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In the twenty-first century there is now greater recognition, at least in the field of textual communication, that scripts other than Latin are used by the majority of the world's population. One such script is Devanagari, a Brahmi-derived script employed by some 400 million users[1] for writing Hindi, Marathi, Rajasthani, Nepali as well as Sanskrit and other languages. Its typographical rendition in print through the use of movable metal type dates back to 1771 in Rome with the publication of the *Alphabetum Brammhanicum*[2] whose rather crude letter-shapes were drawn by unnamed Indian converts.[3] The true authorship of typographical letterforms that have affected and continue to affect the quotidian reading experience in different scripts for innumerable people has proved time and again to be inaccurate or elusive – either unwittingly or deliberately – even into the digital era.[4] Yet historical enquiry has provided a deeper understanding of type-design and type-making processes and the realisation that the final visible result often relies on the concomitant activities of many hands.

Such activities include the frequently overlooked role of type-drawing offices during the twentieth century, which were often staffed principally by women, and which operated in concert with the rarely recorded decisions and actions of key participants that affected the design outcomes.[5] An insight into the multifarious contributions of seemingly invisible hands in the design process and the consequent impact on typographical history is afforded by tracing the origins and development of the Linotype Devanagari digital fonts that were published in the early 1980s, and whose presence continues to be familiar to many millions of readers in the twenty-first century.

Setting precedents
The impetus to render languages in the Devanagari script through typographical means may have originated from evangelical and political forces external to South Asia, yet its particularly successful translation into type was effected by an autochthonous Indian type foundry, the Javaji Dadaji Type Foundry established in Mumbai in 1864,[6] and evinced through the works of its accompanying Nirnaya Sagar Press established in 1869 (Fig. 1 and 2). The specifics of the Devanagari script required particular typesetting techniques to ensure an effective, readable

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[1] See, Vaibhav Singh, 'Devanagari type in the twentieth century: motivations, imperatives, technology and the design process', unpublished Ph.D. thesis, University of Reading, 2017, Fig. 1,

[2] Amaduzzi, Giovanni Christoforo (Ed), *Alphabetum Brammhanicum seu Indostanum Universitatis Kasí*. (Rome: Propogande Fide Press, 1771).

[3] See G. W. Shaw, 'Printing in Devanagari: the evolution of types in Devanagari script', *The Monotype Recorder*, new series 2, (1980), p. 20; and B. S. Naik, *Typography of Devanagari*, (3 volumes, Bombay: Directorate of Languages, 1971), p. 239.

[4] See Fiona Ross, 'Two Bengali grammars – a typographic perspective', https://www.bl.uk/early-indian-printed-books/articles/two-bengali-grammars-a-typographic-perspective; and see below, p. 21.

[5] See Alice Savoie, 'The women behind Times New Roman: The contribution of type drawing offices to twentieth century type-making', *Journal of Design History,* vol. 33, Issue 3 (2020), pp. 209–224.

[6] This foundry continued beyond the founder Javaji Dadaji Choudhary's death in 1892; for further biographical information, see Naik, (1971, note 3) pp. 309-312. Although cast by the foundry, the types are usually referred to as Nirnaya Sagar types, a practice that is followed here.

textual outcome; it is known that the founts[7] employed by the renowned Nirnaya Sagar Press adopted the Degree system of composition which utilised small components particularly for vowel signs (see Fig. 3) and which, unless carefully composed and locked up in the forme, had a tendency to become dislodged and drop out during printing. In 1963 the Nirnaya Sagar Devanagari founts are recorded to have comprised some '600 sorts'[8] to serve, as stated in the foundry's 1967 type-specimen catalogue, the needs of the Hindi, Marathi and Sanskrit languages, thereby occupying many type-cases for high-quality book work.[9]

The utilisation of 400, or over 600 individual characters or character elements that the alternative Akhand system customarily required, for Devanagari composition was certainly not attainable for mechanical typesetting introduced into colonial India for the Devanagari script in the 1930s. The 'inauguration of the Devanagari Monotype machine,' the result of a commercial undertaking involving the exertions of key figures across 3 continents, took place in Poona in 1932;[10] while the Devanagari Linotype machine – the product of another trans-continental enterprise[11] – was launched in Calcutta in 1933 (Fig. 4a and b). The Monotype machine,[12] developed by the British Monotype Corporation, which employed a form of the Akhand system[13] was preferred over the Linotype for good quality work in the Devanagari script, yet it could not meet the exacting standards that Monotype set out:

> However ingenious a machine may be, whatever the speed it may
> attain in composition, quality in printing surface and facility of
> correction are essential features of its practical utility. No machine
> that is devised to do what previously was done by hand can be looked upon
> as correct in principle or perfect in adaptation, unless it
> maintains equal quality and greatly increased quantity of production.
> In such a degree as the machine lowers the standards created by the
> slow evolution of manual methods, it must be pronounced a failure.[14]

Indeed, Monotype could not meet its criterion of producing Devanagari type that was indistinguishable from foundry type: the Monotype matrix case for each typeface could only

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[7] This essay adopts the practice of using the term 'founts' for cast metal type' and 'fonts' for film or digital fonts.

[8] Naik (1971, note 3), p. x; Naik later gives the standard figures for the Degree system as approximately '400 sorts', and the Akhand system as over 600, pp. 341-42.

[9] At considerable cost, as up to 7 cases of type in one size would be needed; see Norman Ellis, 'Indian Typography', *The Carey exhibition of printing and fine printing. The National Library, Calcutta,* (edited by B. S. Kesavan. Calcutta: Government of India Press, 1955), p. 11.

[10] See Vaibhav Singh's excellent account of its development: 'The First Indian Script on the Monotype', *Journal of the Printing Historical Society*, new series 29, (Winter, 2018), pp. 54-70.

[11] Between disparately located Linotype companies: Linotype & Machinery Ltd, England; Linotype & Machinery Ltd branch offices in Calcutta and Bombay; Mergenthaler Linotype Company, USA. The Devanagari Linotype comprised a modified Linotype machine fitted with a Devanagari keyboard and channels of different sizes customised to mechanically compose Devanagari vowel marks and special symbols.

[12] In actuality, it comprised two units: a keyboard and a caster; see F. G. E. Ross, *The printed Bengali character and its evolution*, (Surrey: Curzon Press, 1999), pp. 162-163.

[13] Introduced with the help of 'Sankerrao Date' [Shankar Ramchandra Date], Gopal Krishna Modi, 'The Devanagari System of Types', *7th Conference, All India Type Founders Federation*, (Calcutta: 1982), p. 8.

[14] 'The Lanston Machine for Casting and Setting Single Type in Perfectly Spaced Lines' (n.d.) cited in *The Monotype Recorder*, 39, no. 1, (London: The Monotype Corporation, 1949) p. 16.

accommodate a maximum of 255 characters.[15] Furthermore, the character proportions were somewhat constrained by their necessary adaptation to the relative-unit system.[16] In a region where labour for hand-setting was not in short supply, the Monotype machine did, however, gain in popularity through the casting component of the machine, which was utilised extensively throughout the Indian sub-Continent as a faster means of casting type into case for hand-composition.[17] By 1984 it was recorded that India possessed the greatest number of Monotype hot-metal machines than any other country.[18]

The implementation of the Devanagari script on the Linotype composing machine, initiated in America by Hari G. Govil[19] approaching the Mergenthaler Linotype Company (MLCo), was heralded for facilitating speedy newspaper composition (and thus dissemination) that would ideally, for the Indian vernacular press, match that of the 'English dailies'.[20] However, the Linotype could employ neither the Degree nor the Akhand system and possessed no facility for kerning (allowing part of one character to overhang or interlock with another) – a distinctive handicap for most Indian scripts, particularly with regard to the representation of all the required vowel sounds. Unlike the Monotype system that resulted in the casting of individual types, the linecasting system produced stable lines which could be more-easily be arranged into pages for stereotyping to make curved plates for rotary printing that was favoured by the newspaper industry.[21] Yet, the Linotype was severely constrained by its 90-channel keyboard, which therefore only permitted a limited set of matrices in the main magazine.[22] This limit of 90 characters per typeface could be augmented by a side-magazine of auxiliary characters, but the latter was expensive and slowed down the composing process – a factor antithetical to the exigencies of rapid newspaper production (see Fig. 5).[23]

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[15] Lawrence Wallis, 'Monotype time check', *The Monotype Recorder, one hundred years of type making,* 1897–1997, (Redhill: The Monotype Corporation, 1997), p.4.

[16] See Ross (1999, note 12), pp. 163-164.

[17] The Monotype cast types wore more quickly due to the softer metal; and the kerns and interlocking parts prevalent in Indian-script composition suffered from the pressure exerted by the presses. According to David Saunders, Monotype's recommendations to strengthen the types by using '10% tin, 10% antimony, 80% lead' were often ignored by 'some printers in India'; see Ross (1999, note 12), pp. 177-178.

[18] See Fiona Ross, 'From metal type to digital Letterforms – a straightforward transition?' *Matrix* 9 (Andoversford: Whittington Press, 1989) p. 132; and John Randle 'The Development of the Monotype Machine', *Matrix* 4 (Andoversford: Whittington Press, 1984), p. 47.

[19] Hari G. Govil, was a graduate of Benaras University, who moved to America in 1920. Naik, (1971, note 3), p. 401.

[20] In 1916 it was stated that the Linotype 'class of machine, a machine that casts a slug or line of type from a line of previously assembled and justified matrices at a single operation of casting, is still the most important factor in newspaper printing throughout the world.' J.A. Legros and J.C. Grant, *Typographical printing-surfaces, the technology and mechanism of their production*, (London: Longmans Green and Co., 1916), p. 422. Here was meant English-language daily newspapers: *The Hindu, The Indian Express* and *The Times of India*; see K. S. Vijayapaliah, *Introduction of Kannada on the typewriter, Linotype and Monotype* (Bangalore: 1954), p. 3. See also, Singh, (2018, note 10) p.8, note 6.

[21] The robustness of Linotype-set matter was a significant advantage for printing Indian-script composition, see Ross (1999, note 12), pp. 137-8. In 1930's Bengal, printing the Bengal Electoral rolls was also a key driver for implementing an Indian script on such equipment, ibid, p.148

[22] And duplexed matrices meant that the Light and Bold characters had to be of the same width.

[23] Hence the attention Linotype paid to keyboard revisions by Times of India's Composing Room Superintendent, K.A.G. Krishnan, who was 'keeping record of all operator suggestions re placement of characters' to improve composing speeds by 30%; N. Balasubramanian to W. Tracy et al, 14 October 1963. File 25, Tracy correspondence files, the Non-Latin Type Collection, [hereafter referred to as NLTC], University of Reading. A letter from W. Tracy to M. Parker confirms that three orders according to the new scheme, 'are to

Nonetheless, the quality of the types and hand-composition of the Nirnaya Sagar Press was used as a benchmark by which to evaluate the unavoidably inferior composition afforded by hot-metal typesetting, as is evidenced by documents held in the Linotype archives variously situated in Britain and America.[24] Although the initial sketches of the Devanagari typeface by Govil were, perhaps literally, drawn from or at least inspired by Nirnaya Sagar types, the sheer necessity of drastically reducing the customary foundry character-set required the deconstruction of many characters into separate components with which, in the linear setting of the Linotype, to construct alternative versions of the original type-forms.[25] Furthermore, the machine's inability to kern led Govil to adopt a radical approach to the treatment of the vowel signs in order to approximate their gracefully fitting Nirnaya Sagar counterparts.

Criticism of the resulting Linotype-set printed matter and mention of the superior aesthetics of the typefaces used by the Nirnaya Sagar Press repeatedly punctuate the inter-continental correspondence between interested parties in the development of mechanical composition for the Devanagari script.[26] Thus Linotype Devanagari, as the typeface was inevitably named, which in its hot-metal guise had two distinct styles, underwent a number of revisions over the course of 30 years – one being a seemingly inexact adaptation of Nirnaya Sagar face No. 369 in 1935[27] – thereby acknowledging the Linotype's visually awkward, if not inept, typographical representation of the Devanagari script. Such continual design iterations, pre- and post-Indian independence, demonstrate the company's constant efforts, in the hope of improving machine sales,[28] to produce readable Devanagari-script text within a challenging and changing competitive environment while hindered by the inherent technological limitations of hot-metal Linotype machinery.

Differing designs and approaches
The Linotype company archives in both America and Britain hold copies of a printed type specimen of a 1962 iteration of 'Linotype Devnagari [sic] 14pt' set along with the identical text composed with 'Nirnaya Sagar Type Face–Pica No.1' and also 'Monotype Devnagari [sic] Pica' (Fig. 6). This comparative setting of three versions of the same paragraph clearly illustrates the disparity between different composing systems and their consequent effects on the aesthetics and readability of the different type designs.

The Monotype typeface (given the Monotype Series number 155), and notably its

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consist of 90-channel layout characters plus pi sorts [pi characters] as specified. In no case is there any side magazine.' 31 August 1964. File 25, NLTC.

[24] Principally at the University of Reading and the Smithsonian Institution, Washington.

[25] Govil's system for splitting Devanagari characters for the Linotype is said to have been based on the work of Lokmanya Tilak, Naik, (1971, note 3), p. 401.

[26] For example, W. Tracy to A.C. Bridgman, 6 December 1963. File 25, NLTC.

[27] As Singh relates, this 14pt redesign was initiated by Kedarnath Chatterjee and drawn by an unnamed Bengali artist in Linotype's Kolkata office; the production drawings were prepared by Dorothy Arbogast and H. Meyer in MLCo's New York type-drawing office. The matrices were produced in England by Linotype & Machinery Limited. Singh, (2017, note 1) p.167. Chatterjee was also involved in the redesign of the hot-metal Linotype Bengali with Siresh Chandra Majumdar; see Ross (1999, note 12), pp. 151-3. Majumdar being the owner of the Sri Gouranga Press, (and proprietor of the influential Bengali newspaper Ananda Bazar Patrika) which 'produced the first book with text composed on the Devanagari Linotype in 1934'. Singh, (2017, note 1) p. 157.

[28] The drive for Linotype to improve on its Linotype Devanagari development, and its increasing engagement with Government departments and presses was also propelled by knowledge that 'by 1965 the Constitution will oblige them to print a great deal of official matter in Hindi as well as English', W. Tracy to M. Parker, 3 October 1963. File 25, NLTC.

Akhand-style scheme of composition, was designed in the 1930s by Shankar Ramchandra Date, who visited England and the Monotype Drawing Office where the technical drawings were prepared and put into production.[29] According to the print historian Bapurao S. Naik:

> Monotype Devanagari design in 12pt. (9 set) is based on Nirnaya Sagar Pica No. 1 and is not much distinguishable to the common reader. The larger versions 14 pt. and 16 pt. are the enlargements of 12 pt. design and have no relation to the original Nirnayasagar [sic] design of 14 p. Great Face. In all three cases the Monotype face is wider as compared to the height of the letters.

Naik continues to list a number of 'deficiencies inherent in the Monotype Devanagari currently in use'.[30] In comparison to the Nirnaya Sagar types, the sample of Monotype Devanagari shown in Fig. 6 reveals the differences in design – in the overall proportions, the wider spacing, and the smaller counter sizes that serve to emphasise the vertical strokes – which produce a profoundly different texture on the page to that of its model. Some characters, like ह (ha)and ळ (ḷ), look oversized in relation to others; and the overarching vowel signs, particularly the 'double mātrā', are inconsistent in length. A few of the consonantal clusters, known as 'conjuncts', are set in a linear manner, rather than designed in traditional fashion as a single typeform of vertically stacked consonants (see, 6b, encircled characters). Curiously, one common conjunct, क्र (kra), has different shaping in all three typefaces (see, Fig. 6c). The types, designed by Ranoji Raoji Aru,[31] of the Nirnaya Sagar paragraph do build some letterforms out of components but without the larger gaps between elements shown in the Monotype setting. The latter's fitting is not helped by the poorer alignment of the headline, at least in this specimen, and the very wide inter-word spacing.

The Linotype-set paragraph is even more divorced from the preferred foundry type, as the constant criticisms levelled at Linotype Devanagari that impelled the design iterations remained unresolved even 30 years after its debut. As already indicated, these related chiefly to the necessity of mitigating the deficiencies of its impoverished character-set through the use of common, often ill-fitting, components and to the problematic non-kerning vowel signs. This setting, however, does illustrate the long-standing efforts by B.S. Naik to improve on the aesthetics of Linotype Devanagari by means of the Vijapure scheme, which was 'essentially concerned with the angle of the 'mātrā characters' and their positioning. It unquestionably, shows some improvements in the linear composition of Devanagari over its standard Linotype counterpart (Fig. 7) albeit by utilising a larger array of characters than available on the 90-channel system. However, as the sample reveals, it still provided text with a somewhat broken appearance in comparison to the Nirnaya Sagar setting – even with an additional line added 'showing the reformed sort 'i'.[32]

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[29] And drawn up by the women who staffed the Monotype Drawing Office as recorded by Dora Laing in the worklog notebook, '155 Devanagari' entry 26 November 1931'. Date oversaw from India the development of the Bolder Weight series 346. V. Singh (2018, note 10), pp. 59-61.

[30] Naik, (1971, note 3), pp. 396-397. Vowel sign revisions had been made since the original design and some characters added by the Monotype Drawing Office. A re-design and its popularity for both book and newspaper composition were noted by Balasubramanian to Walter in 1969: 7 July 1969. File 25, NLTC.

[31] See Naik, (1971, note 3), pp. 310-314.

[32] See Ibid, 329-333, passim. The Linotype correspondence files show that the implementation of the Vijapure scheme on the Linotype, named after Ganesh Pandurang Vijapure who devised it, and espoused by Naik, was constantly beset with obstacles. Furthermore, Jeevan Nayak of the Government of India's Central Hindi Directorate telephoned L&M Calcutta concerned that Naik's character revisions represented 'an attempt "to

It is also evident from this specimen and the constant correspondence over two decades between Walter Tracy, Manager of Typeface Development at Linotype & Machinery Ltd (L&M), Natraj Balasubramanian, Manager in India of L&M's Bombay Office, and Mike Parker, Director of Typographic Development at MLCo, that the company group was keeping a close eye on the competition. Monotype, even for newspaper composition,[33] was not Linotype's only competitor: Intertype being one key rival in the area, and whose matrices were able to function in Linotype machines. In comparing designs, Tracy believed that even with matter composed according to the Times of India 90-channel scheme, as shown in Fig. 7, 'the Linotype type face is widely acknowledged to be the better of the two' [34] – a belief compounded upon having sight of Intertype's 10pt Devanagari design. The L&M Calcutta office had succeeded in obtaining a specimen of Intertype's 10pt trial fount for the Times of India, a Linotype customer, and noted in a communication to the London office 'the Intertype 10-pt is felt to be a flop. Matras [vowel signs] are lost and lots of characters doubling [jamming] in the magazine channels'.[35]

In addition to the known defects of linecaster composition for Devanagari, the Intertype 10pt specimen (Fig. 8) does show many problems, particularly inconsistent spacing and some character malformations; yet the type size was a great advantage over the Linotype 14pt fount due to the chronic shortage of newsprint paper during this time and well into the 1970s. The Linotype company, for economic and technical reasons, never met the repeated requests to produce smaller type sizes in metal.[36] Thus, upon yet another request in June 1974, when considerations of adapting Devanagari for photocomposition came into the equation, Balasubramanian (known as Bala), reported that the India office was selling Linotype machines to US specifications with Intertype matrices.[37]

Adaptations for photocomposition
Despite what Linotype would have considered the rather lacklustre sales of 'Devanagari Linotype' machines, the naturally wide dissemination of printed matter composed in an increasing number of Indian scripts on the Linotype ultimately redefined what was to become acceptable as legible typography in the Indian sub-Continent (see Fig. 9 and 10). Notwithstanding its visible impact on textual composition, the Linotype was considered for some years by many in India to be 'as essential as the Typewriter for a progressive nation. Its necessity is ... being felt by Printers in General and Newspaper Offices in particular'.[38] The

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smuggle" Marathi convention into Hindi'. A.C. Bridgman to W. Tracy, 16 November 1963. In 1971, Tracy stated 'The Vijapure scheme does not exist in reality – because not all of the intended characters were made and wenever received a keyboard layout.' Telex, Tracy to H. Moss, 12 February 1971. By 1973 G.P. Vijaypure had died and the 'promoters of the scheme' were 'not as active as before'. N. Balasubramanian to B. Saunders, 30 November 1973. File 25, NLTC.

[33] In the context of newspaper setting, Monotype's breakages were often cited as a means of deflecting criticism of the Linotype Devanagari founts. Balasubramanian to A.H Walker, 27 June 1974. File 25A, NLTC.

[34] W. Tracy to Parker, 3 October 1963. File 25, NLTC. With the exception of some vowel signs, this was perhaps a debateable assessment when comparing the 14pt designs.

[35] Extract of letter from A.C. Bridgman to E.T. Martin sent to W. Tracy, 14 October 1963. File 25, NLTC.

[36] Although Linotype Devanagari founts were reported to set more characters per line than Intertype, which 'would lead to a considerable saving of space', A.C. Bridgman to W. Tracy, 17 September 1963. File 25, NLTC.

[37] N. Balasubramanian to A.H. Walker, 9 July 1974. File 25, NLTC. ' "United States Specifications" was most likely referring to type high, i.e., casting the molds [*sic*] at .918" - .928" or other heights would have been an alternative for certain regions', D. Wood to F. Ross, email, 21 August 2021.

[38] Vijayapaliah (1954, note 20), p. 2.

customary typographical representation of some scripts by the linecaster was more profoundly affected than others: Bengali being a case in point.[39] However, aside from economic drivers and the natural antipathy, particularly pre-independence, in some quarters to acquiring any equipment designated as British, there was an acknowledgement that new typesetting practices coupled with the mechanization of printing could widen dissemination of information to the reading public;[40] a public who were to become accustomed to a new orthography, often endorsed by script reforms that frequently seemed designed to accommodate adaptations of scripts to mechanized typesetting.[41] To today's readers, after decades of reading text set with Monotype's and Linotype's looser fitting hot-metal typefaces, the Nirnaya Sagar hand-composed setting shown in Fig. 6 may appear a little dense.

It has been noted that the customary practice of typefounding companies was to copy existing 'successful' designs when converting a typeface from one technology to another.[42] Yet the Linotype company group, conscious of the poor aesthetics of its hot-metal Devanagari types, looked again to the Nirnaya Sagar Press typefaces for its adaptation of the script for photocomposition. Thus in 1974, Balasubramanian was pleased to quote Walter Tracy's 'heartening news'[43] in a letter to H.B. Kansal, Deputy Secretary to the Ministry of Home Affairs in the Government of India:

> In regard to type design, the Devanagari we are creating for VIP[44] will be similar in type to the Nirnaya Sagar foundry type, with correct traditional matras (no fear of them breaking away in film-setting!). In addition, we shall try to proportion the stroke weights and the inner white areas so that the type will be legible not only at 10 point but 8 point also, because we are aware of the need for economies in printing costs. ... and we will try to make the new faces as effective at 24 point as in the text sizes.[45]

Type specimens produced by the Nirnaya Sagar Press thus formed the starting point for the design of a new Linotype Devanagari typeface in the 1970s that was to be undertaken under Walter Tracy's supervision; Tracy had established the Department of Typographic Development at Linotype Paul Ltd (London) in 1974, which focused on fonts for photocomposition.[46] An immediate concern, which generated much correspondence

[39] See, Ross (1989, note 18), pp. 129-133.

[40] Reportedly, P.K. Roy of the Times of India expressed the opinion 'that the public would accept almost anything which was offered and … emphasised that speed and facility of production was the main factor'; Bridgman to F.A. Trice, (L&M, London), 16, September 1963. File 25, NLTC.

[41] See V. Singh, 'Devanagari type in the twentieth century', pp. 189-191.

[42] See Ross (1999, note 12), pp. 193-194.

[43] N. Balasubramanian to W. Tracy, 9 July 74. File 25, NLTC.

[44] The Linofilm V-I-P (Variable Input Photo-typesetter) produced in 1970; L. W. Wallis, *A concise chronology of typesetting developments, 1886–1986*, (London: the Wykyn de Worde Society in association with Lund Humphries Publishers Ltd, 1988) p. 42. There had been enquiries to implement Indian script on the Linotron 505 machine but its failure to kern and the knowledge that the failure to do so in the case of Linotype hot-metal was 'deplored', negated such a development, W. Tracy to M. Parker, 30 November 1971. File 25A NLTC.

[45] W. Tracy to N. Balasubramanian, 2 July 1974, and quoted in letter from N. Balasubramanian to H.B. Kansal, New Delhi, 28 October 1974. File 25A and 25 respectively, NLTC.

[46] Later called Linotype-Hell Ltd, and finally Linotype Ltd. Meanwhile, 'in the decade 1970-80, there was upheaval in independent India against foreign owned businesses/companies. That was the time, September 1977, when Linotype Associates India Private Limited was formed with all Indian Directors and Late Mr N Balasubramanian appointed Managing Director. This Company overtook the hot-metal business and operations of L&M Branches, becoming authorised representative of Linotype-Paul Limited with sole

between Tracy and Balasubramanian, was in defining the character-set – a concern that remains a key initial consideration for typographical development projects.[47] Potential users were contacted to define a character-set that would meet the needs of both Hindi and Marathi: in particular the joint Managing Directors of the Daily Tej, Viswa Bandhu Gupta and Prem Bandh Gupta, were consulted for Hindi language coverage; and later a number of Government officials including Kansal as well as book publishers for wider language coverage.[48] The Devanagari character-set could now be re-evaluated and expanded from the hot-metal limitations for the V-I-P photo-typesetter; however, there was no longer any possibility of setting additional 'pi characters' (which had been an available, but cumbersome, Linotype hot-metal practice; see Fig. 5 and 9). Tracy was to underline this point on more than one occasion, writing to Balasubramanian on 2 November 1973:

> The important thing, then, is the establishment of a list of characters to be made in the light and bold which can <u>safely</u> be regarded as standard for Hindi and Marathi for all customers. I emphasize 'standard' because all prices and, indeed, the manufacture itself can only be undertaken on the basis of standard procedures; customers cannot be allowed to vary the array of characters on the fonts, because this will mean the making of fresh master negative plates – an expensive and lengthy business.[49]

The V-I-P film fonts offered 96 characters in each film strip; the Devanagari was to follow the model already developed for Gujarati on this photosetter and occupy four film strips to achieve a sufficient complement of characters in two weights. Fonts 1 and 2 would contain the light face; and fonts 3 and 4 the bold. However, sections of fonts 2 and 4 differed as these contained characters, such as mathematical signs and superior figures, in a 'common weight' that could be used with either type style, which Tracy deemed would be 'very useful for newspaper and commercial printing'.[50] The limited capacity of the V-I-P, relative to foundry type, was still a compromise and required the use of components to build some characters. Therefore, various, at first provisional, font schemes were devised – whose characters were mapped as closely as possible onto the Gujarati scheme[51] – to determine the Devanagari contents and font layouts in order to proceed with the artwork for the new typeface design (see Fig. 11).

Establishing new standards
The new Linotype Devanagari design was to be developed by utilising the existing hot-metal drawings, copies of which Tracy requested from MLCo's New York Drawing Office, for their size and weight but revised to be similar in style to Nirnaya Sagar type. The use of film instead of metal type afforded the possibility of overlapping character elements which

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distributorship and marketing rights for their electro-mechanical and electronic photo-typesetting equipment.' WhatsApp message K.K. Singh to F. Ross, 27 May 2021.

[47] See, Fiona Ross, 'Non-Latin scripts: key issues in type design' in Fiona Ross and Vaibhav Singh, (eds.) *Non-Latin scripts: from hot-metal to digital type*. (London: St Bride Library, 2012). 130 (and ff?)

[48] And also consulted regarding hyphenation logic. N. Balasubramanian to W. Tracy 2 February 1973, 10 December 1973; and N. Balasubramanian to Kansal 21 November 1974. File 25A, NLTC.

[49] W. Tracy to Balasubramanian, 2 November 1973. Another unwelcome expense was the then high rate of customs duty into India of '110% on anything connected with electronics or computers', N. Balasubramanian to W. Tracy, 28 May 1973. File 25A, NLTC.

[50] W. Tracy to N. Balasubramanian, 21 August 1975. File 25A, NLTC.

[51] To simplify font manufacture and programming, see W. Tracy to N. Balasubramanian, 1 July 1974 and 16 October 1974 [25A] and below, p 14.

meant that even the Devanagari connecting śirorekhā (the headline which links the tops of most characters) could now appear seamless. Kerning was also possible: right and left kerns were achieved by offsetting all characters to the left, as suggested by Mike Parker, who agreed that the 'Linotype face should be improved for fit and shape and must be revised to include kerns'.[52] Furthermore, Parker and Tracy were keen to explore the possibilities of positioning 'the mātras' [vowel signs] using the Latin 'accent-centring procedure'.[53]

It was expected that the British Type Drawing Office, then situated in Altrincham (Fig. 12), would undertake the new artwork; whereas font manufacture would be undertaken by MLCo in Plain View, Long Island USA. Mike Parker summarised clearly the exacting standards required in the design and production processes for the V-I-P, which required meticulous artwork from the type-drawing office:

> Our tolerances in making fonts for the V-I-P are measured in ten thousandths of an inch. The fonts themselves are made on rather elaborate cameras which would require artwork to a fixed scale, properly registered. The drawing size is approximately ten inches square for each character. We use back-lighted originals – clear characters surrounded by red or black.[54]

However, on 25 June 1974, upon receiving from India an urgent order for V-I-P equipment, and with letter-drawing resources in England unavailable to tackle Devanagari characters (probably due to commitments to Linotype's more successful Arabic ventures) Tracy sought permission from Mike Parker for the British type-designer Matthew Carter to take on the work.[55] Carter already possessed experience with designing typefaces for a script other than Latin, namely Greek and Hebrew;[56] most importantly, he possessed the skills and a keen eye for designing typeforms for both hot-metal technology and photocomposition. With good models from Nirnaya Sagar provided by Tracy,[57] Carter was tasked with first producing trial characters in light and bold, which would be reduced photographically to simulate different type-sizes and sent to India for approval. It was anticipated that he could then complete the artwork in 9 months.[58]

The decidedly positive responses to Carter's trial Devanagari designs (Fig. 13) were

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[52] M. Parker to W. Tracy, telex, 6 December 1971 [25A]. In the history of the Linotype Devanagari development, this offset was to have consequences in transferring to later digital technologies. Parker believed Carter to be their best designer, cited from 1970 correspondence in Helena Lekka, 'Linotype's design of new Greek typefaces for photocomposition in the Greek printing market, 1970-1980', unpublished PhD thesis, University of Reading, 2017, p.109.

[53] The accent-centring routine used software to place the centre of the accents centrally over or under the measured width of the host characters. Since mātras (floating vowel signs that had zero width and so functioned as accents) most frequently needed to be placed to the right-hand side of most characters, the drawings of the mātras needed to be offset horizontally to achieve this.

[54] M. Parker to W. Reed, 7 January 1972. File 25A, NLTC.

[55] Telex W. Tracy to M. Parker, 25 June 1974. File 25A, NLTC.

[56] See Lekka (2017, note 52) p. 109.

[57] In discussion with the author [Ross] in September 2018, Matthew Carter stated that it was Nirnaya Sagar specimens in Naik's book (the single advanced copy rather than the published 3-volume set) that had been used as models; although Tracy did obtain a full specimen book from the press's foundry, as shown in Figure 1.

[58] Linotype-Paul Ltd, internal memorandum, W. Tracy to R. Caesar, 26 July 1974. File 25A, NLTC.

communicated enthusiastically by Balasubramanian via cablegram from India on 18 March 1975 stating that a 'better version does not exist superb', with which Tracy concurred.[59] The resulting new design for photocomposition was delivered in 1976 at first with 'experimental fonts' to the Times of India.[60] Like the hot-metal typeface the new design was named Linotype Devanagari, but showed huge improvements over its predecessor and, commendably, little affinity to the hot-metal designs. Its typographical development had, however, not been a completely smooth enterprise: Linotype's client the Daily Tej was troubled by character alignment issues,[61] which were particularly prominent in Devanagari due to its śirorekhā; the accent placement routine needed to be revised for special instances; some characters failed to appear when keyed; and new or replacement characters had to be added to the fonts, much to the clearly expressed displeasure of Tracy,[62] who was revising Devanagari font layouts, at Linotype's cost, right up to his retirement in October 1977.[63]

Regrettably, there is little extant material output of V-I-P Linotype Devanagari, particularly of the final version. Image 14, taken from the जर्मन समाचार (German Samāchār),[64] clearly demonstrates the benefits of kerning, especially with regard to the arching vowel signs, which aids the flow of the script and visibly increases the readability of texts. Some character combinations do appear disjointed on account of the continued use of common components owing to character set restrictions; and the accent placement routine provided a few problems, as shown in this iteration in which the 'accent' (mātra) should sit above the central vertical stroke of some frequently occurring characters. Recent research, however, reveals that the latter problem was rectified by software programmers in Cheltenham in 1977, but there is no example of this corrected feature in use.

Crucial to the design, however, is the stroke modulation that accords with Indian penmanship, which has the pen cut in the reverse direction to that used for the Latin script (Fig. 15). It is worth noting that such adherence to the Devanagari script tradition was not followed in a new Devanagari design being undertaken at this time for Monotype, which was a collaborative work by the renowned Swiss type-designer Adrian Frutiger and the highly-regarded Indian calligrapher, Mahendra Patel (Fig. 16). Linotype was aware of this design – Frutiger had previously offered it to Linotype – but Tracy had in any event 'wondered if this departure from tradition is acceptable',[65] stating 'I think we should resist to the death any request for Helvetica Devanagari' and concluded that 'it is better to give

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[59] 'I really do think this is the best Devanagari design I have seen'. W. Tracy to M. Parker, 20 March 1974. File 25A, NLTC. And on completion of the Bold, Balasubramanian confirmed the same response from clients, 29 May 1975. File V-I-P, NLTC.

[60] In-house memorandum, W. Tracy to E. Vesey 28 May 1976. File 25A, NLTC.

[61] T.V. Krishnamurthy L&M Bombay, to W. Tracy, 20 June 1977. File 25A, NLTC. Carter describes how at Plainview a 'granite-based fixed focus camera in the grid department' was used, which should have ensured correct alignment. Email to Ross 17 April 2021.

[62] See W. Tracy to N. Balasubramanian 18 July 1975. File 25A, NLTC.

[63] Telex W. Tracy to LAI Bombay, 25 October 1977. File 25A, NLTC.

[64] *The Bulletin of the German Embassy* (New Delhi: 4 May 1978). The lack of extant examples of text set in V-I-P Devanagari may be accounted for by correspondence regarding The Daily Tej: T.V. Krishnamurthy (LAI Bombay) wrote to Vesey, "Hindi on V-I-P is not used at all. The keyboard operators are too slow. … The need to change fonts for character selection is slowing them down and giving rise to errors." 29 December 1977. File 25A, NLTC.

[65] W. Tracy to M. Parker, 9 August 1968 in which he wrote: 'We are all scarred for life by the Vijapure scheme'. File 25, NLTC.

customers a design they know'.[66] Carter's Devanagari cannot be regarded merely as a revival of a Nirnaya Sagar typeface; rather it comprises the skilful reimagining by a professional designer of a traditional typeface design for the new era of photocomposition.

Continuation and innovation: entering the digital era
This development of Linotype Devanagari for the V-I-P laid the foundation for the design of the revised and greatly expanded digital version, given the same name, whose typeforms first appeared in the Indian press in the early 1980s, and which are recognisably present in many of today's popular publications. Research was instrumental in taking the Linotype Devanagari design forward and underpinned all the designs undertaken in the 1980s by the letter-drawing studio, then relocated to Linotype's new British headquarters in Cheltenham.

By late 1978 discussions were taking place, primarily at Linotype-Paul's London office in Kingsbury, about adapting Indian scripts to the new Linotron 202, a 'high-speed digital CRT typesetter';[67] Devanagari and Bengali were the first to be considered. A memorandum of 5 December 1978 composed by Anthony Bisley, Walter Tracy's successor, to Martin Boothman, then Managing Director of Linotype-Paul Ltd, concerning Devanagari stated:

> Miss Ross[68] has prepared, after thorough examination, a paper on this subject along with other comments we have received from India over a period of time from the existing installations that have been in operation.
> I have discussed this with Matthew Carter and I think it would be suitable for him to re-design the typeface and re-draw it. There are some 360 characters to be redrawn, and amalgamated; for this version of the [Linotron] 202, we will have whole conjuncts and will not be using the VIP method of bringing characters together to make conjuncts.
> The cost of this at the standard UK price is £12.00 per drawing. Taking into consideration the amount of work involved, Matthew Carter has said his price would be £4,000, overall. We cannot of course, afford this amount.
> I would suggest, therefore, that we do this in the Studio [letter-drawing studio] and employ Matthew Carter as a Consultant during the period of re-drawing the typeface.[69]

Bisley's suggestion was approved. However, Bisley's term at Linotype was short, and in direct consequence of his management all but one of the letter-drawers, Lesley Sewell, had resigned – which therefore negated the plan for the London letter-drawing studio to take up the work. At this time Sewell was already occupied with the re-design of the P&O

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[66] W. Tracy to M. Parker, 30 December 1971. File 25A, NLTC.
[67] Jonathan Seybold, 'The Linotron 202: Better than anybody anticipated!', *The Seybold report*, vol. 7, No. 21 (Philadelphia: Seybold Publications Inc, 1978), p. 1.
[68] The author, who had joined Linotype initially as a Research Assistant in September 1978, having a background in languages that included Sanskrit.
[69] Linotype-Paul Ltd in-house memorandum, A. J. Bisley, to Martin Boothman, 5 December 1978. File: 202, NLTC.

shipping company's branding by Walter Tracy, who had remained active as an external designer and as an occasional consultant. Furthermore, the success of the Linotron 202 typesetter[70] had encouraged the renowned Bengali publishing house and long-standing Linotype customer, Ananda Bazar Patrika (ABP), to place an order with Linotype to transition from hot-metal typesetting – bypassing filmsetting – directly to digital photocomposition for its Bengali and English language publications. It was established that ABP, as well as other customers, would require Devanagari fonts, but the Bengali type development for the 202 had to take precedence.[71] The intention, therefore, was for Sewell, upon completing other work, to embark upon the Bengali design; however, since the Linotype hot-metal rendition of the Bengali script was even poorer than that for Devanagari, it was evident that a complete redesign was required rather than a conversion of the old design to the new technology.[72]

Furthermore, it was clear that a new approach was urgently needed not only to the typeface design but also to methods of composition, and consequently to the entire typographical development of Indian scripts by Linotype. In Ross's view, this approach should be based on the Indian phonological writing-system as well as Indian penmanship, which would be crucial to the development of digital fonts for Devanagari and other Brahmi-derived scripts.[73] The proposal for such a radical development, formed part of the document prepared by Ross, to which Bisley had referred in his memorandum, entitled 'An Introduction to Indian scripts for photocomposition',[74] several iterations of which were further developed in conjunction with other Linotype colleagues, principally Dr Mike Fellows. In July 1979 Ross sent a copy of the proposed plan with the shorter title 'Indian scripts for photocomposition' to Matthew Carter alongside information about another interim but consequential development for Hindi composition:

> Please find enclosed a copy of the keyboard layout and character list of Hindi for the Linoterm [filmsetter]. The character numbers are those of the VIP font, since it is proposed to use your drawings, subject to your agreement.
> The aim of this scheme for setting Devanāgarī is to produce an efficient low-cost machine, which is capable of setting Hindi without lowering the quality of output already achieved by the VIP; in fact, we hope to make some improvements.[75]

The development and implementation of the Devanagari script on the Linoterm in 1979, according to a new scheme devised by Ross at the instigation of Balasubramanian,

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[70] See Seybold (1978, note 67), pp. 1 and 3-15

[71] Ananda Bazar Patrika Ltd in Calcutta, formerly the Śri Gouranga Press which had produced the first book set with the hot-metal Linotype Devanagari, although principally a Bengali-language publishing house was the first customer for the Linotype Devanagari digital fonts (see above, note 27).

[72] Which was undertaken by the former Linotype employee and experienced freelance type-designer, Tim Holloway, in collaboration with Fiona Ross, who consulted with ABP and Dr Tarapada Mukherjee lecturer in Bengali at the School of Oriental Studies, London University.

[73] Which became more pertinent with an order for further scripts from Ramnath Goenka for *Indian Express* newspapers; Goenka was impressed with the Linotron 202 typesetter and particularly with the quality of the Bengali type design, which he regretted they did not need.

[74] F. Ross, Linotype -Paul Ltd in-house document: 'An Introduction to Indian scripts for photocomposition', 15 December 1978. File: 202, NLTC.

[75] F. Ross to M. Carter, 27 July 1979. Folder: Carter Papers, NLTC.

formed a stepping-stone on the way to developing the revised and expanded Linotype design for digital photocomposition. The letter to Carter notes 'I am sure you are aware of the problems our department has been having for quite some time now',[76] referring to the lack of studio staff which necessitated Carter, who was still residing in England at the time, to take up the revised and extended artwork that required immediate attention. Carter, already a renowned type-designer proved to be remarkably open to revisions proposed – after consultations with Linotype colleagues in India – by Ross, a Sanskrit postgraduate.[77] At one of their earliest meetings Carter had queried the necessity to improve Devanagari type design given the often poor quality of newsprint paper in India during this period; however, he acquiesced to Ross's counter argument that the poor quality of the newsprint meant that type-designs needed to be optimized to improve legibility.

Carter's new artwork for Linoterm Devanagari Light and Bold was despatched for font production to Bruce Lehnert, Manager of Font Engineering at MLCo in Plain View, in November 1979 with a letter explaining:

> Enclosed are drawings and the paperwork for these faces. Some of the drawings are replacements for existing ones, some are special "Linoterm only" forms, and some are for completely new characters. ...
> The replacement drawings are ... revisions of existing letterforms that Fiona Ross prefers for reasons of legibility, and in the case of these 27 characters the existing friskets[78] (as already used for V-I-P Devanagari) should be scrapped and the replacements used for all future Devanagari fonts on all machines.[79]

The Linoterm keyboard and its layout were significant (Fig. 17). There was still a one-to-one correspondence between a font cell, i.e., a sort, and a keyboard code, the number of which was limited to 75 per font; thus, Devanagari Linoterm had a limited character set of 150 characters over two fonts, which necessitated the continued use of components known as 'half-forms' to build most conjuncts. However, the keyboard layout was closer to a popular typewriter layout than Walter Tracy was able to achieve with the V-I-P;[80] and it was logically arranged with half forms occupying the same position in font 2 as their full forms in font 1, excepting the most frequent which retained a font 1 position. A small number of common ligatures (including conjuncts) were included in the fonts and were accessible through the keyboard, e.g., क्र, फ्र, रु रू; and as stated,

> Some ligatures appear on the character list which are not to be found on the keytops. These only number 8 and will be placed in relatively 'logical' positions on font 2. Their positions will be memorised by the operator. Since English will be engraved on the front of the keys, I [Ross] felt that these ligatures could at least be engraved on the sides to avoid any problems. Bala, however, was adamant that this was unnecessary; it was he who first wanted to put Devanāgarī on the

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[76] Ibid.

[77] See Phyllis Hoffman, 'Matthew Carter: Reflects on type design', Thesis. Rochester Institute of Technology, 1999. Accessed from https://scholarworks.rit.edu/theses/3850, pp. 155-158.

[78] Negatives of the drawn characters – in this case, photographically produced, see figure 23.

[79] M. Carter to B. Lehnert, 29 November 1979. Folder: Carter Papers, NLTC.

[80] See W. Tracy to N. Balasubramanian, 29 February 1972. File 25A, NLTC.

Linoterm.[81]

Thus, true to all Devanagari keyboards developed to-date, the nature of the keyboard governed not just the font layout but the character repertoire and therefore the artwork. In other words, the keyboard was central to the development of the typeface design. Consequently, irrespective of staffing issues within the Department of Typographic Development, until the Linotron 202 keyboarding procedures for Devanagari were determined, the design work – of creating integral conjuncts[82] – could not begin. It was to be at this stage that software and, therefore, the invisible hands of programmers contributed to the type-design process for Indian scripts.

As noted above, the development of V-I-P Devanagari constantly referred to the necessity of its adhering to the V-I-P Gujarati layout to use the Gujarati program because 'the programmers are far too busy to prepare a special one'[83]. This injunction by Tracy refers principally to the hyphenation logic, but the first foray into photocomposition for Linotype Devanagari was also constrained because its realisation could not involve the use of software to select contextual forms.[84] Character selection logic had been essential to the implementation of Arabic on the V-I–P typesetter which, in turn, inspired and was crucial to the new scheme for the digital development of Indian scripts proposed in a memorandum by Ross to Bisley, and which asked: 'Has a programmer been appointed or found within the organisation who will be looking after this project?'[85] Grounded in research – and facilitated by the emerging digital technologies of the period and the concomitant eagerness of software programmers to devise new solutions to problems that had previously hindered mechanised composition of Indian scripts – the Phonetic Keyboard devised by Ross with Mike Fellows in 1978 emerged as the core component of the new scheme.

One document outlining the proposed scheme explains:

In the past conjuncts have been formed for typesetting purposes by means of combining half forms – the half forms being engraved on the keytops. This has proved unsatisfactory since it not only necessitates the appearance of additional forms on the keyboard, which are hard to distinguish, but also tends to produce distorted forms of characters. In digitised photocomposition there is no need to employ this method since we are able to store a great number of characters in the font which do not necessarily appear on the keyboard.[86]

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[81] F. Ross to M. Carter, 27 July 1979. Folder: Carter Papers, NLTC.
[82] See Bisley (1978, note 69).
[83] W. Tracy to N. Balasubramanian, 3 December 1974. File 25A, NLTC.
[84] Which, although contemplated, had not been afforded to V-I-P Devanagari, as W. Tracy in 1974 noted that the sales quotation to the customer, the Daily Tej, 'now includes a justifying keyboard for correction. This prevents the use of a look-up programme, and means that all the characters must be found directly from the keyboard'. W. Tracy to N. Balasubramanian, 27 March 1974. File 25A, NLTC.
[85] In-house memorandum, F. Ross to A. Bisley, 15 December 1978: File: 202, NLTC; Linotype UK was arguably the only company at the time to have a team of software engineers solely devoted to supporting non-Latin scripts.
[86] F. Ross, 'Indian Scripts for Photocomposition', (12 July 1979) unpublished in-house document [p.2]. File: 202, NLTC.

In this scheme access to conjuncts was afforded by the introduction of the *Conjunct Key* on the keyboard, which set in motion the character-selection routine specific to the typeface.

The Phonetic Keyboard was revolutionary for its time since, in effect, it demanded an act of faith by its developers, i.e., Linotype, and the earliest users, to believe that for the very first time hundreds of characters were in the font that were not visible on the keyboard; and that it would enable the 'keyboard operator to touch-type phonetically'.[87] However, the Phonetic keyboard was not strictly phonetic: newspaper owners formed the majority of Linotype's customers for whom keying speeds were vitally important, therefore the keyboard continue to allow compositors to key vowel signs in the sequence to which they were accustomed.[88] This feature prevented the great number of mistakes that would otherwise have occurred if transitioning to a purely phonetic scheme, and therefore avoided the necessity of making experienced compositors redundant.

The Phonetic Keyboard was also cost-efficient because, although it relied on the use of Linotype's proprietary software, it could be implemented on standard keyboard hardware – the 'objective' being 'an efficient keyboard which is simple to use and fast to operate and yet can handle all the complexities of the Indian languages'.[89] Thus, in continuance of Balasubramanian's edict that 'we [Linotype] strongly believe in the right of man to express himself in the best typographical form',[90] no attempt was made to patent it. Moreover, in embracing new technology Linotype was not wedded to the notion of maintaining backwards compatibility with previous technologies for existing customers who wished to 'go digital'.[91] It can be said that the Phonetic Keyboard, was the tool that from the early 1980s transformed the visible appearance of Indian-script typography.[92] Its implementation provided unprecedented freedom in developing new character-sets and in conceiving new design practices; thereby providing the incentive and opportunity to achieve higher typographical standards, which, in turn, depended on the activities that took place both within and outwith Linotype's UK drawing-office (Fig. 18).

New hands, new processes
It was at first calculated in 1979 that the new digital Devanagari fonts would require 283 glyphs (digital characters or character elements) in each weight of Light and Bold and, although Matthew Carter was willing and able to undertake a greater number of the required Devanagari revisions and additional drawings than originally envisaged, it was evidently imperative to re-staff the letter-drawing studio. Following the Typographic Department's relocation to Cheltenham in 1980, contrary to Linotype's customary practice,

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[87] Ibid.

[88] I.e. in visual sequence, for example, for the word हिन्दी , (hindi) the first character in the keying sequence would be the kerning vowel sign 'i although it is pronounced after the second character 'h'. In current practice, the vowel signs are re-ordered so the 'h' is keyed first.

[89] Ibid. For further details, see Ross (1999, note 12), pp. 216-222.

[90] 'Points for Meeting with Home Ministry June 1974 – Devanagari', by N. Balasubramanian, in letter to A. Walker, 27 June 1974. File: 25, NLTC.

[91] See Fiona Ross, 'An approach to non-Latin type design', *Language culture type* (edited by J. Berry. New York: Association Typographique Internationale, 2002), p. 70.

[92] The publishing house Ananda Bazar Patrika (ABP) were the first to endorse the keyboard, which was instrumental in confirming its acceptability since Bengali conjuncts often bear scant resemblance to the consonants from which they are derived. As ABP also required Devanagari, at their suggestion, due to the nature of the Phonetic keyboard, theirs comprised the first 3-script keyboard comprising Bengali, Devanagari, and Latin.

and encountering Tracy's disapproval, it was decided to hire university graduates rather than school-leavers.[93] The staff who, over the next twelve months, were recruited had stemmed from backgrounds in fine art, calligraphy, and cartography. Although by then the letter-drawing office only undertook non-Latin designs[94] (namely, Arabic, South Asian, Thai and Ethiopic scripts), the test for applying to join the Studio was to draw freehand a copy of the Times Europa 'S' designed by Walter Tracy – as Georgina Surman, who was to undertake the majority of the Devanagari extension work, recalled in an interview on 14 November 2019.[95]

Serendipity played a part in Surman's recruitment in the early 1980s: despite graduating with a BA in Fine Art, she joined Linotype to work in the Accounts Department at the Cheltenham office. There she was spotted for her 'arty' dress sense by Terry Byrne, Manager of Font Services, to whom the Department of Typographic Development reported in the absence of a replacement for Bisley. Others were to join the Studio briefly but by 1983 – the year when the digital Linotype Devanagari fonts were being implemented in newspaper offices for India – the staff had stabilised to those depicted in Fig. 19. The team, which is how the Department staff saw themselves, was divided between those described as letter-drawers, who worked in the Studio, and those involved in research and development. This cohort, with one exception, worked together for over a decade.[96] It was by no means a conscious decision to hire principally women. However, most of the men who applied for positions appeared to lack commitment to working on the typographical development of non-Latin scripts that required many months of training through practical experience.

The research which lay behind the implementation of Devanagari on the Linotron 202 (conducted in parallel with a study of the history Bengali type)[97] was based on the desire to 'arrest the degradation of Indian typeforms imposed by the introduction of hot-metal typesetting practices'; and the premise that 'to appreciate how the printed forms had arrived at their current shapes, it was essential to view them from an historical perspective and to assess whether factors influencing their design were still pertinent in the digital era'.[98] Consequently, the notion that research underpinned best practice was fostered throughout the Department's time at the Cheltenham Linotype headquarters. Regular seminars on Indian orthography for both the letter-drawers and the research assistants were therefore introduced by Ross in recognition that a thorough understanding of Brahmi-derived scripts, such as Devanagari and Bengali, was highly beneficial to the execution of their digital typographical representations. Staff were encouraged to visit the

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[93] The Department then comprised just Fiona Ross and Lesley Sewell; Ross reluctantly took on the running of the drawing office in 1980.

[94] The Department of Typographic R & D was keen to shake off the previously used term 'exotic', which was inappropriate for scripts used widely outside Europe, and because it would occasion offensive comments and attitudes towards the all-female staff of the Department. The term non-Latin was considered at Linotype to be a technical term that would counter the dominance of Latin as the default software and approach to type-design and font production.

[95] G. Surman, Interview with Alice Savoie, 14 November 2019.

[96] Sarah Morley, a University of Reading graduate, while enjoying the work as a researcher mainly employed on Arabic type development, left as she recognised there was no route for promotion. Ross, who was Head of Typographic Development, was only made manager in 1985, several years after fulfilling this role and was the first female manager at Linotype UK.

[97] By Ross (forming the basis of a PhD in Indian Palaeography at SOAS), which culminated in the first Bengali digital fonts: Linotype Bengali, first published in ABP's eponymous newspaper in 1982 (shown in Fig. 29).

[98] Ross (2002, note 92), pp. 65 and 70.

libraries of SOAS and St Bride in order to seek out pertinent information under guidance. Furthermore, the small in-house library that Walter Tracy had started was expanded to include further information on relevant scripts and exemplars of good typographical practice, a selection of which was acquired through the Linotype Associates India Private Ltd, (LAI) headed then by Balasubramanian with whom the Department continued a close relationship over the years (Fig. 20).[99]

In the 2019 interview, Georgina Surman confirmed that 'a strong research component' formed part of the design process which, often informed by script primers that illustrated correct stroke sequences in character formation, was initiated by drafting characters specified by Ross on tracing paper, which would then be scrutinized and amended when appropriate before being drawn up as finished artwork. However, the design process for the Devanagari digital type development was somewhat unusual in two regards. Firstly, although the design required over 200 additional original characters and a small number of revisions (not '360 redrawn' as Bisley had inaccurately stated[100]), the base characters had already been designed and published; and while staff were in the process of being recruited and trained, Carter had already undertaken revisions for the Linoterm and was continuing to add a considerable number for the Linotron 202 implementation (see Fig. 21).[101] Secondly, and more importantly, the artwork was at a size that was specific to Matthew Carter, which had not been employed in Linotype-Paul Ltd's letter-drawing office by Walter Tracy.

Hitherto, the design process for new Linotype designs in the London letter-drawing studio tended to comprise pencil drawings of "finished artwork" within a drawing area of approximately 12 inches on paper from which a hand-cut negative, a frisket, would be cut from Rubylith masking film – a process at which Sewell excelled, and which was followed for the Linotype Bengali digital fonts drawn by Tim Holloway.[102] As recorded:

> The drawings and friskets were register-punched and aligned
> with a transparent background drawing-mask by means of a pin-bar in
> order to ensure perfect character fit – a particularly essential requirement
> for joining scripts. Each typestyle would have its own drawing mask
> produced by the Department showing the baseline, the kerning
> area and the size of the typesetting window along with vertical lines
> spaced according to the relative unit-width system employed. Earlier typefaces
> would have different drawing-masks for the different master sizes.... [103]

However, Carter's Devanagari drawing size related to a particular camera that was situated

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[99] Nataraja Balasubramanian died at the age of 56 on 23 January 1982; his son, Balasubramanian Ramnathan (known as Ramnath), took on the role of Managing Director of the LAI in February 1982; email Dhananjay Ramnathan to Ross, 5 June 2021.

[100] Bisley (1978, note 69).

[101] Documentation from Carter lists some 171 in the Light weight and 173 in the Bold weight, 28 July 1980. Folder: Carter Papers, NLTC. Presumably money saved on salaries for non-existent staff helped pay for Carter's artwork.

[102] Which were digitised at Stempel AG. (Frankfurt, Germany); as were Sanskrit Devanagari additions at a later date.

[103] Fiona Ross, 'The Linotype Non-Latin Collection, University of Reading', *Non-Latin typefaces: at St Bride Library, London and Department of Typography & Graphic Communication, University of Reading, (*edited by R. Banham and F. Ross. London: St Bride Library, 2008), p. 34.

at MLCo in Long Island, named in one piece of correspondence as the 'Brown camera'.[104] The fact that the artwork followed Mike Parker's practice at Mergenthaler to use 'black on-white inked-in right-reading drawings' and was produced on 'Cronaflex mylar drafting film"[105] measuring approximately 9 inches, indicates that the friskets were made by photographic means with this camera and overseen by Bruce Lehnert. This process greatly accelerated font production times (Fig. 22 and b)).

The Devanagari artwork was originally drawn to the relative-unit system of 18 units to the em-square for determining character widths; however, again aided by software development – and experience gained from the ongoing digital Bengali development – it was clear that to achieve the desired precision in the fitting of vowel signs and other marks it was imperative that all artwork adopt the more refined 54-unit system.[106] Trials by Holloway for Bengali composition and in the Studio for Devanagari also demanded from the software support team the possibility to kern (in increments of up to 9 units) in both directions (Fig. 23) – finally laying to rest the ghost of Linotype's hot-metal practices. Furthermore, it was imperative for innovative software to enable superscripts or subscripts to be positioned according to different x–y co-ordinates as necessary – an earlier V-I-P restriction had been that of having either 'high' or 'low accents'. In practice this now meant that in the Devanagari fonts, for example, the two superscripts, the ekar ◌ and the anusvara ◌ could adopt different positions as found in manuscript practice (Fig. 24). As Mike Fellows was to remark: "it is all about fonts and the software. If you don't have both ... you cannot achieve fine typography".[107]

Further improvements were introduced to the Devanagari design, which after April 1982 was undertaken in the Cheltenham letter-drawing studio headed by Georgina Surman and which at that time included Hellie Fuller. Photographic reductions (Fig. 25) of new or revised artwork were periodically sent to Carter for review until he decided such reviews were no longer necessary, particularly as he was not overly familiar with the script. Furthermore, there was growing self-confidence in the Department's increasing Devanagari type-design and font development skills, which had benefitted from Carter's initial assistance, and which were supported by Linotype's software engineers – and by Balasubramanian and K.K. Singh in India, who were in close touch with their customers whose requirements and feedback were relayed to Cheltenham. Consequently, the additions and revisions to the Linotype Devanagari designs, comprising the design of fully formed conjuncts and the reshaping of ill-proportioned hot-metal legacy forms, under Ross's supervision became points of reflection and discussion between colleagues rather than merely instructions handed down to the letter-drawers as had been the case under Walter Tracy's management. In other words, Georgina Surman and those working with her

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[104] M. Carter to M. Parker, 9 June 1975. Folder: Carter Papers, NLTC. Contrary to former information, Carter stated it was not specifically built to cater for his artwork; discussion with Ross, September 2018.

[105] M. Carter to F. Ross, email, 17 April 2021. He recalls that 'the capitals of Snell Roundhand, which was made in this way, are about 5.5. inches high.'

[106] See A. Savoie, *International cross-currents in typeface design: France, Britain and the USA in the phototypesetting era*, unpublished PhD thesis, University of Reading, 2014. pp. 216-217, and 233-237. The even more flexible system of 1000 units was available and adopted in PostScript font production in the late 1980s, see, F. G. E. Ross, *The printed Bengali character and its evolution*, 2nd revised edition, (Kolkata: Sishu Sahitya Samsad, 2009), p. 222.

[107] Mike Fellows interviewed by Fiona Ross and Alice Savoie (online interview) on 16 June 2020.

were able to make design decisions rather than simply execute orders, which marked a significant change in letter-drawing office practices for the British branch of Linotype (Fig. 26).

It has also been also by Mike Fellows that 'probably the most significant change at that time was having the type developers of the Type Drawing Office or the Type Department in the same building as software development and, as time went on, this became a more critical, close association".[108] The letter-drawing staff constituted part of a vital team that was informed and buttressed by the input and activities of other interested parties in the development of the fonts. Within the Typographic Department itself, the R & D staff were responsible for numerous inter-related tasks which, aside from working with programmers (specifically Mike Fellows and Ishmail Parekh) on software specifications, included: defining character repertoires, font specifications, keyboard layouts, character encodings, contextual ligature information tables (known as contextual look-up tables) and, as a legacy of Bisley's hasty departure, supervising keytop engravings.[109] Ros Coates, a core member of the R & D staff, reflected in 2020:

> It's a definite yes to feeling part of the team. From what I can remember, a large part of my role involved testing the fonts for problems and if encountered, I would inform the programmers until the whole software/font package worked as it should before release. I certainly felt part of a strong team where everyone contributed to achieving the same goal.[110]

The character encodings and contextual look-up tables (conjunct tables for Devanagari),[111] were effected for the Linotron 202 typesetter by Font Selection Tables (FSTs) determined for each weight on punched paper-tape by Ross and Coates. Fellows has described FSTs as the technical framework needed to provide the functionality required for the new approach for typesetting Indian scripts. They not only enabled type developers to specify the link between keyboard input and selection of font elements but also allowed them to define co-ordinates for subscript and superscript positioning, the hyphenation logic, and any contextual spacing or kerning (Fig. 27).[112] Once the digitized Devanagari fonts were received on floppy disc from MLCo, the software programme (subsequently developed as the All-India programme) and FSTs were loaded onto the Linotron 202 by means of its paper-tape reader; whereupon font and software testing could begin, as well as the setting of type specimens to be sent to LAI for feedback (see Fig. 28).

Initially, much of the testing and typesetting was done virtually blind, or rather by using a Latin-script Visual Display Unit until Coates was able to undertake, with great skill, the less

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[108] Mike Fellows, Follow-up questions to interview, recorded 20 August 2020.

[109] Immediately prior to his departure, in the full knowledge that he was leaving, Bisley arranged for the Department, whose staff only comprised Ross and Sewell, to take on many additional tasks, such as specifying and supervising the character engravings on keytops.

[110] R. Coates to F. Ross, email, 11 March 2020.

[111] Conjunct tables were specified in the FSTs by a listing of character strings (utilising character numbers) that when combined would result in a specifically designed conjunct also specified in the table. The utilisation of the 'conjunct key on the keyboard' preceding the specified combinations would drive the software program to select the correct conjunct for typesetting. Conjunct tables formed part of the routine testing of fonts, and the typeset results were sent to LAI and clients for reference. See Fig. 27 and 28.

[112] Email M. Fellows to F. Ross, 2 August 2021.

urgent but nonetheless imperative task of designing Devanagari screen character shapes that were limited by the 12 x 9 dot-matrix configuration of the then front-end unit to the typesetter called the MVP Editing Terminal.[113] The Linotron 202 produced typeset copy in galley form on photo-sensitized paper that was processed in a darkroom.[114] The test results and type specimens were scrutinized for any errors in design, software, encodings, vowel-sign positioning, alignment, and so forth, by all those who had a hand in Linotype Devanagari's creation and development. The typographical development of digital fonts for Linotype Devanagari set the pattern for future South Asian-script in-house type-design and typographical development: it being a trans-continental enterprise that relied on the interdependence between all participants to facilitate textual communication in different languages through innovative practices.

Reception

By October 1983 the Linotype Devanagari fonts were in use in India, and a report of a visit to the Indian Express (IE) offices in Delhi and Bombay (Mumbai) states that the operators were 'touch typing at some speed and seemed happy with the keying procedures'.[115] The report also describes the conflicting responses to the new Devanagari designs from two IE editors. P. Joshi, the Delhi editor, was unused to foundry type forms – 'some of the conjuncts he totally misread but insisted on his authority' – and wished to use half forms, not realizing how this might affect the quality of the design. Krishna Kumar Singh, Systems Manager of Linotype India Delhi, considered such an intervention to be a retrogressive step not to be contemplated, particularly as Ramnath Goenka, the newspaper proprietor had chosen to purchase Linotype equipment on account of the quality of the typeface design achieved for Bengali.[116] Furthermore, Mrs V. Pendse-Naik, the Marathi editor of *Lokaprabha* at the IE Bombay offices, declared the conjuncts to be 'correct' and was happy to report an increase in readership since introducing the Linotype Devanagari digital design.[117]

Pendse-Naik requested that more Marathi conjuncts be created in pursuance of IE's policy of not using half forms, or the 'halant sign' (which deleted the inherent vowel), in composing the often-needed transliteration of loan words and foreign names that formed unusual consonantal clusters. Fortunately, the Phonetic Keyboard, which ensured the disentanglement of the keyboard from the number of characters in the font, meant that contrary to Walter Tracy's times, it was possible to add to the character-set even after equipment had been installed without affecting the keyboard hardware. The use of customised Font Selection Tables (FSTs) also permitted the character-set to vary according to language requirements; separate ones were created for Hindi, Marathi, and Rajasthani

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[113] Wallis (1988, note 44), p. 54. This was the same unit that had been used to drive the V-I-P and the Linoterm; therefore, customers upgrading to 202 could use the same terminal but with new software. Later versions of Apple keyboards, rehoused by Linotype as, for example, Linokey II, were employed utilising the Phonetic Keyboard for South Asian scripts.

[114] Hence typeset output was costly, therefore proofing devices such as the line-printer LP82 were devised at Linotype for Indian scripts.

[115] F. Ross, 'India Visit Report' unpublished Linotype in-house document, 2 December 1983 (author's copy), p. 1. At a later visit to the Times of India offices (the only newspaper to transition from V-I-P to the Phonetic Keyboard), the editor reported that keying speeds had improved by 40% in one week and thus did not need to make any redundancies. A policy of the leading Keralan newspaper *Malayala Manorama* was never to 'make anyone redundant'. Ibid, p. 14.

[116] Ibid, p. 3.

[117] Ibid, p. 20.

composition, and some were tailored to specific customer requirements. Over time, the Linotype Devanagari character set exceeded 300 glyphs as conjuncts for neologisms and transliterations were added. Sanskrit and Vedic forms also expanded the fonts as they were updated for implementation on new generations of Linotype typesetting equipment. In the course of each transition to a new technology, and to take advantage of any technological developments, the design was re-evaluated, and digital outlines reviewed and refined by the Typographic Department; yet the Linotype Devanagari typeface, propelled by Linotype proprietary software, retained its identity – even for the first iteration of Postscript fonts in 1988 that required a temporary reduction in the character set.

The typeface design, taking its cues from Nirnaya Sagar types developed by the Javaji Dadaji Type Foundry but with less stroke contrast and revised proportions, took pains to follow Indian penmanship, and in its digital iteration achieved a stroke fluency with kerned forms akin to manuscript lettering. Many conjuncts could be more compact than their V-I-P renditions, and also benefitted from precision in mātra positioning. However, the characters ख (Kha), ध (Dha) and भ (Bha) in their digital format continued to reveal the tell-tale signs of script-reform strictures, which Balasubramanian insisted to Tracy were a government requirement (at least for ध and भ).[118] Although deliberately compact in width to achieve economies of space for newspaper setting, the Linotype Devanagari digital fonts set a new standard of textual composition in this script, which included letter-shapes that had not been seen in print for 40 years. Mike Fellows, in his later position as Marketing Director, reported that with Linotype's Indian-script digital fonts, coupled with its reliable and high-quality typesetters, the Linotype company enjoyed a 90 percent share of the Indian vernacular newspaper market in the last two decades of the twentieth century: the Linotype Devanagari fonts having the largest readership (see Fig. 29).[119]

It had long been a company policy of Linotype not to name designers of typefaces upon their release unless the designers were famous. Thus, it was possibly only at the publication of the 1983 photograph of Department staff in 2008 that those at the core of Linotype's non-Latin digital font development became publicly visible, were named, and revealed to comprise an all-female team.[120] There can be no doubt that the work undertaken by the Typographic Department during this time was respected by colleagues in other interested departments and particularly by colleagues overseas.[121] Mike Fellows in a 2020 interview recalled that 'Martin Boothman [Managing Director] appreciated and was interested in what was being done, I think, and understood that this was ground-breaking stuff, which a lot of people wouldn't have understood'.[122] Such appreciation or respect was not naturally accorded to the Department by other Linotype staff, many of whom were unaware of the reception to its typographical exertions, as Fellows summarised "80 percent

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[118] N. Balasubramanian to W. Tracy, 31 July 1975. File: 25A, NLTC. The 'looped' nature of these forms were reduced by Ross in the subsequent Rohini, Adobe Devanagari and Murty Hindi typefaces.

[119] Although Fellows's report might sound like a marketing statement, the point he was underlining was that the fonts could not have occupied such a large market share at this time had it not been for the reliability and quality of Linotype's typesetters.

[120] *Linotype Express*, (Cheltenham: Linotype Ltd, 1983), p. 3*;* and Fig. 19.

[121] Including Linotype's Middle East Liaison Office (MELO), situated first in Beirut and then in Nicosia, Cyprus, who requested assistance in obtaining Arabic to the same quality as they had observed in the Bengali and Devanagari fonts. The technologies at that time meant that type-design and type-making could not be carried out independently.

[122] M. Fellows interviewed by Fiona Ross and Alice Savoie, 16 June 2020.

of the company had no idea what was going on".[123] It was apparent at the time that the sales representatives located in Cheltenham tended to see fonts merely as peripheral to machine sales, an understandable tendency since they only received commission for the latter. Surman recalled the lack of respect even from some senior managers connected with the Department. Referring to one man under whose management the Department was placed for a period of time: 'Fiona [Ross] pushed for us to get better wages but... he didn't regard us as anything other than, you know, the girls who draw stuff in that room'.[124] That it was women who were at the heart of the enterprise did not seem to be the issue. The Head of Personnel in 1983, when discussing a pay-rise for the drawing-office staff with Ross, who had stressed the importance of the type work, declared that the Personnel Department would not 'be held to ransom by tuppeny-ha'penny artists'.[125]

Ros Coates, who had undertaken clerical work prior to joining Linotype, was herself not displeased with her salary and felt she received recognition for her skills. However, she succinctly voiced the situation that applied to the entire Department: "I don't recall any one moment when I questioned whether I was being underpaid against my male colleagues. Perhaps this was to do with being the only person assigned to my specific role and therefore there was no direct comparison available."[126] The work undertaken by the Department was highly specialised, thus comparisons with others to seek parity in pay were unfeasible. Surman, who was concerned about over-specialisation and disliked working in an office, however, stayed for over 10 years honing her creative design skills and making decisions that went far beyond those expected of a 'letter-drawer', to the benefit of innumerable readers. Ambition was not a strong point for Surman or Ross, who were particularly invested in the work itself, but it was evident that there was no clear career progression for the Typographic Department's staff within the company.[127] The Department expanded significantly when in 1988 it was granted a license by Adobe Inc. to use their tools for PostScript font production and became a key group in the newly founded Special Projects team headed by Fellows. However, Linotype Ltd closed its offices in 1996, and the Linotype Devanagari fonts were no longer legitimately available for purchase for over 25 years.

Legacy
At its publication in 1983, the Linotype Devanagari digital typeface can be said to have made a significant contribution – building on by its earlier counterparts – to providing a visible representation of potentially over 120 South Asian languages. Unfortunately, its appearance as the principal heading and body text typeface in national newspapers did not spark a renaissance in Devanagari type design. On the contrary, with the concomitant development of accessible and affordable font-making tools, it, like its sister Linotype Bengali design, increasingly became subject to piracy – at the hands of publishers as well as type foundries, who were secure in the knowledge that Linotype would not prosecute.

Evidence of such piracy is immediately discernible in many publications that make use of cloned forms of the Linotype Devanagari type-design: these exhibit inconsistent design traits through poor digital outlines; an evidently limited character-set, necessitating

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[123] Ibid.
[124] G. Surman, interviewed by Alice Savoie, 14 November 2019.
[125] M. Fellows Interview, 16 June 2020.
[126] R. Coates to F. Ross, email 11 March 2020.
[127] See interviews of Mike Fellows and Georgina Surman.

the re-adoption of ill-fitting half-forms indicative of hot-metal and, to a limited extent, film composition; and poor layout software that contributes to poor fitting (spacing and mātra positioning).[128] The many examples of poor typographical practices utilising fonts masquerading as Linotype Devanagari illustrate how imitation rarely produces more than a superficial resemblance to the original designed fonts and their embedded attributes, and only serves to impair readability. Recent years, however, show encouraging signs of the emergence of original, quality Devanagari designs. Furthermore, in 2019, the company Monotype Imaging, which had acquired Linotype in 2006, re-released the Linotype Devanagari fonts, but now in 5 weights in OpenType format, and with added contextual forms, particularly variable length vowel signs[129] – and inevitably with more hands in the mix.[130]

As a case study in type-design and font development, that of the Linotype Devanagari digital fonts is perhaps an outlier since the factors, and actors, influencing its conception and gestation can be traced over an unusually extensive period and through a fair number of design iterations. Yet, documenting the digital typeface's origins and development assists in countering the impression, often given in historical accounts, that type design is customarily a solitary occupation undertaken by one acclaimed individual. Especially for South Asian scripts, most typeface designs – which can only be useful to a community when manufactured as working fonts – emerge from a collaborative enterprise informed and executed by different contributors in answer to specific typographical needs. It hardly needs stating that it is not possible to acknowledge the entire multiplicity of contributors to the design and font development process, some of whom may have unknowingly influenced design decisions, nor to note all the multifarious activities that helped form the final typographical outcomes.

Such a case study illustrates how researching archival resources, eliciting oral accounts from eyewitnesses, and analysing material outputs, assists in assembling a more accurate and nuanced account of typographical developments such as the Linotype Devanagari digital fonts than has appeared in received print histories. It assists in recognising the value of contributions from often-overlooked key participants in the creative process, such as the vital design work from women in the letter-drawing studio, crucial information from overseas colleagues, or innovative work by software or research and development pioneers.

The creation and production of the Linotype Devanagari fonts was the result of international collaboration; and those engaged in their development were keenly aware that they were not only collaborating with their immediate colleagues but with unseen hands across the centuries stretching back to the days of Nirnaya Sagar to help provide a better reading experience for millions across the globe. Inevitably, many hands continue to remain invisible.

(Fig. 30)

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[128] M. Fellows remarked that an 'aspect of Linotype's quality … was consistency of design throughout a typeface'. See: Follow-up questions to interview, 20 July 2020.

[129] First introduced for Devanagari by Holloway and Ross, produced by John Hudson, see Ross (2009, note 109), pp. 223 and 224.

[130] Lisa Timpe and Gunnar Vilhjálmsson were the designers employed by Monotype Imaging Inc (which acquired Linotype GmbH and thus its fonts in 2006) to revive the typeface for publication in OpenType format under Ross's consultancy.

[9565 words + footnotes]
FR 29 August 2021