the other hand, he asserts that 'Sculpture . . . is essentially spatial, but via spatial means temporality is achieved; narrative is essentially temporal, but by means of synchronic complexity the functional equivalent of space is achieved. So it is in music' (ibid.:126).

Armstrong has his critics (eg. Rosaldo 1972). Defining 'art' as those works that elicit feeling (that are 'affecting' works) could be considered restrictive and giving too much significance to the inarticulate and, for cross-cultural studies, the often inaccessible. Armstrong's focus on art as metaphor, a device for creating a new understanding of the world by bringing into relationship 'images' that are not normally related, does meet with favour. Also acceptable is the notion that every culture has its own, consistent way of structuring metaphors across the various art forms (graphic design, sculpture, dance, music, folk narratives, and so forth). The issue is how to determine the units for comparison and analysis.

In this exploration of graphic designs, songs and narratives of central New Guinea and the upper Sepik, we follow Armstrong's recognition of the spatio-temporal characteristics of forms, and attribute both spatial and temporal characteristics to graphic design, songs and narrative.

As examples of graphic design, we have chosen the designs carved onto arrow fore-shafts (**Figs 1-3**). They are finite 'north-south' but can be rolled out infinitely 'east-west' (**Fig. 12**). For the purpose of this analysis, the design is a spatial characteristic and the 'roll-out' the equivalent (an analog) of a temporal characteristic. Similarly, the disposition of tones (notes) of motifs in melodies as written in music notation may be considered a spatial characteristic and the progression of motifs of the melody as a temporal characteristic. This then provides a framework for comparing the structural characteristics of arrow designs and music.

Washburn and Crowe's coding of one-dimensional and two-dimensional symmetries of graphic forms (1988, Tables 4.1 and 5.1; 2004, Figures 1.7 and 1.11) provides a basis for the structural analysis of the arrow designs. The compositional analysis of the musicologist can be adapted for our purposes but we are not aware of a generally-accepted way of analysing the structure of narratives in a comparable manner.

[2] Armstrong is not entirely consistent in these distinctions; his Table 2 attributes 'situation' as a temporal characteristic of sculpture and the graphic arts.

Armstrong proceeds by analysing narrative according to the synchronic axis of intensionality/extensionality (or, centripetality/centrifugality) and the diachronic axis of continuity/discontinuity (see his Table 3, p. 70 and Table 8, pp. 144-5). However, this level of analysis does not suit the kind of structural analysis we are presently exploring for the arrow designs and songs of central New Guinea and the upper Sepik, although it may be possible to carry out such an analysis.[3]

2. THE DATA

In 1967, 1968 and 1969, Craig collected for museums hundreds of arrows in the upper Sepik and central New Guinea region and for hundreds of others that he did not collect, he made rubbings to record the designs carved on the cylindrical fore-shafts and heads of the arrows (**Fig. 12**).

Figure 1. Central New Guinea arrows.

[3] Roberts asserts that 'Abau songs are unmistakably centripetal in their compositional structure . . . Star Mountains songs technically contrast in their markedly centrifugal quality' (MS, 2012).

Figure 2. Using marsupial incisor to cut barbs.

Figure 3. Upper Sepik arrows

In 1972-73, Craig recorded songs and legends of the Abau and Amto speakers of the upper Sepik; the legends were published in 1981. In 1984, Robert Brumbaugh published a significant number of Telefol stories (*weng sang*). Commencing in 1981, Roberts recorded the songs of the Wopkeimin people living under the shadows of the Star Mountains, published as a book in Mandarin Chinese in 1996 while he was living and teaching in Taiwan. The book was revised and published in English by the Institute of Papua New Guinea Studies (Roberts 2014).

In 2004-2010, a research program based at the South Australian Museum was carried out that accumulated photographs and documentation of 10,000 objects from the upper Sepik and central New Guinea, held in museums and private collections around the world. The aims, methods and some results of the Upper Sepik-Central New Guinea Project may be found at www.uscngp.com (or Google USCNGP) and Fyfe 2008, 2009, Fyfe & Bolton 2011, 2015.

The two regions of that study are linked by the Sepik River that rises in central New Guinea and flows north then east through its upper basin. The Sepik was navigated to 720 km (upstream of the Sepik-May River confluence) by the Schrader expedition of 1887. In 1910, Leonard Schultze-Jena, a member of the German component of a Dutch-German boundary marking expedition, followed the Sepik well into the central mountain region but short of its source basin. The Hamburg museum expedition spent a short time on the Sepik in 1909, travelling only as far as Malu, near present-day Ambunti (Reche 1913). The most thorough exploration of the Sepik was by the Kaiserin-Augusta-Fluss Expedition of 1912-14, during which Richard Thurnwald followed the Sepik up to its source near Telefomin and its tributaries in the Upper Sepik Basin – the Yellow and Sand Rivers, the North River, the Hauser (Green), August (Yapsie) and October Rivers (Thurnwald 1914, 1916)[4]. During that expedition, ethnographic collections were made, most of which are in the Berlin Museum (Kelm 1966).[5]

The upper Sepik consists of a swampy riverine environment at 50–150 metres ASL, partly encircled by hills and mountains up to 1500 metres (**Fig. 4**). The cultures and languages are relatively heterogeneous. Sixteen language groups are in the upper Sepik study region; three each of the Trans-New Guinea and Kwomtari Phyla, four of the Sepik Phylum and four unrelated languages (**Fig. 5**). During the 1960s-1970s, c.18,000 people were members of these language groups.

[4] For translations of these two reports, see www.uscngp.com/papers/ See also 'The Fate of Richard Thurnwald's Sepik Ethnographic Collections' and 'Thurnwald and Rodoni in the Upper Sepik 1914' at that site.

[5] Craig covered much of the same ground in his collecting expeditions of the 1960s and 1972-73.

Figure 4. <u>Above</u>: upper Sepik River, looking south-east; <u>below</u>: Border Mountains settlement.

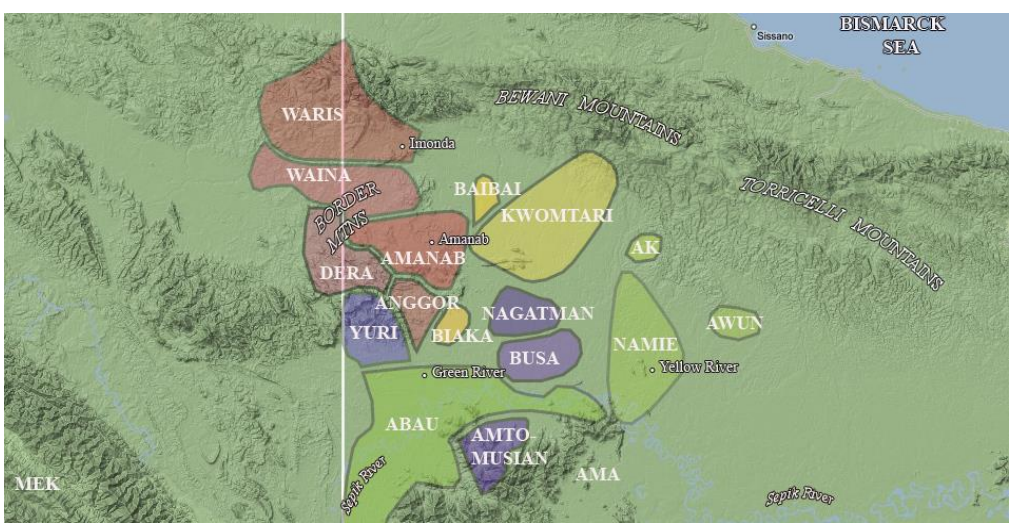


Figure 5. Upper Sepik and Border Mountains languages

Processing of starch from sago palms was supplemented with fruit and vegetable slash-and-burn gardening, minor pig husbandry, hunting, fishing and the gathering of wild foods (**Figs 6, 7**).

Figure 6. Abau hunter assembling his dogs, Idam Valley, upper Sepik

Figure 7. Nagatman woman making 'hot-water' sago; note sago 'sausages' on leaf, top left.

Central New Guinea is a highlands environment ranging from 1500 to 4000 metres ASL at the headwaters of the Sepik, Fly and Digul rivers (**Fig. 8**). The cultures and languages are relatively homogeneous. Seven language groups are in the study region, all of the Trans-New Guinea Phylum of languages; six in the Ok Family and Oksapmin, a Sub-Phylum-Level Isolate (**Fig. 9**). During the 1960s-1970s, c.30,000 people were members of these language groups. Subsistence horticultural practices were based on taro, with some sweet potato and/or, minor pig husbandry and hunting (**Figs. 10-11**).

Figure 8. Central New Guinea village, Eliptaman, Telefol speakers.

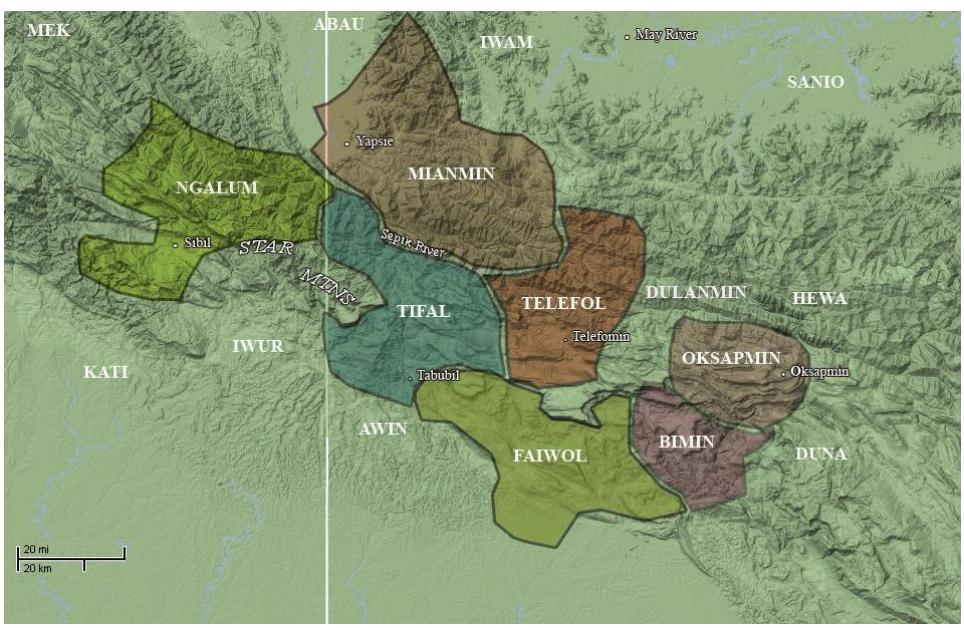


Figure 9. Central New Guinea languages.

Figure 10. Atbalmin (TIFAL) women in sweet potato garden, Central New Guinea.

Figure 11. Left: Atbalmin men and boys. Right: Taro garden at Falamin (TELEFOL).

For information about other aspects of the cultures of these peoples, go to www.uscngp.com/papers/, www.uscngp.com/photographs/, and www.uscngp.com/dataset/

3. THE ARROW DESIGNS

During the 1960s field surveys, Craig did rubbings of the designs (**Fig. 12**) and recorded data on the names of owners and makers, the names of their settlements, language names and the particular function of each arrow (hunting, warfare, birds, etc.). He asked about the designs, and the names given to particular motifs.

It seemed to him that, supplemented with rubbings of designs on arrows in museum collections representing examples from geographical areas he had not visited, there were sufficient numbers to see whether the structure, ie. the symmetry, of the designs varied significantly according to language and/or geographical area.

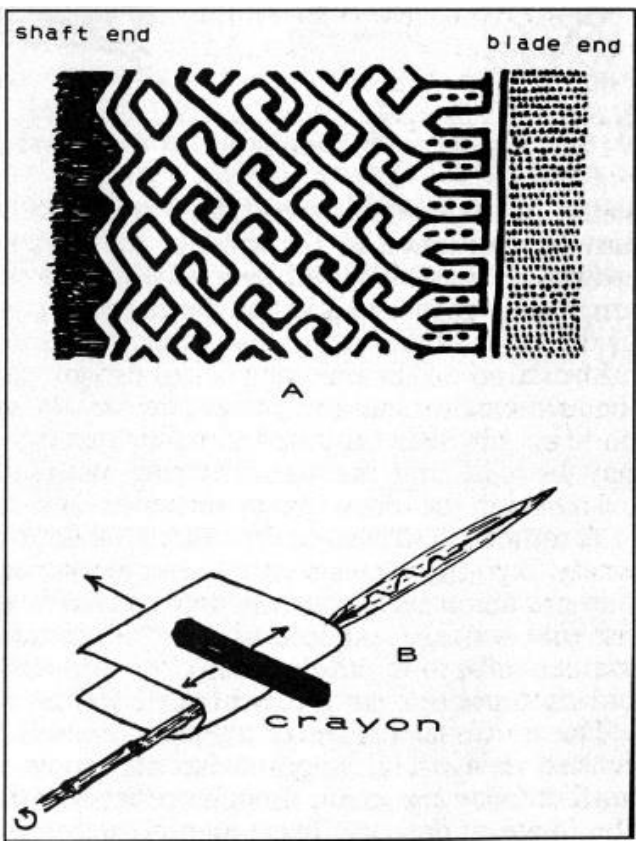


Figure 12. Method of making rubbings of arrow designs

The patterns roll out infinitely ‘east-west’ but are limited to the length of the fore-shaft ‘north-south’. The designs were sorted according to settlement, within language areas, and all the designs that were the same or closely similar were put together. Following this process, a simple taxonomy of symmetry was devised (**Fig. 13**):

A. Serial Repetition **(SR)**: a single design element or complex of design elements repeated at both right angles to the axis of the arrow ('east-west') and along the axis of the arrow ('north-south');

B. Inversion Symmetry **(IS)**: a design element or complex of design elements subjected to mirror image symmetry around an axis at right angles to the length of the arrow.

C. Diagonally Deflected Symmetry **(DDS)**: a design element or complex of design elements subjected to mirror image symmetry as above but with the 'reflected' image shifted a half-position to one side, often so that the two halves inter-penetrate;

D. Agglutination **(AG)**: a design built up through the addition of several different or alternating elements which are integrated along the axis of the arrow ('north-south').

E. Single Element **(SE)**: a single design element repeated at right angles to the length of the arrow ('east-west');

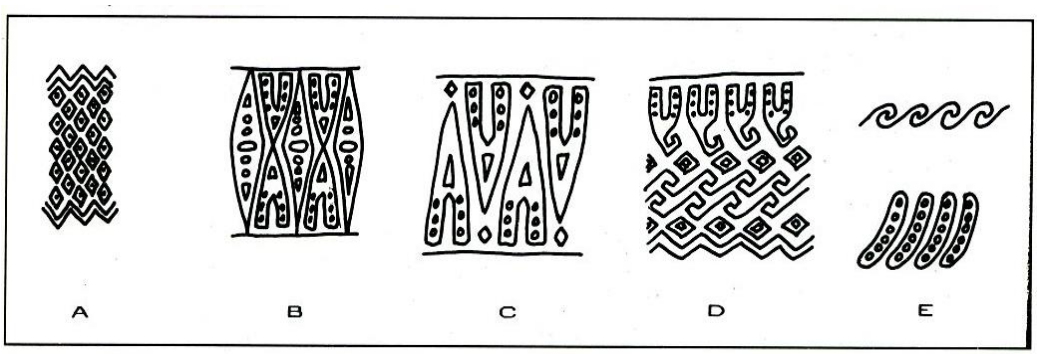


Figure 13. Five structural principles of arrow designs (after Craig 1988, Fig. 34).

The results of a 1984 analysis of 1357 designs on bamboo-bladed arrows were published as Table 1 in Craig 1990. More designs were added for a total of 1847 designs that were published as Table I in Craig 1995 (**Fig. 14**).

This structural analysis came out of consideration of the data itself, not from a pre-existing system of analysis. In 1984, Craig was not aware of the system later proposed by Dorothy Washburn and Donald Crowe (1988; 2014: 3-17).

Language Groups or Area	TOTAL N	TOTAL %	SE %	SR %	IS %	DDS %	AGG %
Aitape	105	100	24	2	26	42	6
Keerom (Waris)	22	100	18	5	27	36	14
Total 'North Coast'	127	100	23	2	27	41	7
Border Mountains (Waina, Amanab, Anggor, Yuri)	134	100	6	4	5	82	3
Eastern Abau	47	100	9	9	19	57	6
Central Abau	94	100	3	22	14	58	3
Western Abau	63	100	3	14	21	54	8
Sobger River	18	100	–	17	22	61	–
Idam/August Valley	66	100	5	18	14	48	15
Total Abau	288	100	4	17	17	55	7
West Range (Amto, Bo, Blimo)	35	100	–	20	17	14	49
Sepik Hills (April, Wogamush, L-Schulze)	154	100	12	12	8	14	54
Mianmin	246	100	11	2	18	8	61
Oksapmin	29	100	14	3	7	35	41
Telefol	263	100	14	2	22	27	35
Tifal	106	100	12	2	27	30	29
Faiwol	85	100	20	3	24	34	19
Total Mountain-Ok	729	100	14	2	21	22	41
Ngalum	111	100	–	39	43	18	–
Eastern Mek	45	100	–	31	53	16	–
Central Mek/Langda	76	100	3	45	39	13	–
Total Sibil-Mek	232	100	1	39	44	16	–
Nth/Sth Ngalik	36	100	3	50	22	8	17
Dani	38	100	8	24	21	18	29
Total Ngalik-Dani	74	100	5	36	22	14	23
Uhunduni	11	100	–	9	9	82	–
Ekagi, Moni, Dem	63	100	–	6	33	61	–
Total 'Western'	74	100	–	7	30	63	–
TOTAL	1847	100					

Figure 14. Analysis of arrow design structures (after Craig 1995, Table 1).

For his 1995 paper, where he compared the structure and motifs of designs on arrows from the upper Sepik and central New Guinea to designs on Austronesian Lapita pottery (c. 3000-2000 BP) (**Fig. 15**), although he had become aware of Washburn and Crowe's structural principles, he did not have the time and resources to re-analyze the designs accordingly.

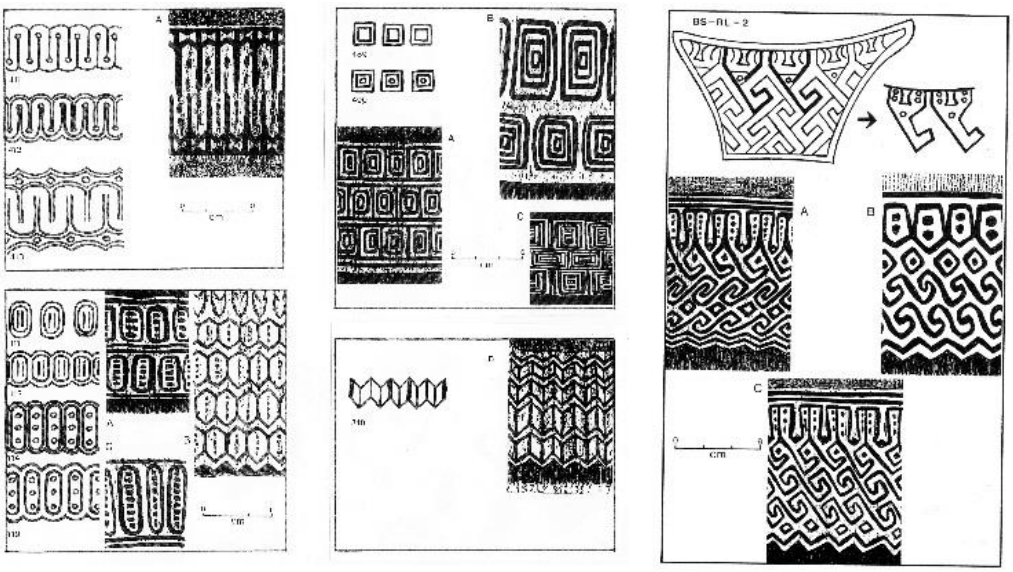


Figure 15. Left and centre: Lapita designs to left, compared with USCNG arrow designs to right; right: Lapita pot design at top; similar central New Guinea arrow designs below.

However, the analysis indicated interesting parallels that suggested a re-think of notions of Lapita designs being imported wholesale into Melanesia. Perhaps the designs were non-Austronesian, widespread in New Guinea, and later applied to Lapita pottery at locations of interaction of Austronesians and non-Austronesians.

4. THE UPPER SEPIK-CENTRAL NEW GUINEA PROJECT

As noted above, in 2004-2010, two ARC-Linkage grants made it possible for the Project team to gather images and data for over 10,000 objects from the upper Sepik and central New Guinea, held in museums and private collections worldwide (www.uscngp.com/about/). We developed a geographically-based method for accessing these images and data so that scholars, and peoples from whom the objects came, could view the material.

At present, 2480 objects appear in the website dataset: www.uscngp.com/dataset/ – the remaining 7500 are being prepared by volunteers. The search program is based on Google Earth satellite imagery so that all objects – images and basic

data – from within a particular language polygon, or from particular settlements within a language polygon, can be viewed.

Andrew Fyfe, the PhD student working on the project during that time, with handcraft technical contributions from Jill Bolton, published results of analysis of technical details of arrow bindings and string bag looping and colour patterns to determine whether changes in these material culture variables are the result of differences in language or simply geographical distance (Fyfe 2009, Fyfe & Bolton 2011, Fyfe & Bolton 2015).

We have recently completed the coding of several hundred bamboo-bladed arrow fore-shaft designs according to motifs, and the structural principles of Washburn & Crowe, and will subject them to statistical analysis to see whether graphic design behaves differently to craft techniques in terms of the variables of language versus geographical distance.

The symmetries coded by Washburn and Crowe are more differentiated than the simple symmetries Craig devised for his 1984 analysis. Thus:

- 'Serial Repetition' includes Washburn and Crowe's *p1, pmg, pmm* and *cmm*;
- 'Inversion Symmetry' includes Washburn and Crowe's *pmm2* and *p1m1*;
- 'Diagonally Deflected Symmetry' includes Washburn and Crowe's *pma2* and *p1a1*;
- 'Agglutination' is equivalent to Washburn and Crowe's *p111* plus *p112*;
- 'Single Element' includes Washburn and Crowe's *pma2, p112* and *p111*.

Craig communicated with Washburn and Crowe regarding the coding of some of the more difficult designs and in the process of reviewing the data, Washburn commented (2 February 2015):

> The real takeaway from this is most patterns are organized by *pma*2/*pmg* symmetry. Whether it is in one or two dimensions is less important than is the dominance of this way of organizing the motifs. The really different designs [are the ones that] have NO reflections, just bifold rotation' (*p112*; see **Fig. 16**).

This applies more to Upper Sepik than to Central New Guinea designs.

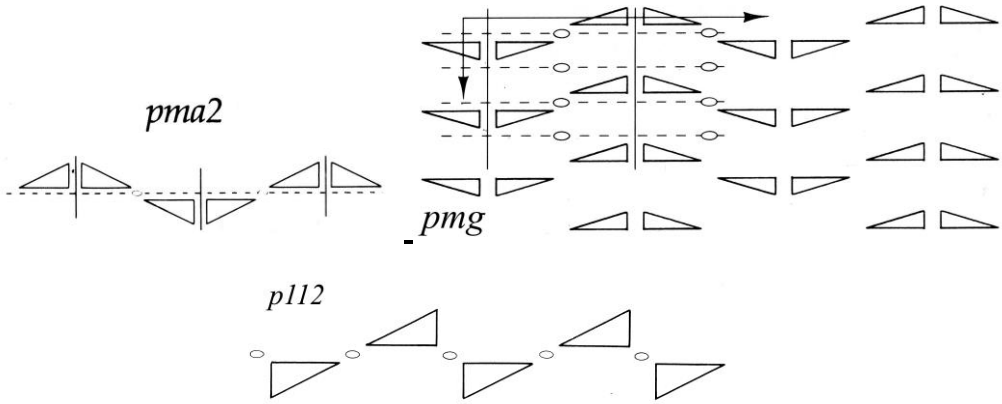


Figure 16. Top left, *pma*2, top right: *pmg*; bottom: *p112* (Washburn & Crowe 1988).

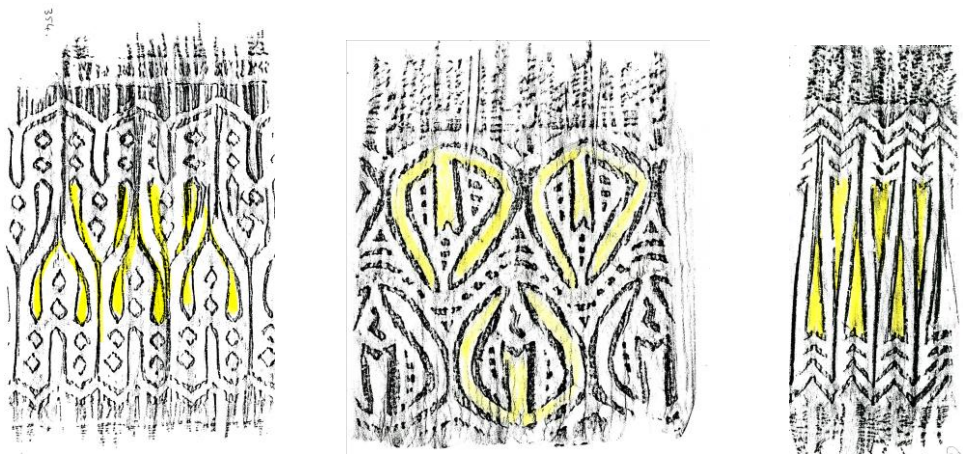


Figure 17. Three upper Sepik *pma2* arrow foreshaft designs.

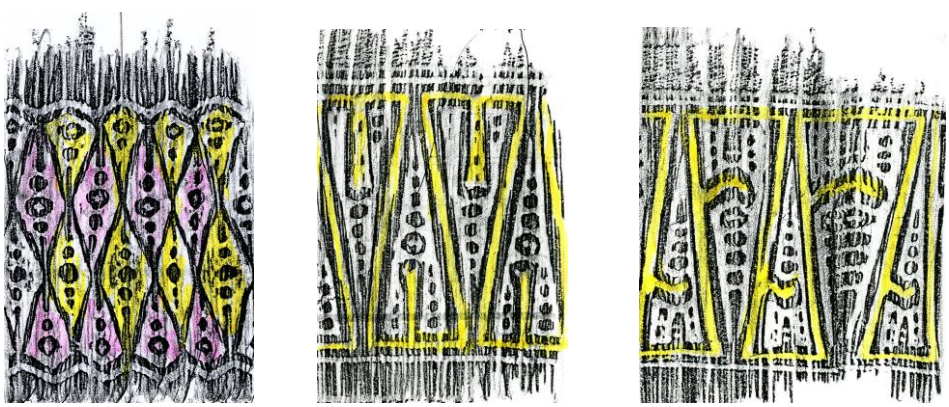


Figure 18. Left and centre: two central New Guinea *pma2* arrow foreshaft designs; right: although similar to the centre design, this is not *pma2*, but *p1a1*, because of the placement of the protrusions inside the triangles (see Washburn & Crowe 1988, Table 4.1 and p.124).

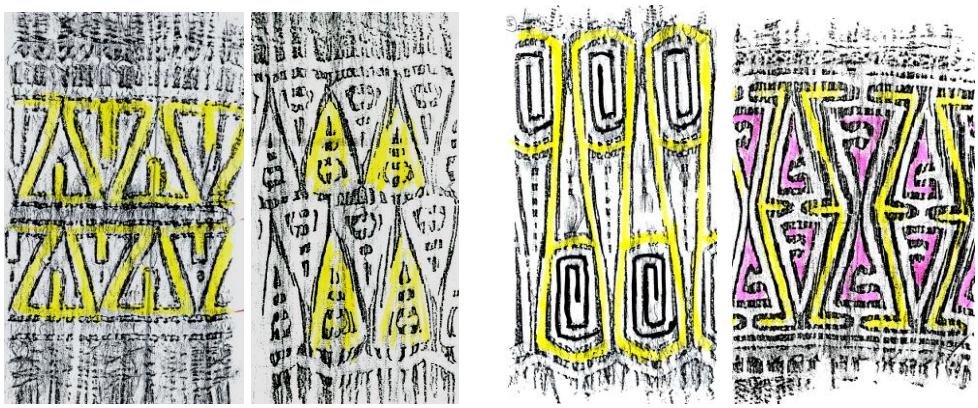


Figure 19. Left: *pmg* arrow foreshaft designs: upper Sepik and central New Guinea; right: *p112* arrow foreshaft designs: upper Sepik and central New Guinea.

Note that in the Washburn and Crowe system, some designs are 'one-dimensional' (the design is repeated only along the 'east-west' axis: **Figs 17, 18, 19 right**) and others are 'two-dimensional' (repeated along both the 'east-west' axis and two or more times along the 'north-south' axis (**Figs 19 left, 20**).

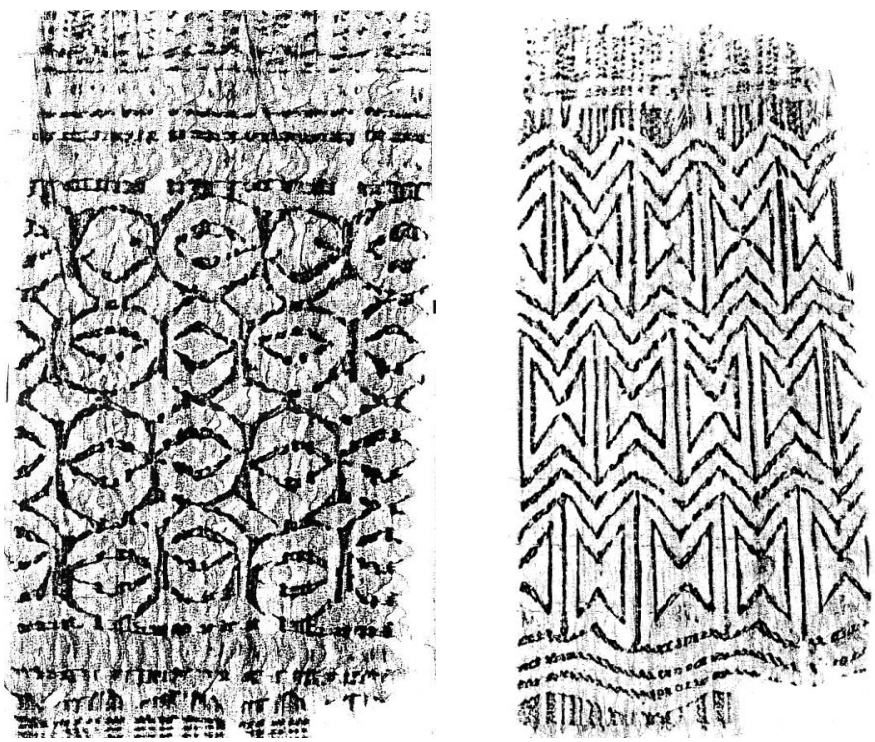


Figure 20. Arrow foreshaft designs, Abau, Upper Sepik; left: *pmm*; right: *cmm*.

It should be mentioned that designs etched or pyro-engraved on bamboo tobacco-smoking tubes are similar to the designs carved on arrows (see examples in Craig 1990) and could be analysed according to the same procedures as used for the arrow designs. But that will be for another day.

5. ARROW DESIGNS, SONGS AND NARRATIVES OF CENTRAL NEW GUINEA

Strictly-speaking, the arrow designs, songs and narratives considered here are not all from the same ethno-linguistic group. The arrow designs are of the Telefol and Tifal speakers (see **Fig. 14**), the songs are of the Tifal speakers (Roberts 2014) and the narratives are Telefol (Brumbaugh 1984). Although Telefol is a different language to Tifal, whose songs were recorded by Roberts, they are languages of the same sub-family and their traditions, material culture and rituals are almost identical (Brumbaugh 1990).

Arrow Designs

In **Fig. 14** above, it is apparent that Telefol and Tifal arrow designs have predominantly what Craig termed 'Inversion Symmetry' (*pmm2* and *p1m1* - 22% and 27% respectively), 'Diagonally-deflected Symmetry' (*pma2* and *p1a1* - 27% and 30% respectively), and 'Agglutination' (35% and 29% respectively). Only 2% of the designs were examples of 'serial repetition'.

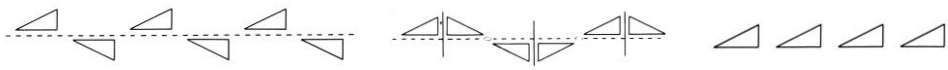
Songs

In the Preface to his book on the songs of the Star Mountains, Roberts discusses the structure of the music and identifies 'inversion' (pp. xxxix-xli) that, with a little imagination, might be considered equivalent to Craig's 1980s 'Inversion Symmetry' (Washburn and Crowe's *pmm2* and *p1m1)* and 'Diagonally Deflected Symmetry' (*pma2* and *p1a1*). Roberts writes (2014:xxxix):

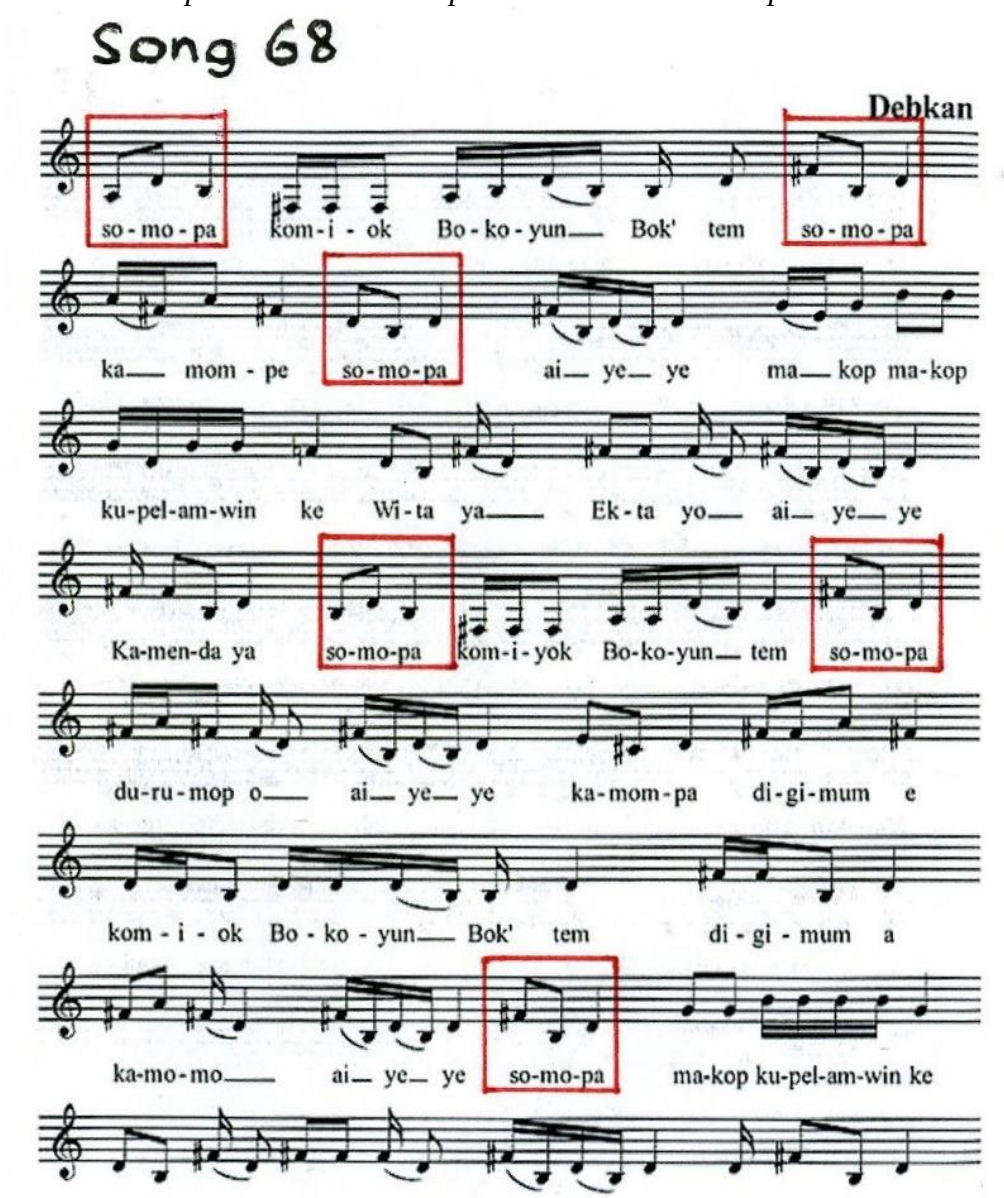
> In the European heritage of written music, an exact mirror, with precisely the same distances between the notes mirrored, is called **strict inversion**. When the shape of the music alone is mirrored, with varying distances between the notes, we have **free inversion**. See the word *somopa* in **Song 68** for its motif in the first word of the song, and then its free inversion at the next occurrence of that word on the same line. This motif then appears throughout the song with various words and inverted back and forth, mirrored one way and then the other.

What is particularly interesting about **Song 68** is that the *somopa* motifs in the first line are asymmetric; the first and third notes are different. Therefore, the symmetry displayed by the two occurrences of *somopa* in the first line is equivalent to *p1a1* in the Washburn & Crowe schema for one-dimensional

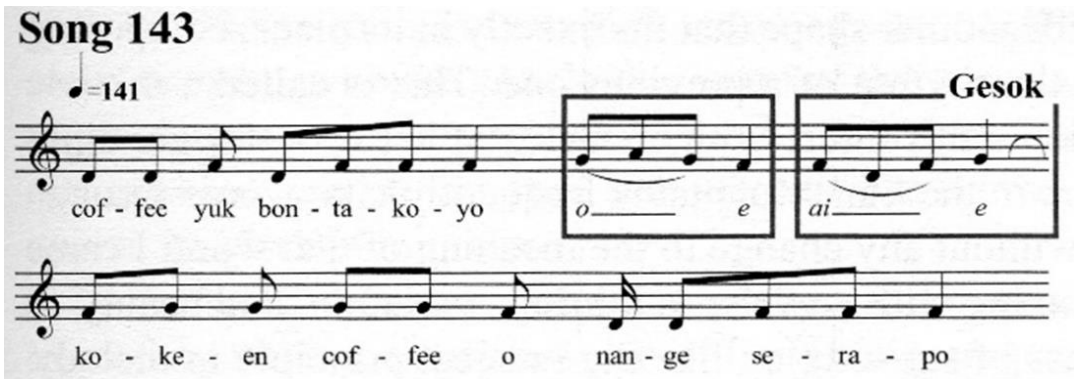
graphic patterns. However, the *somopa* motif in the second line and its first occurrence in the fourth line are 'vertically' symmetrical (the first and third notes are the same) so the symmetry in this case is *pma2*. The *somopa* motif at the end of the fourth line is asymmetric and identical to the *somopa* motif in the seventh line (there is repetition 'east-west') so these two are equivalent to *p111* in the Washburn & Crowe schema.



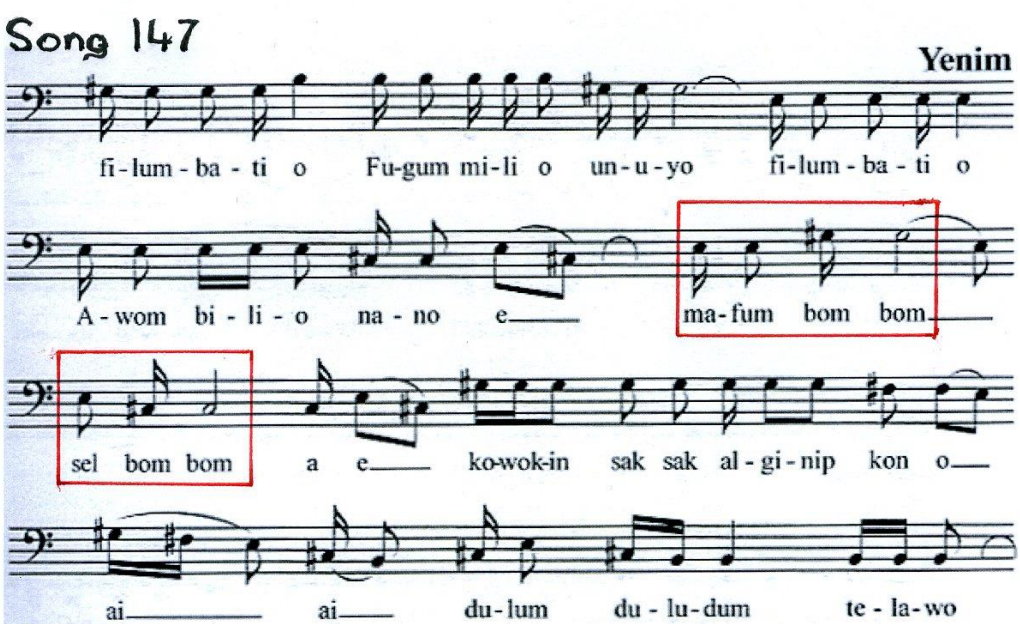
p1a1 *pma2* *p111*



Similarly, in **Song 143**. Here there is 'free inversion' that is an example of 'diagonally-deflected symmetry', equivalent to *p1a1* in the Washburn & Crowe schema:



Roberts goes on to point out (2014:xli) that the inversions in Central New Guinea songs are not just in song, but also in words in the songs. 'In this region, mirroring is accomplished by using two names for the same thing, like the pairing of *sel* and *mafum*, which are different regional names for the same ceremonial headdress, in **Song 147**. Here these two words are sung in proximate inversion of each other [*p1a1*], creating a mirror in word and melody.' Since *mafum* is a two-syllable word, the tone E is repeated, but voiced once for *sel*.



Oral narratives
The challenge is to find symmetries in the oral narratives. Candidates for comparison to the songs recorded and transcribed by Roberts may be found among the Telefol stories (*weng sang*) recorded and translated by Robert Brumbaugh (1984; see www.uscngp.com/papers/).

Story Nr 2 **is 'A Gardener and a Fruit Cutter'**. In summary, two men, a taro gardener and a fruit (cucumber?) gatherer live together and share their crops. The gardener goes down to the river and snares a bag containing a leg of pork and cooked taro floating by. He eats it all then travels upstream to see where it came from. He discovers a woman there who sets him several tasks to deflect his desire to have intercourse with her. His final task is to harvest two pandanus fruit that change into two beautiful young women who he takes home as his wives.

Meanwhile, the fruit cutter notes the non-return of the taro gardener, goes down to the river, and has the exact same experience as the taro gardener but overcomes the woman's resistance and has intercourse with her. She sets him the same tasks as she set the taro gardener, which he performs poorly. She sends him off with the same final instruction to harvest two pandanus fruit, but he damages one of the fruits which change into two women, one lame and one well. He has intercourse with them and takes them home as wives. Both men had children, a boy and a girl.

The experience of the taro gardener is mirrored by that of the fruit cutter, almost exactly. An 'inversion' of the theme is signalled by the suggestions that the fruit cutter is somewhat incompetent, and by the woman saying: 'Your friend who came didn't have sex with me. He just came and made a garden, slept at the house, and left. You are a different kind of man altogether, that you came and had sex with me . . . are you a gardener or a good-for-nothing?' This inversion could, arguably, be considered as the equivalent of *p1a1* in graphic designs and 'free inversion' in the songs ie. not the exact opposite experience but almost the same with some details different (**Fig. 18, right**).

Story Nr 4 **is 'No-eyes and Good-eyes'**. Summarising a complex story, No-eyes was a blind hunter and Good-eyes a gardener. They shared their food but No-eyes, unable to leave the house, defecated inside which incensed Good-eyes and they fought and the blind man was killed. The narrative transitions to tell of two sisters who come into conflict over a detached penis, the cause of the older sister's pregnancy, and she kills her younger sister. Here we have an inversion symmetry of gender, with the killing of one of a pair by the other, caused by

defecation versus impregnation. Again, this may be considered the equivalent of *p1a1* in graphic designs.

***Story Nr 5* is 'Five Brothers'**. While hunting, four of five brothers sequentially encounter an old man who claims he is their father, who tricks them and kills and eats them; this is an example of 'serial repetition', (perhaps *p1* in the Washburn and Crowe system). The remaining, youngest brother finds the old man, rejects him as his father, tricks him and kills him, then with the help of a spirit-bag, revives his four brothers from their bones discarded by the old man. The symmetry in this story might be considered an example of 'diagonally deflected symmetry', *pma2* or perhaps *p1a1* in graphic designs: four brothers killed by an old man (a 'false father'), the old man killed by the fifth brother, four brothers revived by a young man (a 'true brother'). Coincidentally, perhaps, the 'serial repetition' and 'diagonally-deflected symmetry' of the experiences of the five brothers is reflected in the arrow design in **Fig. 21**, where the bottom line of motifs is diagonally deflected from the serial repetition of the four lines of motifs above.

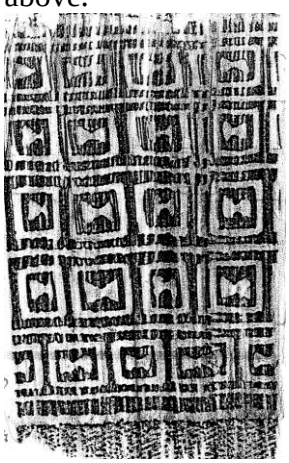


Figure 21. Arrow design from Miamduvip, Telefolmin.

6. ARROW DESIGNS, SONGS AND NARRATIVES OF THE UPPER SEPIK

We have sufficient data only for the Abau of the Upper Sepik. We compare the designs on Abau arrow foreshafts (made by men), the men's Fight Songs (*okiei*) and the stories told by the men.

Arrow designs

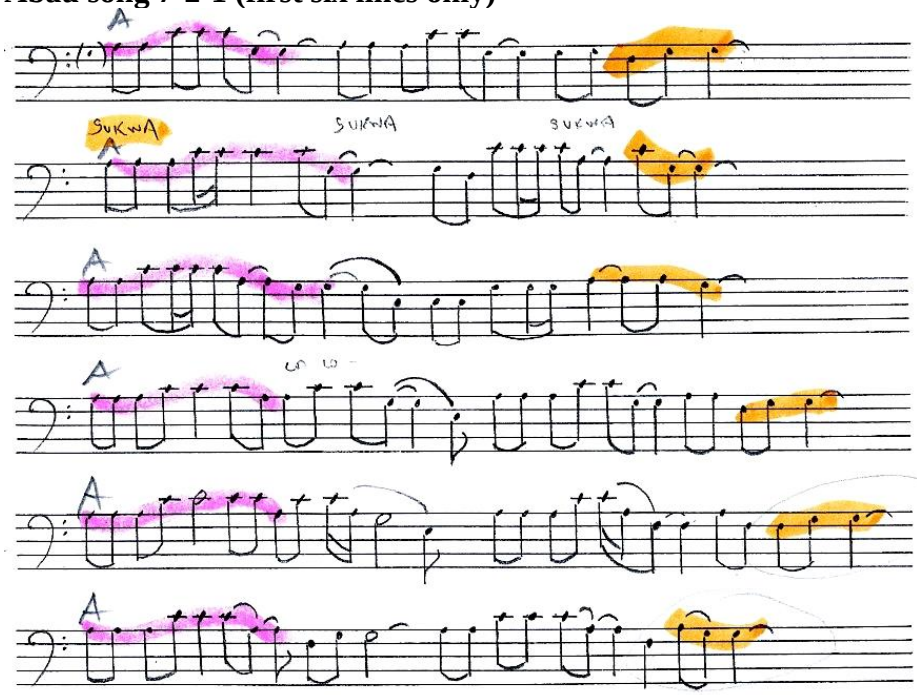
In **Fig. 14** above, it is apparent that Abau arrow designs have predominantly (55%) what Craig termed 'Diagonally-deflected symmetry' ie. *pma2* and *p1a1* in the Washburn and Crowe system. Less frequently the designs have 'Inversion Symmetry' (*pmm2* and *p1m1* - 17%) and 'Serial Repetition' (*pm* and *cm* - 17%).

Songs

Abau songs were recorded by Craig in 1972-73 and transcribed into music notation by Roberts in 2012. Remarkably, most lines of most of the songs commence with the note A, and all lines of all the songs end with the note G. The Star Mountains songs are by comparison quite variable on which note a line of a song will begin and end, with frequent changes in pitch. This gives Star Mountains songs a centrifugal character, whereas the Abau songs demonstrate a centripetal character, 'allowing the piece to conclude, sound complete and come to rest at the final cadence' (Roberts, MS 2012).

The two major symmetries to be seen in Abau songs is repetition and inversion, the former at or near the beginning of the lines of a song and the latter usually at the end of the lines of a song. For example, in the song **7-2-1** [6] about the white cockatoo (*sukwa*), the opening phrase is repeated with slight variation and the concluding phrases demonstrate inversions, some strict (lines 5, 6) and the others free. This particular song has another kind of symmetry. Seven lines commence the opening phrase on A; the 8th line is a different motif commencing with D, and the next seven lines repeat the first phrase (again with slight variation) starting with A.

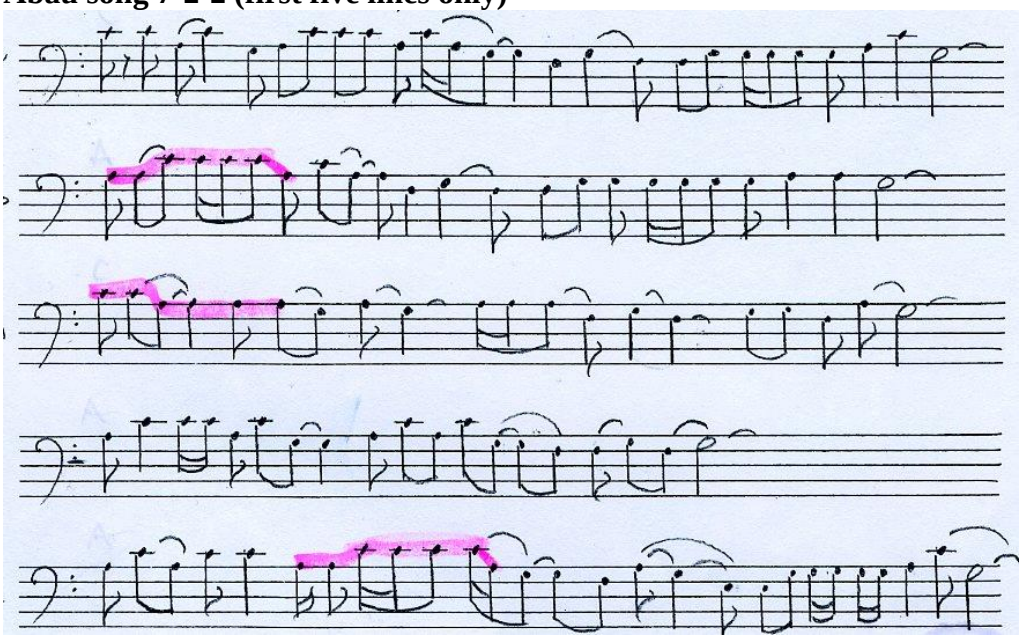
Abau song 7-2-1 (first six lines only)



[6] This song is at Tape 7, Side 2, Track 1 (7-2-1)

In another song (**7-2-2**), about a warrior who put bird of paradise plumes in his hair to sing-sing, the opening phrase of lines 2 and 3 demonstrates inversion symmetry (in this case, *p1m1* if slight differences are ignored, otherwise *p1a1*). The opening phrase in line 2 is transposed towards the middle of line 5, is repeated at that position in lines 8 and 9, and transposed back, slightly varied, to the beginning of lines 13 and 14 (arguably, examples of *p111*). The whole of lines 12 and 16 are almost identical.

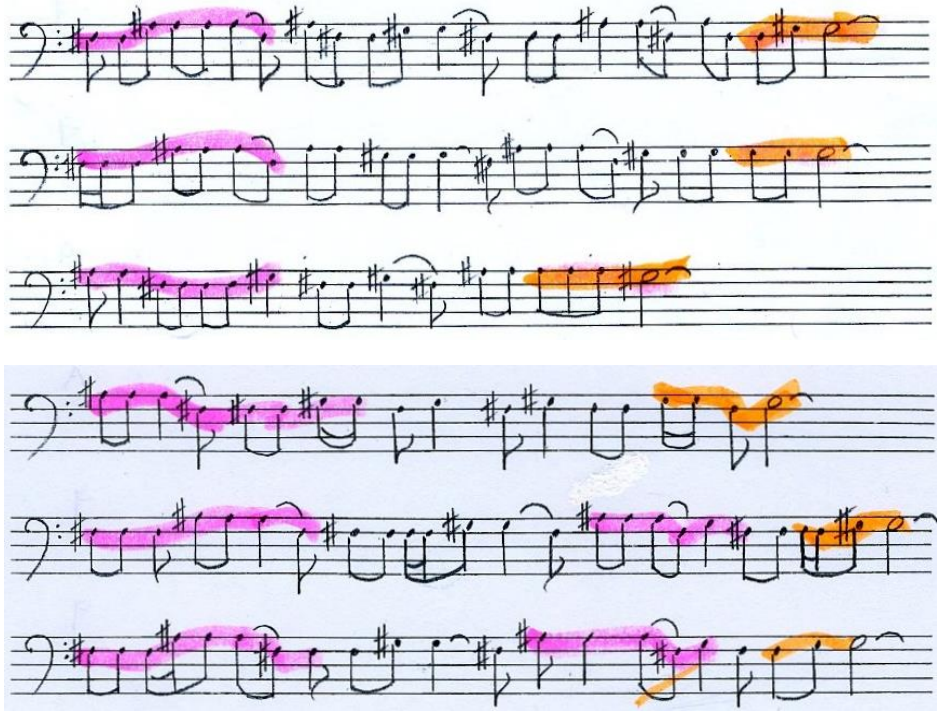
Abau song 7-2-2 (first five lines only)



In Song **7-2-9**, the first phrase of the last six lines demonstrates repetition followed by inversion and inversion followed by repetition, which in itself is an inversion symmetry.

Although I could not identify examples of 'Diagonally-deflected symmetry' (*ie. pma2* and *p1a1*) within a single line of a song, if two lines are considered together, then examples of 'Inversion symmetry' become examples of 'Diagonally-deflected symmetry'. This highlights the looseness of the comparisons of the structures of graphic designs, songs and narratives, given that graphic designs are essentially spatial, and songs and narratives temporal, in nature.

Abau song 7-2-9 (last six lines only)



Oral narratives

Examples of Abau narratives may be found at www.uscngp.com/papers/ *Legends of the Abau of the Idam Valley...*, recorded and transcribed by Craig.

Labiou, the Wallaby. Much of this story is structured by repetitive acts of the wallaby Labiou. A woman hung up her string bag containing her baby while she went down to the river to wash. The wallaby came and stole the baby boy. He cared for him, 'not like human parents who sometimes neglect their children'. When the boy grew, the wallaby stole bow and arrows for him to learn to hunt and stole bananas from the boy's parents' garden. Then the wallaby stole a man's weapons and tools the man had put aside while he went down to the river to wash. The boy, now a young man, built a large communal dance house and planted a garden.

The wallaby became concerned to reduce the young man's labour at processing sago and other domestic chores, so he went and stole the personal belongings of two unmarried women who were fishing in the river and lured them to the young man's house. The women became enamoured of the young man and decided to stay with him. Together the women prepared a lot of sago and he shot pigs and smoked the meat.

Meanwhile the girls' relatives went out hunting to prepare a mourning feast for the girls and the stolen baby (mirroring the preparation of food by the young man and the two girls – *pmm2*). The wallaby lured the people to discover the young man who revealed himself as the stolen baby and the two girls as his wives. During the celebrations, the wallaby stole some food from a man's garden but was killed and eaten. The young man killed the people who had eaten his 'father'.

Here we have several repetitive acts of theft by the wallaby to provide for the needs of the boy/young man (equivalent to *pm* or *pmm* in graphic design), the final act of theft resulting in its death (*p1a1*). The young man then revenged the death of his 'father' ('inversion symmetry', *p1m1*).

The Adventures of a Spirit-Man provides further examples of 'serial repetition'. A spirit-man lived with a man and his wife. They treated him badly and the spirit-man decided to exact some revenge. He carved five canoes from different timbers then attempted to have intercourse with the man's wife but found he needed to cut her hymen to succeed. The husband, returning from hunting, found himself on the opposite side of the river to his house, where the spirit-man and his canoes were, and called out for help to cross. The spirit-man tricked the husband four times in each of the canoes by appearing to come to get him but returning to his side of the river without him. The fifth time, the spirit-man picked up the husband and his hunting dogs but had instructed a crocodile to grab one of the dogs. This made the husband angry but the spirit-man confided that he had enabled the wife to successfully have intercourse and suggested the husband have sex with her. The result was so pleasurable that the husband forgave the spirit-man for tricking him.

Later they built a dam across the river to trap fish but the spirit-man stood downriver of the dam and instructed the husband to break the dam. The spirit-man was swept downstream and became embedded in the sand 'like a log' where three women consecutively came to get water, were penetrated by the spirit-man's erect penis, and became pregnant. The spirit-man's penis missed a fourth woman. The women realised there was a man there, dug him out, and they all four became the spirit-man's wives.

In this story there are two episodes of serial repetition: four times the spirit-man tricks the husband but the fifth time delivers the husband as requested – arguably *pmm* followed by *pma2*. Anger over the loss of the dog is ameliorated by the new pleasure of sex with his wife (*p112*). Then follows the episode of penetration of

three women by the spirit-man's penis (*pmm*), failure with the fourth (*p1a1*), but all becoming his wives.

Woblioti the Outcast. Woblioti, a man who kills people randomly, even of his own settlement, is banished and his brother goes with him to keep him company. However, Woblioti kills his brother after a serious argument and is overcome with remorse. He goes feral into the forest, but a young woman takes pity on him and, in gratitude, Woblioti helps her, her sister and their old father to hunt, builds a house and makes a large garden for them. He then returns to where he had left his slain brother and resurrects him with magic rites. He goes back to his community and is welcomed as a changed man. The symmetry in this narrative may be considered the equivalent of *p1a1* in graphic designs.

7. CONCLUSION

As Washburn and Crowe have demonstrated (1988, 2004), symmetries of culture are 'non-random patterns . . . The problem of why people do things similarly is pervasive, profound, and not trivial. It deserves our best systematic efforts' (1988:41). Armstrong asserts that in relation to the physical properties of works, 'it is of the greatest urgency to establish a highly generalized language capable of identifying and describing constituent physical units and of stating their relationships' (1971:42), ie. their structure.

This exploration of possible consistencies in structure of the designs on arrows, of the songs and narratives of the people of central New Guinea and the upper Sepik confirms the consistency of the structure of graphic designs, songs and narratives within these cultures but also has revealed weaknesses in the categories and comparisons. Comparison of graphic designs and songs is less problematic than comparison of those two forms with narratives. But it is a start, from which a more valid methodology may be developed.

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