

Anatomy of Devanagari Typefaces

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Introduction

The anatomy of a letter can perhaps be defined as a system which depicts the structural makeup of a letter; describing certain key parts within the letter for a given typeface. These morphological articulations of the characters within the font form the first level of description within the typographic ontology of a script. The Latin script, due to its long and elaborate tradition in printing; has a fairly standardized vocabulary to describe its letterforms. Unlike western typographic systems, theory and literature on the anatomy of Devanagari letters is sparse—although there are a few experts who have tried to articulate the various features of Devanagari letters.

This article discusses the various approaches taken by four experts in describing and defining the anatomy of Devanagari letters. Within these approaches we will focus on the vocabulary used to describe the diacritical and vowel signs in Devanagari, the elements within each of the Devanagari letters and the terminology used to describe them. We'll also examine the reference or guide lines used to mark the limits and proportions of the individual parts of a letter. This article also attempts to gauge the strengths and limitations of each of the approaches. Finally, we'd consolidate the similarities that exist amongst the various approaches.

Bhagwat & Naik

One of the first attempts towards a graphical

classification was done by S.V. Bhagwat¹. Devanagari letters till then had not² been subjected to such a graphical analysis³. Bhagwat's main focus was on handwritten Devanagari and not on printed Devanagari; Naik⁴ nonetheless believed that his insights on the graphical structure of Devanagari are enlightening. Bhagwat first creates groups of letters based on shared graphical properties. Six grouping systems for letters based on the following criteria are given on:

1. Size
2. Simplicity
3. Motion, stroke and angles
4. Endings, flourishes, fenced etc.
5. Groups according to the parts of letter design.
6. Groups based on graphical similarity (see fig.1)

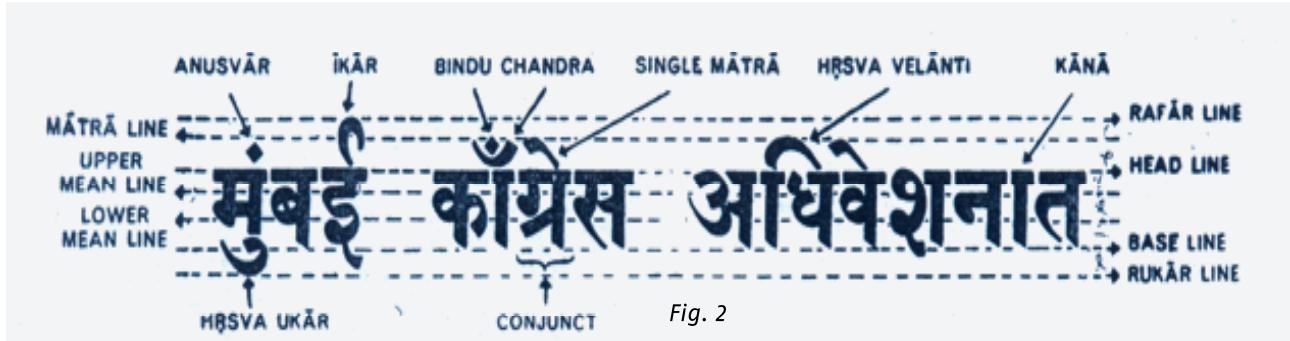
He then goes on to define (see fig.2) the guide lines for the letters and terminology for some of the graphical

Letters	Common element	Letters	Common element	Letters	Common element
ग म ध न	र and/or ऋ	प ष फ ण	ष	अ आ ओ औ अं अः	अ
र स (ग ख)	र (र)	ट ठ ड द (क्ष)	ट	ए ए	ए
त ल लृ	र	ऊ उ इ ई ञ ह	ड	म ऋ	म
व ब क ख	व	य थ	य	उ ऊ	उ
च (ज) घ ष छ	व or ष	श ळ ञ ञ	—		

Fig. 1

elements that exist within the letters. The guide lines defined by him are as follows:

The top lines are the "Rafar line", followed by the "Upper matra line" and the "Head line". The head line is also referred to as the "Shiro rekha", Bhagwat chooses



the upper limit of the Shiro rekha to denote the head line After the head line, the upper mean line and lower mean line are indicated. The upper mean line denotes the point from which the actual letter starts, it is the line where the “peg” of the letter ends and the actual letter begins, for example the topmost counter of the letter क and व. The lower mean line is marked where the distinguishing characteristics of the letters comes to an end for example the lower end of the first half of ग or the lowermost part of the counter of the letter क and व. These lines are followed by the base line, which is where the complete letter ends and the lower Matras begin. The lowermost line is the “Rukar line” named so that is the line where the lowest portion of the Rukar ends.

This division of letters is simplistic in comparison with the other schemes discussed in this article, it fails to address issues of the proportion of letters, double ligatures etc. It is also obsolete in a certain sense primarily because it uses handwritten Devanagari as its source material. Therefore it is interesting to note that, in this model two lines are marked above the Shiro rekha—the Upper matra line and Rafar line. A marked difference between the height of the matras and the height of the Rafar is seen mostly in handwritten or calligraphic Devanagari. This scheme cannot be applied to contemporary Devanagari as in most of these the typefaces the

heights of the Rafar and the Upper Matras are equal. If we were to consider Bhagwat's scheme for contemporary Devanagari typefaces then the two lines (Upper Matra line and Rafar line) would merge into one another. Bhagwat titles his figure as “Graphic Elements in Devanagari Letters”, the new contribution that he makes to the vocabulary of graphic elements of Devanagari is the term—the “loop”, which. he uses to describe the top of letters such भ and श.

Bapura Naik⁶ also attempted a graphical grouping (titled “Graphical Classification of Devanagari Varnas”) of letters—this grouping is a more succinct version of Bhagwat's grouping based on the parts of the letter. Naik graphically organizes the letters into five groups (see fig.3) based on the position of the Kana or the verti-bar.

	Vowels	Consonants	
Group 1	letters with full verti-bar	attached (अंत्यदंडयुक्त)	20
	अ	ख घ च ज झ त थ ध न प ब भ म य व ष स क्ष ञ	
Group 2	letters with full verti-bar	detached (अंत्यदंडयुक्त)	3
	ग ण ण		
Group 3	letters with a short-bar	(अल्पदंडयुक्त)	14
	उ ऊ लृ लृ	ड छ ट ठ ड ड द ल ह ळ	
Group 4	letters with a central-bar	(मध्यदंडयुक्त)	4
	ऋ ॠ	क फ	
Group 5	letter without a bar	(दंडरहित)	1
	र		

Fig. 3

It is worthwhile to notice that in this scheme the letter ए is missing. According to the given logic this letter would have a half verti-bar which would have increased the number of groups from five to six. One could also consider the fact that in group 5 the letter र is considered without a bar, in many contemporary Devanagari fonts the letter र is drawn with a half verti-bar as against a small arc from the Shiro rekha which is considered in the given example—in such a case one can group the letter ए with र and call it a group of letter with half verti-bars. The terminology used by Naik⁷ (also Bhagwat and Gokhale) is the typical terminology which is used to describe Devanagari vowel signs in schools while teaching Devanagari. The terms used for vowel signs are:

Vowel	Matras ⁸	Name
अ		
आ	।	Kana
इ	ि	Short <i>velanti</i>
ई	ी	Long <i>velanti</i>
उ	ु	Short <i>ukar</i>
ऊ	ू	Long <i>ukar</i>
ऋ	ॠ	Single <i>prithvi</i> sign
ॠ	ॡ	Double <i>prithvi</i> sign
ऌ	ॢ	Single <i>klpti</i> sign
ॣ	ॣ	Double <i>klpti</i> sign
ए	ॆ	Single <i>matra</i>
ऐ	ॆ	Double <i>matra</i>
ओ	ॊ	Kana <i>matra</i>
औ	ॊ	Kana double <i>matra</i>
अं	ं	Anuswar
अः	ः	Visarga

M W Gokhale

The next attempt at creating a vocabulary for Devanagari was done by M W Gokhale; it was first published in 1975–76⁹. Gokhale uses the “body” paradigm to describe

the various portions of the Devanagari letters—the body is used as a reference for the vertical proportion of the letters. The lines defined by him are as follows:

- उर्ध्वरेखा (topmost line)
- शिरोरेखा (head-line, start/end)
- स्कंधरेखा (shoulder line)
- नभरेखा (navel line)
- जानुरेखा (knee position line)
- पदरेखा (foot line)
- तलरेखा (extreme bottom line)

Regarding the proportion of letters, Gokhale uses the stroke thickness (thickness of the pen stroke) as the base unit. He suggests—to define the upper Matra signs we need minimum four strokes and bottom Matras need

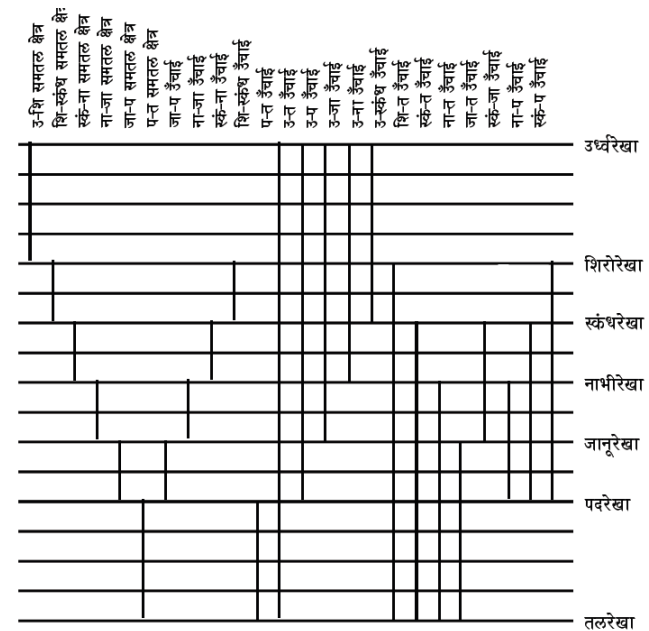


Fig. 4

a minimum of four strokes. Thus four strokes for upper, eight strokes for the main characters and four strokes for the bottom Matras are necessary. Total 16 units of strokes can be considered as a primary parameter for the total height. He also goes on to suggest—for practical purpose the thickness of the pen stroke could be 1/16th of the type height (see fig.4) According to this scheme, “an expert designer can vary the proportions if guide lines and alignment zones to suit his/her design needs¹⁰”. The description of the various parts of Devanagari letters is called “Cartographic description of Devanagari” in his document. The supporting figures show the labelled terminology.

Some notable terminology that we can see here is, शिर्षदंड for the “peg” or connecting part of a letter such as द; सर्पकार मरोड for the elongated loop of the letter क्ष; विवर for counter space in the letter च which has an open

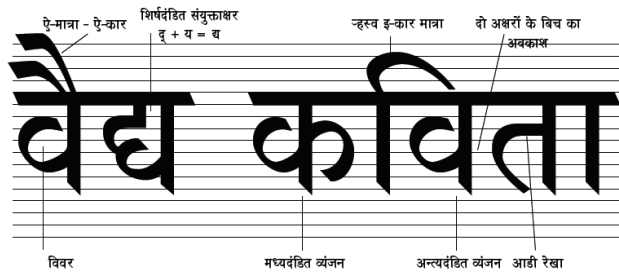
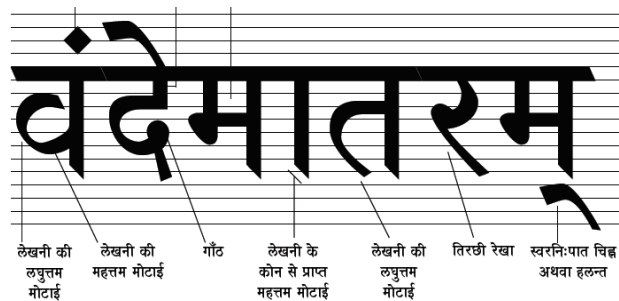


Fig. 5



counter in the given example. गाँठ i.e. a knot, more precisely a filled knot in the letter द. बंदिस्त अन्वकाश for the enclosed counter space in the letter म.

Mahendra Patel

Mahendra Patel designed two digital Devanagari fonts for the National Institute of Design Ahmedabad, in 2001 and 2004 respectively¹¹. In the documentation of these projects he uses the following set of guide lines—these lines not only stand independently for Devanagari, but Patel has also laid down their relation to the Latin reference lines. The Devanagari reference lines laid down by Patel are:

- Upper most line
- Upper Matra Line
- Shiro Rekha Upper line
- Shiro Rekha Lower line
- Kana Lower line
- Vertical Conjunct line
- Lower Matra line
- Lower Matra line for vertical Conjunct
- Lowermost line

He further enumerates the following design aspects of his font by grouping “Characters in Formwise Categories”. The groups formed by him are:

1. “Angular Endings”: The endings or terminals of letters such as क ग ज ट ड ण त त्र प फ य ल व ष ए २ ५ ७
2. “Block Loop Endings & Joints”: Block looped endings would be seen in letters such as न while block loop joints would be seen in letter such as ख क्ष ज्ञ द भ म र श स ह्य इ ऋ.
3. “Loop Endings and Joints”: Loop here again denotes an open loop so a letter with a looped ending would be छ ढ थ श while letters with open looped joints would be क्ष and प्र.
4. “Merging Joints” (a curve to curve/straight stroke): such as in letters क ख घ च त्र द्र ह ३
5. “Right Angle Joints” (straight to straight/curve stroke): Shown in the letters such as ग्र ज त म न २ ४ ७

6. "Looped Form" defined here as letters which have a considerable portion of their body looped, such as the letters: ष ६ ८ ९

Patel defines two kinds of loops for his letters—a "block loop" which is a filled knot it can be an ending (as in the letters ञ) or a "block loop join" (such as in the letter र) similarly an open loop is an open knot (where the counter is visible) it again comes in two flavours; a open loop ending (the letter छ) and an open loop join (the letter क्ष).

It is important to note here that the terminology defined here, is highly dependent upon the shape of the characters—a particular character can have a variety of forms and the terms applied here refer to the specific font designed by Patel. An example to show this is the letter ऋ, in the font designed by Patel the letter ऋ does not have a counter or a loop even, whilst it is very common to see a ऋ with a loop (filled or otherwise).

Observations

After analysing the various divisions and nomenclatural terms used by various experts; one can make the following observations:

Certain terminology is unanimously used by all the experts. This is more or less the terminology of the Matras (dependent vowels) and other diacritical signs. The terms where there seems to be a large level of consensus are noted below (alternative names are shown alongside).

In describing various parts of the letter—many a times experts have named the same part of a letter with different names. As an example if we consider the part which Bhagwat refers to as a "loop" is further classified by Patel into two kinds: blocked (filled) and open (with

Character	Sign	Nomenclature
	˘	<i>Halanta, Virama</i>
आ	ा	<i>Kana</i>
इ	ि	Short, <i>hrasva velanti</i> ¹²
ई	ी	Long, <i>dirgha velanti</i>
उ	ु	Short, <i>hrasva ukar</i>
ऊ	ू	Long, <i>dirgha ukar</i>
ऋ	ॠ	Single <i>prithvi</i> sign, <i>hrasva Rukar</i>
ॠ	ॡ	Double <i>prithvi</i> sign, <i>dirgha Rukar</i>
ऌ	ॣ	Single <i>klpti</i> sign
ॣ	।	Double <i>klpti</i> sign
ए	ँ	Single <i>matra</i> ,
ऐ	ं	Double <i>matra</i>
ओ	ो	<i>Kana matra</i>
औ	ौ	<i>Kana double matra</i>
अं	ं	<i>Anuswar</i>
अः	ः	<i>Visarga</i>
	ँ ॡ ॣ	<i>Anunasika, Chandrabindu</i>
	ँ	<i>Chandra</i>
	ऽ	<i>Avagraha</i>
र	्र	<i>Ra-kar (short slanted line)</i>
र	्र	<i>Rashtra sign (chevron shaped sign)</i>
र	र्	<i>Reph, Rafar</i>
र	्य	<i>Varyacha, eyelash र (Marathi)</i>

a counter) loops. These two are further placed into two contexts: "loops at the end" and "loops at the joints". If we consider the same element, Gokhale calls the "blocked loop" of Patel as a गाँठ or "knot". Similarly the

portion which Patel refers to as a counter is referred to as a विवर (for an open counter) and बंदिस्त अवकाश for a closed counter.

While dividing letters, the most important reference line seems to be the Shiro-rekha or the head line. In its definition, two experts have defined it considering its width—defining two lines within the Shiro-rekha—an upper Shiro-rekha line (आद्य शिरोरेखा) and a lower Shiro-rekha line (अंत्य शिरोरेखा). Only one expert (Bhagwat) uses the upper limit of the as a reference for the Shiro-rekha.

Most of the other reference lines are marked by vertical upper limit that the width of a stroke can take or the vertical lower limit that the width of a stroke can take. A typical exception to the above observation is the नभरेखा (navel line) which defines the horizontal maxima that the stroke takes while drawing certain characters with circular strokes.

In the division of letters, one can see a similarity between Bhagwat's divisions and Gokhale's. The latter seems to be a more elaborate and expanded version of the previous scheme—above which is placed the body paradigm which dictates the vertical proportion of letters. One can see differences when we compare the letter division schemes (especially in the proportions—as an example compare Bhagwat with Patel) of all the experts. However the guide lines which are common and have been delineated by all are:

- Upper Matra line, Matra Line, उर्ध्वरेखा (topmost line)
- Shiro-rekha, Head line, शिरोरेखा (head-line)
- Initial line, Upper Mean line, स्कंधरेखा (shoulder line)
- Lower Kana line, Base line, पदरेखा (foot line)
- Lower Matra line, Rukar line, तलरेखा (extreme bottom line)

Conclusion

The existing literature on this topic is very limited and experts have afforded only a page or two to the description of the Devanagari letters. Considering the existing literature on the anatomy of Devanagari letters—it seems as if there exists a common unanimous vocabulary which is used to describe Devanagari vowel signs—minor linguistic differences do exist within these terms, but they are translatable in most cases. There are a number of differences in the nomenclature used by experts to describe the specific parts (stroke elements) within Devanagari letters. Many a times, the same elements are labelled by different experts differently, in this again some experts describe certain terms much more elaborately than others. The Latin typographic letterform is almost unanimously governed by at least four reference lines—the ascender, descender, x-height and the cap height. There exists no universal consensus on the reference lines for Devanagari letters.

One can see from the given literature there are differences in the methods and nomenclature within the theories proposed by the various authors. However there are certain similarities too; these similarities ascertain the significant features and divisions of Devanagari letters. We can sense here a need for a unifying anatomical model for Devanagari typefaces which resolves the differences between the given assorted schemes by incorporating the essential features mentioned by each of the experts.

Notes & References

1. Bagwat S V, Phonemic frequencies in Marathi and their relation to devising a speed script, Deccan college Pune, 1961
2. Two pamphlets published on Devanagari calligraphy in Marathi: Apte, Jagdeesh Pandurang, Chitraroop

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Devanagari, Poona February 1960 and Ravale Lakshman Sakharam, Hastakshar Darshan, Popular Book Depot Bombay, 1964

3. The summary is consolidated from Naik, Bapurao S., *Typography of Devanagari* (Bombay: Directorate of Languages, 1971)

4. Ibid pp 205-214

5. A letter-peg is defined by Bhagwat as, a small vertical dash (or short bar) hanging from the head-line and supporting the main body of a letter.

6. Naik, Bapurao S., *Typography of Devanagari* (Bombay: Directorate of Languages, 1971) p176

7. Ibid p177 & p186

8 Naik explicitly uses the term Matra with a capital M to denote all the vowel signs, while matra with a small m is used for the vowel signs of ए and ऐ.

9. Gokhale, Mukund. *An Experiment on Devanagari Type Design System*. Pune: Script Research Institute, 2004.

10. Gokhale, Mukund. *An Experiment on Devanagari Type Design System*. Pune: Script Research Institute, 2004. P19

11. Patel Mahendra. *Type Design Development Project*, National Institute of Design 2004

12. The term velanti is a typically Marathi word (origin from the Marathi word वेल (vel): of a vine or other scandent shrub) used to denote the dependent vowel sign for इ and ई.

About the Author:

Girish Dalvi is a doctoral student at the Industrial Design Centre (IDC), Indian Institute of Technology Bombay, working in the area of Devanagari Typography.