Athabaskan Phonetics and Phonology

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should this be "Hargus, Sharon"? (Hargus is my last name.)

Abstract

There is a long tradition of phonetic and phonological research on Athabaskan languages, some synchronic in focus, some diachronic. A variety of theoretical approaches have been employed. An understanding of the morphology is required for research in virtually any other subfield of Athabaskan linguistics, including phonetics and phonology. Most research on Athabaskan languages has been undertaken by nonnative speakers of Athabaskan languages. Instrumental phonetic studies are now available for a variety of phenomena in the languages of this family.

1. Overview

Athabaskan[1] (also spelled Athabascan in Alaska and Athapaskan in Canada) is one of the largest language families of North America, both in terms of number of languages[2] and geographic area occupied by speakers at the time of contact, as seen in Figure 1 (Kari 2008).

— change to .

This article is an introduction to work on both diachronic and synchronic issues in the phonetics and phonology of Athabaskan languages, with some reference to morphology as well, as required, given the complex interaction between phonology and morphology in the languages of the family. Research questions about Athabaskan phonetics and phonology have tended to arise from within the languages and include what is the system of phonological contrasts (in a particular language) and how are the contrasts phonetically realized? How does the language support or inform the reconstructions of Proto-Athabaskan phonology that have been proposed? What is the set of morphophonemic alternations in the language and what are their distributional restrictions? Some phonetic and phonological research questions have arisen from theoretical concerns: does the descriptive phonological apparatus required for the language support or refute current theoretical proposals? What phonetic measures best distinguish a particular set of sounds (differing along some phonetic dimension)?

2. Morphology

Most research on Athabaskan phonetics and phonology has focused on sound patterns at the level of the word. As the morphological analysis adopted by a researcher can impact the phonological analysis, an understanding of Athabaskan morphology is essential for such research. Overviews of Athabaskan morphology include Tuttle 2002; compounds, Rice 1984, 2009; verb prefix positions, Kari 1989; Rice 2000; Tuttle and Hargus 2004; conjugation and mode system, Rice and Hargus 1989. Approaches to the study of Athabaskan morphology have been overwhelmingly descriptive, but see McDonough and Willie 2000 for an experiment involving Navajo word formation.[3]

Much research on Athabaskan phonology has involved analyses of verb prefix alternations (5.3). Certain features of Athabaskan verbal morphology are daunting for both

Fig 1. Map of Athabaskan and related North American language families (Kari 2008).

grammatical analysis and lexicography (Hargus 2007a). Verbs contain prefixes that occur in a fixed order with respect to each other (traditionally specified via a prefix position template; see Kari 1989). There are also discontinuous verbal morphemes, as shown in (1) for Witsuwit'en,[4] a dialect of Babine-Witsuwit'en (Babine) (Hargus 2007b). In (1), the discontinuous morphemes consist of (a) verb root and prefixes, the traditional 'verb theme' of Athabaskan linguistics (e.g. Sapir and Hoijer 1967), (b) prefixes alone, (c) is an actual word showing the intertwining of these morphological elements ((a) is underlined, (b) is bold), leading to surface discontinuity.

(1)   Sample discontinuous verbal morphemes
        a. /O–u–yin/[5]   'pick O (berries) while stationary'[6]
        b. /we#s–ʔ/–[7]   nonperfective negative
        c. [wec'ontəzisyitl]   'I won't pick berries'

here & elsewhere, the underlining seems too thick

acceptable meaning load [handwritten]

As well, different morphemes may be associated with different boundaries or phonological domains and/or may exhibit idiosyncratic alternations (Stanley 1967; Hargus 2007b).

Overviews of the verbal morphology are available for many of the languages: Dakelh (Carrier), Morice 1932; Navajo, Sapir and Hoijer 1967; Young and Morgan 1987; Kari 1976; McDonough 2003b; Koyukon, Thompson 1977; Slave, Rice 1989a; McLeod Lake Tsek'ene (Sekani), Hargus 1988, 1989; Lower Tanana (Tanana), Tuttle 1998; Tanacross, Holton 2000; Witsuwit'en, Hargus 2007b; Dena'ina (Tanaina), Tenenbaum 1978; Tsuut'ina (Sarcee), Cook 1984; Dene Sųłiné (Chipewyan), Li 1946; Cook 2004; Hupa, Golla 1970.

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3. Diachronic Studies

Given the size of the language family, assumed relatively shallow time-depth of 2500–3000 years (Krauss 1973; but see Kari 2010), and breadth of reconstructions and other historical-comparative work, much synchronic research on Athabaskan languages has been guided to a certain extent by knowledge of Proto-Athabaskan. Succinct overviews of Proto-Athabaskan phonology can be found in Leer 1979; Krauss and Golla 1981; and Cook and Rice 1989. More specialized information about prosody (Leer 2005), coda nasality (Leer 2008), and Athabaskan-Eyak-Tlingit correspondences (Leer 2010) is also available.[8]

Reconstructions of aspects of PA phonology had been proposed by (e.g.) Sapir 1931; Hoijer 1942, 1963, but major progress on the reconstruction of Proto-Athabaskan did not really come until the 1960s with the founding of the Alaska Native Language Center by Michael Krauss. At that time, Krauss personally undertook or directed fieldwork on many of the Athabaskan languages of Alaska, resulting in better descriptions of the phoneme inventories of the Athabaskan languages of Alaska. The currently reconstructed consonant and vowel phonemes of Proto-Athabaskan are shown in (2) and (4). The table of consonants in (2) is from Leer 2005, who uses standard Athabaskanist transcriptional conventions, where [d] = voiceless unaspirated alveolar stop, [t] = voiceless aspirated alveolar stop, etc. Leer 1996:197 mentions that *dz *ts *ts' *z *s are best interpreted as dental rather than alveolar. IPA equivalents of the symbols in (2) are provided in (3).

[handwritten note: "This symbol should be ƛ̓, not ʔ?"]

(2)	PA consonants (Leer 2005:284)			
*d	*t	*tʰ		
*dl	*tɬ	*tɬ'	*l	*ɬ
*dz	*ts	*ts'	*z	*s
*dž	*tš	*tš'	*ž	*š
*džʳ	*tšʳ	*tšʳ	*tšʳ	
*gʸ	*kʸ	*k'ʸ		*xʸ
*G	*q	*q'	*ɣ̇	*x̣
*m	*n	*ŋʸ		
*w	*y			

(3)   PA consonants, IPA version

*t	*tʰ	*t'		
*tɬ	*tɬʰ	*tɬ'	*l	*ɬ
*ts	*tsʰ	*ts'	*z	*s
*tʃ	*tʃʰ	*tʃ'	*ʒ	*ʃ
*tʂ	*tʂʰ	*tʂ'		
*c	*cʰ	*c'		*ç
*q	*qʰ	*q'	*ʁ	*χ
*m	*n	*ŋʲ		
*w	*j			

The vowels currently reconstructed for PA, four full and three reduced vowels are shown in (4), with IPA equivalents in (5):

(4)   PA vowels (Leer 2005:284)

i:			u:
	ə	ʊ	
e:		ɑ	a:

(5)   PA vowels, IPA version

i:			u:
	ə	ʊ	
e:		ɑ	ɑ

Krauss 1964 reconstructed the essential points of the PA vowel system, but did not transcribe the length of full vowels and used the symbols 'A' and 'U' for [ɑ] and [ʊ], respectively. Subsequently, there has been clarification or vacillation on some points: (a) length of full vowels, (b) quality of full vowels, (c) quality of reduced vowels. Re (a), Leer 1979 showed the length of full vowels as an optional component, *i(·), *e(·), *a(·), *u(·), commenting (p. 12) that 'the length of full vowels was evidently not phonemic in PA'. Krauss and Leer 1981 consistently transcribed the full vowels as long except before glottal stop. Re (b), Leer 1979 noted that *e: was 'phonetically [æ]', and *a: 'phonetically [ɔ]'. Re (c), Leer 1979 transcribed the reduced vowels *ə *ə *u. The first appearance of [ɑ] in a publication may have been in Krauss and Golla 1981, where this symbol is undefined. Leer 1996 also used [ɑ] instead of [ɑ].

Tracing the development of tone has been a major issue (see also 5.5), as some Athabaskan languages have phonemic tone and some do not, and of the tonal languages, some have high tone where others have low.[9] A connection between tone and glottal stop was noted by Li 1933, but the hypothesis that Athabaskan tone arose from syllable-final glottalization was not clearly laid out prior to Krauss 1964 and his fieldwork in Alaska with speakers of Eyak. In Eyak, vowel nuclei can contrast in length and/or glottalization (e.g. Krauss 1965), a major clue to Proto-Athabaskan phonology. Leer 1979 posited a process of 'constriction' for Proto-Athabaskan whereby vowels before certain types of glottalized consonants became laryngealized (transcribed [ẹ] etc. in Athabaskan linguistics) (and from there developed into high pitch in 'high-marked' languages or low pitch in 'low-marked'

languages). Kingston 2005 described physiologic mechanisms by which either high or low pitch can be produced from laryngealization.

The Proto-Athabaskan obstruent system has developed in intricate ways in the daughter languages. Armed with an understanding of correspondences involving sibilants in key Alaskan languages like Tanana and Deg Xinag (Ingalik), Krauss 1964 was able to reconstruct an additional PA consonant 'place' of articulation, now generally reconstructed as retroflex affricate. Tsetsaut, an extinct Canadian Athabaskan language (Boas and Goddard 1924), was also an important language in working out this diachronic puzzle.

The reconstructed phonological system of Proto-Athabaskan has received few challenges. Leer 1979:10 noted that 'the question of contrast between original *γ [voiced palatal glide] and *ɣ̃ [voiced palatal fricative] is quite problematic', and Rice 1997 argued against reconstructing both. (Leer 2005:284 explicitly accepted Rice's proposal.) Cook 1981, critiquing a 1976 ms. version of Krauss and Leer 1981, suggested that instead of *ỹ and *w̃, *ŋ (>/i>) might be reconstructed instead. Symbols close to the latter appear in Krauss and Leer 1981:5, who explain that [ỹ] and [w̃] appear to have been '[syllable]-final' allophones of *ŋ and *m, respectively.

Some Athabaskan diachronic phonological studies have worked out the development of all or part of the Proto-Athabaskan sound system in particular languages: Apachean, Hoijer 1942; Slave, Rice 1977, 1989a; Dakelh (Carrier), Story 1984; Navajo, Leer 1987; Gwich'in, Leer 1996; Witsuwit'en, Story 1984 and Hargus 2007b.

More recently, a different type of diachronic study has been undertaken by Howe and Fulop 2005. In the northern Athabaskan languages, the *dz and *dž̃ʳ series of consonants have diverse reflexes, and Howe and Fulop 2005 are concerned with developing a feature system that easily describes the set of attested changes to these sounds. They propose that the acoustic features [flat] and [grave], the latter redefined as 'the *audible* presence of significant low frequency noise in a sound', are needed.

4. Phonetic Studies

4.1. PRODUCTION STUDIES

As pointed out by McDonough 2003a, there have been relatively few instrumental phonetic studies of Athabaskan languages prior to the last twenty years. Notable exceptions include Goddard 1907–1910 on Hupa and Goddard 1912 on the Cold Lake dialect of Dene Sųłiné. Goddard made use of a kymograph and 'vowel tracer', among other instruments, and the works mentioned include kymographic tracings of energy and pitch, measures of consonant and vowel duration, photographs of lip positions in vowels and palatograms of consonants. Goddard's instrumental phonetic descriptions, although not experimental, were nonetheless unusual for their time. Unfortunately, Goddard's work did not stimulate other contemporaneous phonetic studies of Athabaskan languages, possibly because of the growing influence of Edward Sapir, who disliked Goddard and his work (Golla 2003; Krauss 2005).

Only a few other instrumental contributions to Athabaskan phonetic research (Hogan 1976 and Lindau 1984, both studies of ejectives) appeared prior to the development of personal computing. Since the early 1990s there has been a steady increase in the number of production experiments on aspects of Athabaskan phonetics and phonology. This trend can be attributed to the availability since that time of cheap and easy ways to perform phonetic measurements via personal computer. The majority of these studies use acoustic data. While some studies explicitly test hypotheses about Athabaskan phonetics or

phonology, another simple and obvious benefit of instrumental phonetic studies is the ability to verify the transcriptions which have formed the basis of much research on Athabaskan languages (see also 5.1).

In the remainder of this section, I summarize studies according to findings, phenomenon studied and measurement, rather than by language. Suprasegmental studies are discussed in 5.5.

Athabaskan languages typically have three-way contrasts in laryngeal state between stops and affricates, inherited from Proto-Athabaskan (§3). Bob 1997 studied the laryngeal properties of voiceless unaspirated stops in Tahltan, finding that the labial stop is produced with voicing in each of three environments, post-sibilant, post-nasal and intervocalically, whereas alveolar and velar stops were generally voiced only after a nasal or intervocalically. For Jicarilla Apache, Tuttle 2000 confirmed a phonetic difference in voicing and/or prenasalization between /t/ < *t and /t/ from *n, suggesting incomplete merger of these sounds despite their uniform orthographic representation as <d>, similar to a phenomenon found in much more poorly documented Galice (Tuttle 2005a). More recently, McDonough and Wood 2008 studied duration and release characteristics of stops and affricates in two dialects of Dene Sųłiné (Cold Lake, Fort Chipewyan), Dogrib, North Slavey and Tsilhqut'in (a.k.a. Chilcotin). Their findings include confirmation that Dene Sųłiné alveolar stops have an affricate-like release ([tˣ]), like Navajo. Other studies of the three-way laryngeal contrast in stops/affricates are available for Navajo, Lindau 1984 and McDonough and Ladefoged 1993; Western Apache, Gordon et al. 2001; and Witsuwit'en, Wright et al. 2002; Hargus 2007b.

Several studies have investigated morphological and/or positional effects on consonant duration. Descriptive statistics for the duration of various Navajo consonants in different morphological domains are provided in McDonough 2003b. Bird 2002, summarized in Bird 2004, studied the duration of intervocalic consonants in the Lheidli dialect of Dakelh, concluding that intervocalic consonants are significantly longer than initial or final consonants and that stem-initial consonants are significantly longer than other intervocalic consonants. Bird's finding of extraordinary intervocalic consonant length was questioned by Müller 2009 for Beaver and not replicated in an experiment for Fort Ware Tsek'ene by Hargus 2010a. In Jicarilla Apache, Tuttle 2005b found evidence of phrase-final lengthening and also found that prefix syllables are shorter than those of stems, suffixes and particles. Tuttle 2005b found that stops and nasals in San Carlos Apache have longer duration in stem-initial position than in other morphologically defined contexts. In Witsuwit'en, Hargus 2007b confirmed partial neutralization in duration of the 't'- and 'd'-qualifier verb prefixes, which have merged as 'd'- in a number of languages. Tuttle 2008 investigated possible phonetic manifestations of domain edges in Ahtna – word initial, word final and stem-initial positions – finding that stem-initial consonants are characterized by consonant fortition (Fougeron and Keating 1997). Hargus 2008 confirmed that the prefix sequence (*hə-{-łə-) (Leer 2000) has become an ejective lateral affricate [tł'] word-initially in Deg Xinag, but has fewer ejective characteristics than stem-initial lateral ejective affricates.

Several studies have investigated properties of fricatives. Holton 2001 studied the voicing contrasts among previously transcribed voiced, voiceless and 'semi-voiced' fricatives in Tanacross, reducing these to a two-way contrast between 'fortis' and 'lenis' fricatives, with allophonic differences in voicing among the lenis fricatives. Spectral properties of fricatives have been studied in Navajo (McDonough 2003b), Western Apache (Gordon et al. 2001), Hupa (Gordon 1995), Deg Xinag (Wright et al. 2005a,b, 2008), and Dene Sųłiné (Flynn 2008).

Spectral and temporal information about vowel systems is also available for some languages. Studies of duration and formant values of languages with conservative vowel systems (Witsuwit'en, Hargus 2007b; Deg Xinag, Hargus 2010b) support the quality and quantity differences reconstructed for PA vowels by Krauss 1964. As noted by Leer 1979, some languages have changed the Proto-Athabaskan full/reduced system into a long/short system, and phonetic studies of duration and/or formant values have appeared for some of those languages: Navajo, McDonough et al. 1993; McDonough and Austin 1994; McDonough 2003b; Hupa, Gordon 1995; Western Apache, Gordon et al. 2001; Dogrib, Martel and Saxon 2005.

Some languages contain glottalized sonorants in word-final position. Hupa has an unusual contrast between pre- and postglottalized sonorants, instrumentally confirmed by Gordon 1995. Hargus 2007b found intra- and interspeaker variation between pre- and postglottalization in the production of Witsuwit'en [n'].

4.2. PERCEPTION EXPERIMENTS

In contrast to the ever-growing literature on production studies, there have been very few phonetic perception experiments. One study by Davis and Hargus 1998, summarized in Wright et al. 2002, presented minimal pairs along the ejective/nonejective dimension to native listeners of Witsuwit'en, along with control data for minimal pairs differing along other phonetic dimensions. Listeners correctly identified fewer ejective/nonejective stop and affricate pairs when compared to other phonological contrasts, suggesting that ejectivity is relatively difficult to perceive in that language even for native listeners.

5. Noninstrumental Phonological Studies

A large number of descriptive theses, dissertations and grammars of Athabaskan languages contain a significant phonological component: Kari 1976 on Navajo, Thompson 1977 on Koyukon, Tenenbaum 1978 on Dena'ina, Hargus 1985 (Hargus 1988) on McLeod Lake Tsek'ene, Randoja 1990 on Halfway River Dane-zaa, Rice 1989a on Slave, Holton 2000 on Tanacross, and Moore 2001 on Kaska. Article-length descriptions include Story 1989b; Doig River Dane-zaa vocalic system; Golla 1976; Tututni phonology and morphology; Scollon 1975; synchronic and diachronic aspects of Gwich'in (Kutchin) phonology; Cook 1971, 1984; vowel duration and pitch in Tsuut'ina; Krauss 1975; Cook 1983a, 1989a; 'flat' (pharyngealized) sibilants in Tsilhqut'in; Cook 1983b, 1991, interresearcher transcriptional differences in Dene Sųłiné vowels and consonants; Cook 1985, Dakelh [n] and [ŋ]; Collins 1989, vowel length and nasalization in Tolowa.

5.1. THE NATURE OF THE DATA

The bulk of Athabaskan linguistic studies, including most of those just mentioned, is based on data that have not been instrumentally verified but rather recorded by the technique that phoneticians pejoratively refer to as subjective listening. In other words, it is data that are transcribed by a nonnative-speaking researcher with varying degrees of second language learning success. The data may or may not even be verifiable by another researcher, if no recording (audio or video) was made of the fieldwork session, as was typical of field research in the first part of the 20th century and even later.[10]

While this characterization of the data may make it seem suspect, when trying to achieve broad descriptive coverage of an under described language, it is simply not possible to instrumentally verify every transcription. A balance must be struck between quality and speed of data collection. However, one safeguard to the quality of data collected via subjective listening is built in through redundancy in the collection of morphological and syntactic paradigms. As these are collections of related words and sentences, a researcher hears multiple repetitions of the same or similar forms and so has multiple chances to transcribe correctly.

5.2. ROOTS AND STEM DOMAIN

The root is generally the last syllable of an Athabaskan word and contains much of the word's lexical meaning. Athabaskan languages typically do not borrow verbs from other languages (see §8), but in cases where that is known to have happened, the borrowed verb becomes the verb root; e.g. Fort Ware Tsek'ene -/dʒʌm/'jump' < English *jump*. Leer 1979 is a classic study of the morphological and phonological properties of Proto-Athabaskan verb roots, originally written as an undergraduate thesis. Leer distinguished between roots and stems: 'a root is here defined as an underlying form, from which through regular phonological modification of the vowel nucleus and/or suffixation, the stems of a given stem set or group of stem sets may be identified. A stem is thus defined as root + modification ± suffix.'[11]

Some phonological phenomena apply uniquely to roots. Many descriptions of Athabaskan languages have noted that roots must be stressed (5.2). In many of the languages, voiced and voiceless fricatives are in complementary distribution in root-initial position (Krauss 1976). Rice 1989a argued that in Slave such fricatives are underlyingly voiceless, as these have a wider distribution than voiced alternants.

Marinakis 2003b and many earlier researchers recognize the Stem domain, a phonological constituent based on but not isomorphic to the morphological stem, 'the root of the word as well as any affix which has been incorporated into the syllable or syllables of the root.' The 'D-effect rule' is a well-studied alternation which applies in the Stem domain: a voiceless unaspirated stop fuses with a following continuant, glottal stop, and/or nasal (depending on the language). Howren 1971 provided a rule-based overview of this alternation in several languages. Constraint based analyses of the Athabaskan D-effect are also available: pan-Athabaskan, Lamontagne and Rice 1993, 1994; Slave, Wilhelm 2001; Witsuwit'en, Hargus 2007b. The D-effect rule is triggered by verb prefixes outside of the root: the 'D-' 'classifier' and, in some languages, the first person dual subject prefix (Story 1989a). Analyses of the D-effect are naturally affected by assumptions concerning the underlying representations of the 'D-' prefixes (Shaw 1991).

Gwich'in, Dane-ẕaa, and most dialects of Tsek'ene have undergone a process of Palatalization, which applies in the Stem domain. In McLeod Lake Tsek'ene, root-initial [d t t'] have become palato-alveolar affricates before [i ɪ e u]. Palatalization occurred historically, leading to changes in lexical representations such as those in (6).

(6)   McLeod Lake Tsek'ene root-initial Palatalization
a. stems

PA			McLeod L. Tsek'ene	
	*-deʔ 'horn' (Krauss and Leer 1981)	>	McLeod L. Tsek'ene	-džeʔ
	*tu; 'water' (Krauss and Leer 1981)	>		tšu
	*t'es 'charcoal' (Krauss 2005)	>		tš'ès

b. disjunct morphemes
PA   *te# 'into water'   >   tše#

As a synchronic phenomenon, Palatalization only applies in the Stem domain. When the D-Effect rule applies before the root vowel [i (I) e] or [u], Palatalization also applies. In (7), the perfective stem formed from the root 'step' is [ʔèts] and the future stem is [ʔəs]. Both forms in (7) have undergone the D-Effect rule, whereby 'D-' fuses with [ʔ]:

(7)   McLeod Lake Tsek'ene
a.   k'èsədits'èts 'we (du.) stepped on it'
b.   k'èdədəyit'əs 'we (du.) will step on it'

The form in (7)a. has additionally undergone Palatalization because the perfective stem vowel is [e].

   Other root-specific phonological phenomena are more static in nature. Leer 1979 noted limitations on the distribution of reduced vowels in Proto-Athabaskan roots (reduced vowels must precede a consonants other than glottal stop), and reduced number of contrasts in manner and laryngeal state root-finally as opposed to root-initially. Studies of contrast-based properties such as features (e.g. Rice 1992, 1994; Hargus 2007b) tend to focus more on roots than on prefix morphophonemics, because the prefixes, being formed from closed classes of morphemes, exhibit a reduced inventory of the contrasts found in roots. For example, Fountain 1998 noted for Navajo that while root vowels can contrast in nasality, nasalized vowels never occur in the rightmost, 'conjunct' (5.3) verb prefixes. However, Martel and Saxon 2005 found that vowel length contrasts in Dogrib are neutralized in roots, although maintained in the verb prefixes.

5.3. PREFIX MORPHOPHONEMICS

A traditional research area within Athabaskan phonology has been description of the elaborate morphophonemics of the verb prefixes. Just as the morphology of the verbal prefixes is complex, so too are the phonological alternations caused by these morphemes as they come in contact with each other. Descriptions of these alternations are available for a variety of languages: Dogrib (Howren 1968), Koyukon (Kroul 1976; Thompson 1977), Navajo (Stanley 1967; Kari 1976; Fountain 1998; Alderete 2003), Slave (Rice 1980, 1989a), Tsuut'ina (Cook 1984), McLeod Lake Tsek'ene (Hargus 1987, 1988), Tsilhqut'in (Cook 1989b), Ahtna (Kari 1990), Deg Xinag (Hargus 2000), Witsuwit'en (Hargus 2007b).

   While understanding the intricate alternations involving verb prefixes is a valid object of study in and of itself, it is also necessary for other types of research on Athabaskan languages. For example, verbal conjugation prefix has been implicated in studies of Athabaskan aspect (Axelrod 1993; Smith 1996; Rice 2000; Wilhelm 2007), so it is important to be able to recognize whether a verb is *s-, *n-, or *y- conjugation (Krauss 1969), more recently analyzed as situation aspect (Smith 1996). The (underlying) conjugation marker may not be obvious from the surface form of a particular verb and may be determined only by unravelling verb prefix alternations.

   Some Athabaskan verb prefix alternations have spawned a small literature. Consonant (sibilant) harmony has been the focus of both rule-based (Tsuut'ina, Cook 1978;

Proto–Athabaskan, Saville-Troike 1985; Tahltan, Shaw 1991; Navajo, McDonough 1991; Tsilhqut'in, Cook 1993) and constraint-based studies (Navajo, Fountain 1998; Tsilhqut'in, Mah 2006; Hansson 2007).

One of the challenges of Athabaskan verb prefix phonology is the need for boundaries or domains of different sorts, such as the Stem domain (5.2). Another famous word-internal juncture is the 'disjunct boundary' (symbolized '#') (Li 1946; Kari 1975b), which distinguishes 'disjunct' (more leftward) from 'conjunct' (more rightward) verb prefixes. Eyak verb prefixes are cognate only with the Athabaskan conjunct prefixes (Krauss 1965), and Eyak cognates to Athabaskan disjunct morphemes, where known, are free morphemes (Hargus and Tuttle 2003), suggesting that the left edge of the Athabaskan-Eyak verb may have been the conjunct prefixes. Hargus 1991 pointed out that some Athabaskan languages provide more robust evidence for the boundary than others. Rice 1993 noted much more variability in Athabaskan languages in the order of the disjunct prefixes than in the order of the conjunct prefixes. The disjunct prefixes are frequently referred to as 'clitics' rather than prefixes (e.g. Fountain 1998; McDonough 2000; Leer 2006–2010), but Hargus 1997 argues against applying this term to the disjunct prefixes. Rice 2000 has characterized the conjunct prefixes as functional items and the disjunct prefixes as lexical items, a proposal adopted by Alderete 2003 for Navajo.

Another verb prefix internal domain that is recognized in studies of some languages is one which distinguishes the conjunct 'qualifier' prefixes (Kari 1989) from other conjunct prefixes (Rice 1982; Hargus 1988). Hargus 2007b, reviewing evidence for the qualifier boundary in Witsuwit'en, concluded that the phenomena usually cited are specific to a small number of morphemes, raising the question of whether a domain/boundary approach is appropriate (at least for Witsuwit'en).

In recent years, the field of Athabaskan phonology has shifted somewhat away from descriptions of prefix morphophonemics, in part because rule-based approaches to phonology have fallen out of theoretical favor. However, unlike rule-based descriptions of Athabaskan languages, there are no comprehensive constraint-based descriptions of the verb prefix phonology of an Athabaskan language, perhaps because of the sheer difficulty of doing so, although portions of such descriptions are available for Navajo (Fountain 1998; Alderete 2003), Witsuwit'en (Hargus 2007b), and Ahtna (Causley 1994; Hargus and Tuttle 1997). Of these, Fountain's analysis of Navajo is the most complete, at least as a description of conjunct verb prefix phonology.

Another reason for the shift away from descriptions of verb prefix morphophonemics is that purely phonological descriptions of these alternations have come under fire from McDonough 1990b, 1996, 2000. McDonough has challenged the productivity of these alternations, suggesting that the Athabaskan verb is a phonological and morphological compound, consisting of an inflectional 'stem' plus the traditional verb stem:

(8)   Model of morphological structure of Athabaskan verb (McDonough 2000:161)
         disjunct clitics # (AGR) [(QU) Istem]$_{infl}$ [(CL) Vstem]$_{verb}$**wd**

(In (8), QU = qualifier prefix; CL = classifier prefix.) The IStem morphemes of McDonough's model are 'based on' the system of word formation used in Young et al. 1992, particularly their Base Paradigms (McDonough, p.c.).

The bipartite model has a certain attractiveness. One of its claims is that the rightmost verb prefix alternations are lexicalized. Previous analyses of verb prefix alternations some-

times posited quite abstract underlying representations, such as the /ñ/- perfective prefix posited by Rice 1989a for Slave. Vajda 2010 has suggested that there are bipartite similarities between the verb structure of both the Na-Dene and Yeniseian language families. However, from a descriptive standpoint, the bipartite model leads to some redundancy. For example, McDonough 1996 analyzes each member of the optative prefix paradigm in (9) as an instance of an Istem:

(9)   Some examples of the Istem (McDonough 1996:245)
          sg   du
1   ósh   ood
2   óó   ooh
3   ó

In traditional approaches to Navajo phonology and morphology, such as Kari 1976, the 1sg member of the paradigm in (9) would be analyzed as /ó/- optative /ʃ/- 1sg subject, but as seen in (10), in the Istem model *ósh-* is analyzed as a portmanteau morpheme:

(10)   biih wóshkad 'toss it into it' (McDonough 1996:245)
          [ósh] [ɬ – kaad]
          [opt/1s] [CL – opt 'move in a spreading manner']

It is useful to keep in mind the separate claims of the Istem model: (1) that the verb exhibits some phonological properties of a compound and (2) that some inflectional morphemes have become reanalyzed as portmanteau morphemes. A compounding account of the verb prefixes in McLeod Lake Tsek'ene has been proposed by Halpern 1992 as an alternative to the right-branching model of the verb prefixes used by Rice 1982 and Hargus 1988. Hargus 2007b has adopted a simplified version of the phonological compounding model of the verb prefixes for Witsuwit'en, as shown in (11), recognizing Prefix and Stem domains that are derived from but not identical to morphological prefix sequences and roots:

(11)   Phonological structure of verbs with no incorporated roots in Witsuwit'en
[[PREFIX] [STEM]]$_{PWD}$
Hargus 2007b points out several phonological ways in which the structure in (11) differs from that of noun compounds.

5.4. SYLLABLES

The syllable or its skeletal precursor has played a role in research on some languages. Wright 1984 described restrictions on Navajo segment sequences in terms of a CV-template, suggesting that the most prevalent vowel of the conjunct prefixes, [i], was the result of epenthesis between adjacent C-slots (but see Alderete 2003 for another approach to the same problem). Speas 1984 proposed that the CV-template played a role in morphology, regulating affix order in Navajo. Although both Wright and Speas had to make simplifying assumptions about Navajo in order for their analyses to work, their appeal to the syllable is seen in later work in the family, such as Rice 1989c on Slave and Randoja 1990 on Halfway River Dane-zaa syllables and verb prefix ordering restrictions.

Constraint-based phonological analyses also make use of syllables. These include Causley 1994, Rice 2003 on Ahtna, Fountain 1998 on Navajo, and Marinakis 2003b (summarized in Marinakis 2003a) on Dogrib (Tłı̨chǫ Yatiì). Marinakis, building on previous analyses of Dogrib by Howren 1979 and Ackroyd 1982, proposed a restricted inventory of Dogrib syllables in a constraint-based analysis.

Hargus and Tuttle 1997 suggested that some schwa~zero alternations in the verb prefixes, notably those involving the Athabaskan 'peg prefix' (Krauss 1969), are best analyzed by recognizing that the 'peg prefix' is a morpheme. Many previous approaches had treated these alternations either as a phonological rule with morphological conditioning (e.g. Rice 1989a) or syllable conditioning (Randoja 1990). In McDonough's Istem model, however, the 'peg prefix' is also treated as a morpheme.

5.5. THEORETICALLY DRIVEN RESEARCH

As noted earlier, much research on Athabaskan phonetics and phonology has been driven by questions arising within the structures of the languages themselves. However, some research has been driven by theoretical questions. Halpern 1992, mentioned above in 5.2, in a cross-linguistic study of clitics, reanalyzed tonal and segmental McLeod Lake Tsek'ene data from Hargus 1988, suggesting that the verb prefixes and root form a prosodic compound rather than right-branching structure. Vaux 1996, based on Babine data in Story 1984, argued for retention of the feature [Advanced Tongue Root] in phonological theory. Levi 2004, based on data from Hardwick 1984, argued that Tahltan has underlying glides. Alderete 2003 proposed that if constraints which hold of lexical categories are ranked higher than constraints which hold of functional categories, then certain gross phonological characteristics of Navajo follow, such as 'the sound structures of conjunct prefixes are always *a proper subset* of the larger sound inventory' (p. 114).

6. Suprasegmental Phonology

Apart from syllables (5.4), other word-level suprasegmental phenomena in Athabaskan languages consist of stress, and in some of the languages, tone. Rice and Hargus 2005 provide an overview of issues in the description of suprasegmental phonology in Athabaskan languages.

Descriptions of aspects of stress/prominence are available for some languages. Gessner 2003, working with speakers of the Lheidli dialect of Dakelh, studied phonetic properties of pitch, duration and amplitude of stressed and unstressed vowels, confirming proposed differences between the prosodic properties of Lheidli and those of the Nak'azdli dialect of Dakelh arrived at via subjective listening (Pike 1986; Story 1989c). Although syllables have also been made use of or explicitly argued for in some descriptions, the stress foot generally does not figure in descriptions of stress in Athabaskan languages. One exception is Rice 1990, who argues that the foot plays a role in Slave in describing tone, prominence and vowel quality. Other studies of stress include the Salcha dialect of Lower Tanana, Tuttle 1998; Proto-Athabaskan, Leer 2005; Jicarilla and White Mountain Apache, Tuttle 2005b; Tahltan, Alderete and Bob 2005; Witsuwit'en, Hargus 2005, 2007b; Tsek'ene, Hargus 2005; Slave, Rice 1989a, 1990, 2005.

The literature on tone in Athabaskan begins with Sapir 1922, the first study in which tone was transcribed in an Athabaskan language (Krauss 2005). The interaction between

tone and vowel length in Tahltan has been studied by Alderete 2005, who found that low-toned vowels are significantly longer than high-toned ones, confirming observations by Nater 1989. Other studies of tone include Tsilhqut'in, Cook 1989b; Owens 1991; Rhyasen 1995; Dene Sųłiné, Li 1946; Gessner 2005; Tanacross, Holton 2000, 2002, 2005; Dakelh, McDonough 1990a; Gessner 2002; Western Apache, Tuttle and de Reuse 2000; Reuse 2002, 2005; Tsuut'ina, Cook 1971; Starlight et al. 1998; Navajo, De Jong and McDonough 1993; McDonough 1999; Tanana, Tuttle 1998; Tuttle and Kaisse 1996; Tuttle 2003; Dane-zaa (Miller 2003, 2007). The more recent of these descriptions of stress and tone generally include some sort of instrumental confirmation of the data. Instrumental phonetic confirmation of Kingston's tonogenesis scenario for Athabaskan (§4) is provided by within-language variability in pitch perturbation before [ʔ] and [n'] in nontonal Witsuwit'en (Hargus 2007b).

7. Sentence-Level Phonology

For the most part, phonetic and phonological studies have focused on phonology at the level of the word rather than above the word. However, even the issue of where to draw the line between morphosyntactic word and sentence is a difficult one in Athabaskan languages, hinging in part on how 'Phonological Word' is defined (Hargus 2007b). The left edge of the word is particularly difficult to define, as noted in several studies (Hargus 1997; McDonough 2000; McDonough and Willie 2000; Tuttle 2002).

Perhaps the most obvious problem to tackle in the phonology-syntax interface is intonation. Several studies have noted that declarative sentences are marked by phrase-final L tone; e.g. Slave (Rice 1987, 1989a,b); Tanacross (Holton 2005), Dena'ina (Tuttle and Lovick 2007), Fort Ware Tsek'ene (Hargus and Abou 2008), Witsuwit'en (Hargus 2009), and Dane-zaa (Müller 2009). Note that Slave, Tanacross, Tsek'ene and Dane-zaa are tone languages while Dena'ina and Witsuwit'en are nontonal. The widespread finding of phrase-final L in declarative sentences becomes more interesting in light of the instrumentally confirmed findings of McDonough 2003c that Navajo declarative sentences, yes-no questions and sentences with focused constituents do not contrast in edge tone in that language. Some Athabaskan languages also provide support for yes/no questions being marked by an H phrasal tone (Slave, Tanacross, Tsek'ene).

8. Contact Phonology

Several studies of Athabaskan languages have assessed the reshaping of loan words according to phonological forces of the borrowing languages. Most of these have examined words borrowed from European languages into an Athabaskan language; e.g. Krauss 1983 on French borrowings into Hare and other northern Athabaskan languages; Story 1984 on borrowings from French into Dakelh and Babine; and Prunet 1990 on borrowings from French into Dakelh. Some grammars also contain a section on contact phonology and borrowing; e.g. Slave (Rice 1989a), Witsuwit'en (Hargus 2007b).

Kari 1977 noted a number of phonological and lexical similarities between Ahtna and the Upper Inlet dialect of Dena'ina, which he attributed to their contiguity (see Figure 1) and consequent bilingualism, if only passive. One such phonological similarity is the fact that Ahtna and Upper Inlet Dena'ina contain 'six consonant series' as reflexes of the Proto-Athabaskan obstruent system (2), whereas Lower Inlet Dena'ina contains seven consonant series.

(handwritten margin note: symbol is too big)

On a larger scale, Rice 2004 considered possible effects of contact from other indigenous languages on Athabaskan phoneme inventories: Dene Sųłiné and Cree, Koyukon and Iñupiaq, Tsuut'ina and Blackfoot, Plains Apache and Kiowa, and Hupa/Tolowa/Cahto (contact with various neighboring California languages). Her survey confirms an observation originally made by Sapir 1921 that Athabaskan language inventories generally do not borrow much from other languages, judging from the relative stability of their phoneme inventories. Still, some properties of phonological systems seem to reflect contact. For example, Tsilhqut'in has innovative pharyngealization linked to certain sibilant consonants, and pharyngealization is found in neighboring Shuswap, an interior Salish language (Kuipers 1974).[12] As noted by Kari 1975a and Rigsby and Kari 1987, contact between Gitksan and Witsuwit'en, the western dialect of Babine-Witsuwit'en, must have played a role in the shaping of the Witsuwit'en consonant inventory, for example, the preservation of syllable-initial palatal stops in Witsuwit'en, unlike the eastern Babine dialect of Babine-Witsuwit'en (Story 1984).

A smaller literature on borrowings from Athabaskan into neighboring languages also exists. Nater 1994 identifies possible loans from Athabaskan into Nuxalk (Bella Coola, Salish). Rigsby and Kari 1987 discuss loans from Witsuwit'en into Gitksan. Leer 2005 mentions a few lexical items that are phonologically and semantically similar between Athabaskan and Tsimshianic.

9. Phonological Acquisition

Although most Athabaskan languages are endangered, and some are extinct, a few are still being learned by children.

Saville-Troike 1996 describes the acquisition of Navajo verbal morphology by five children aged 13 to 42 months at the time of initial recording. Although phonological difficulties are not discussed in this article, some transcriptions show phonological deviations from adult forms: e.g. child (age unspecified) **nil nizhoni** (cf. adult **shił nizhóní** 'I like it' (lit. 'it is nice for me')). Note the voiced lateral in place of voiceless lateral fricative.

(handwritten margin notes: bold; symbol is too big)

Cook 2006 describes the acquisition of consonants in Dene Sųłiné by primarily one child, 2 years and 3 months old at the time of initial observation. Over the 8- month observation period, the child acquired the three-way laryngeal contrast among stops, in the following order: voiceless unaspirates > voiceless aspirates > ejectives. Manner contrasts among obstruents were acquired in the order stops > affricates > fricatives.

10. Phonological Consequences of Language Loss

As mentioned earlier, most languages in the Athabaskan family are endangered. However, there is not a large literature on characteristics of language loss; i.e. characteristics of the language patterns of fluent native speakers to semi-speakers with innovative 'simplifications'.[13] One contribution to this genre is that of Cook 1989c, who describes the speech of semi-speakers of Dene Sųłiné and Tsuut'ina. Cook's observations about Dene Sųłiné mergers and increasing variability were essentially further comments on data that had been collected and analyzed by Rice 1978; Jehn 1980 and Henry 1980 and compared with more conservative sources on Dene Sųłiné. For Tsuut'ina, Cook noted some idiosyncratic variation (replacement of final glottal stop with [t] in one speaker and retention of prefixal *ł (>/s/for all other speakers)), as well as loss of final nasals and nasalized vowels.

(handwritten margin notes: symbol is too big; symbol is too big; remove italics)

11. Future Directions

For languages with very small numbers of speakers within the Athabaskan family, time is running out for documentation. Archival research can continue but will be limited by the size of the corpus and factors such as who collected the material and how it was collected (e.g. whether there are audio-visual materials or not).

Within Athabaskan phonetic and phonological research, if recent trends are an indication, experimental research is likely to continue. A new researcher joining the field would be expected to be competent in instrumental phonetic research. Given the variety of sound changes attested in the family, Athabaskan languages would be fertile ground for perception tests designed to uncover perceptual difficulty and ultimately perhaps explain some of the attested sound changes in the family.

Short Biography

Sharon Hargus does research primarily on the phonetics, phonology and morphology of Athabaskan languages. She is the recent author of *Witsuwit'en Grammar: Phonetics, Phonology, Morphology* and recent co-editor (with Keren Rice) of *Athabaskan Prosody*. She has received grants from the National Science Foundation and other agencies for research on Athabaskan languages and has worked with speakers of Tsek'ene, Witsuwit'en and Deg Xinag. She is currently a professor of Linguistics at the University of Washington, where she has worked since 1986. She holds a BA in Linguistics from the University of California, Berkeley, and MA and PhD degrees in Linguistics from UCLA.

Notes

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[1] Krauss and Golla 1981:67 state that 'Athabaskan is the spelling preferred by the Alaska Native Language Center, since it reflects more directly the usual American English pronunciation (ˌæθəˈbæskən)'

[2] Goddard 1996 lists 44 languages.

[3] McDonough and Willie 2000 evaluated the reactions of ten Navajo listeners of 'various levels of fluency' to different types of errors involving verbal morphology. Unfortunately, as the authors note, 'since the participants were not controlled for their level of fluency, it is difficult to draw conclusions from the data.'

[4] Language names used in this article are those preferred by speech communities, where known. In some cases, these differ from better known historically used names. Alternate language names are given in parentheses at first usage.

[5] In this article, data are generally transcribed as it is in the source(s) for each language, except where symbols differ too much from general linguistic interpretations. See §3 for Athabaskan transcriptional conventions.

[6] O ('Object') in (1) and elsewhere is a transitivity marker, indicating that a direct object is required. O shows where a prefixal object would appear with respect to other verb prefixes.

[7] The symbol # is the 'disjunct boundary' (§5.1).

[8] Athabaskan is widely considered a family within Athabaskan-Eyak, the other branch of which is Eyak. Athabaskan-Eyak is a family within Athabaskan-Eyak-Tlingit (AET) (Leer 2006–2010), also known as Na-Dene (Krauss 1973; Levine 1979; Enrico 2004).

[9] In one language, Dane-zaa (Beaver), dialects differ in their tonal reflexes of glottalization (§6).

[10] In the field methods training, I received as a graduate student at UCLA in 1980, notes were taken in a notebook during a fieldwork session and no recording was made unless we were working on texts. During my first independent fieldwork in British Columbia on McLeod Lake Tsek'ene in 1982, I was fortunate to meet up with Keren Rice, who showed me the benefits of leaving the recorder going during elicitation, and augmenting/correcting the transcription afterward.

[11] This is the usual approach to analysis of Athabaskan verb stem variation in the daughter languages; e.g. Hardy 1979. See Eddington and Lachler to appear for a connectionist approach to Navajo verb stems.

[12] Kuipers 1974 classes [ˁ] as 'uvularized' in the phoneme inventory but elsewhere refers to 'pharyngealized' effects of this consonant on neighboring vowels.

[13] Field linguists may prefer to work with the speakers who are most conservative and who have most intact linguistic competence within each speech community.

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USING E-ANNOTATION TOOLS FOR ELECTRONIC PROOF CORRECTION

Required Software

Adobe Acrobat Professional or Acrobat Reader (version 7.0 or above) is required to e-annotate PDFs.
Acrobat 8 Reader is a free download: http://www.adobe.com/products/acrobat/readstep2.html

Once you have Acrobat Reader 8 on your PC and open the proof, you will see the Commenting Toolbar (if it does not appear automatically go to Tools>Commenting>Commenting Toolbar). The Commenting Toolbar looks like this:


If you experience problems annotating files in Adobe Acrobat Reader 9 then you may need to change a preference setting in order to edit.

In the "Documents" category under "Edit – Preferences", please select the category 'Documents' and change the setting "PDF/A mode:" to "Never".
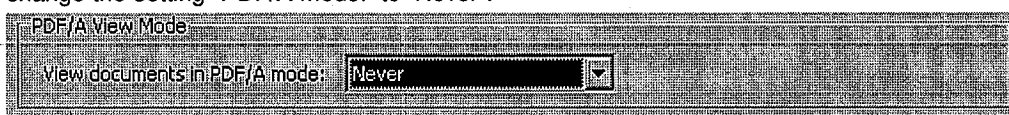
Note Tool — For making notes at specific points in the text

Marks a point on the paper where a note or question needs to be addressed.
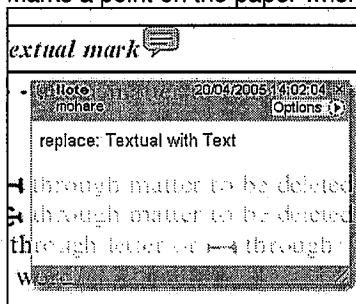
How to use it:

1. Right click into area of either inserted text or relevance to note
2. Select Add Note and a yellow speech bubble symbol and text box will appear
3. Type comment into the text box
4. Click the X in the top right hand corner of the note box to close.

Replacement text tool — For deleting one word/section of text and replacing it

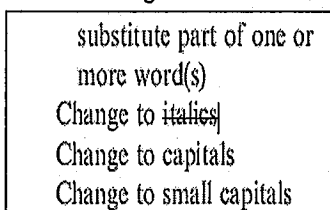Strikes red line through text and opens up a replacement text box.
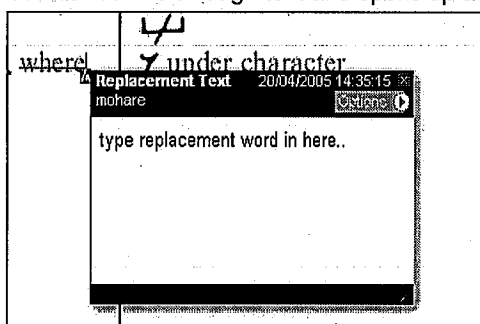
How to use it:

1. Select cursor from toolbar
2. Highlight word or sentence
3. Right click
4. Select Replace Text (Comment) option
5. Type replacement text in blue box
6. Click outside of the blue box to close

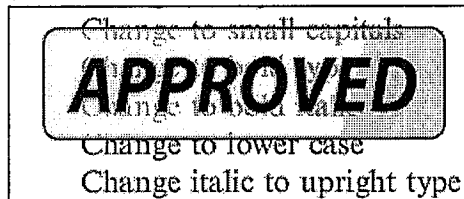## Cross out text tool — For deleting text when there is nothing to replace selection

Strikes through text in a red line.

How to use it:

1. Select cursor from toolbar
2. Highlight word or sentence
3. Right click
4. Select Cross Out Text

**Approved tool — For approving a proof and that no corrections at all are required.**

	How to use it:
Change to small capitals **APPROVED** Change to lower case Change italic to upright type	1. Click on the Stamp Tool in the toolbar 2. Select the Approved rubber stamp from the 'standard business' selection 3. Click on the text where you want to rubber stamp to appear (usually first page)

Highlight tool — For highlighting selection that should be changed to bold or italic.

Highlights text in yellow and opens up a text box.
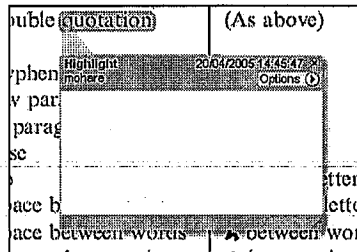
	How to use it:
(highlight tool screenshot)	1. Select Highlighter Tool from the commenting toolbar 2. Highlight the desired text 3. Add a note detailing the required change

Attach File Tool — For inserting large amounts of text or replacement figures as a files.

Inserts symbol and speech bubble where a file has been inserted.
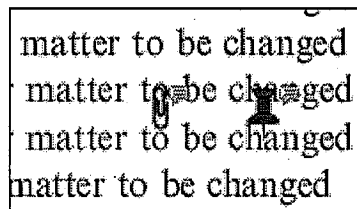
	How to use it:
matter to be changed matter to be changed matter to be changed matter to be changed	1. Click on paperclip icon in the commenting toolbar 2. Click where you want to insert the attachment 3. Select the saved file from your PC/network 4. Select appearance of icon (paperclip, graph, attachment or tag) and close

Pencil tool — For circling parts of figures or making freeform marks

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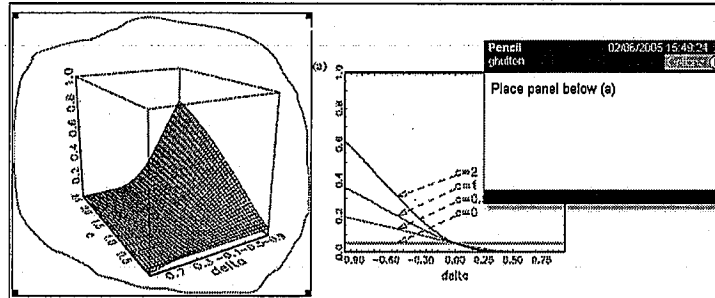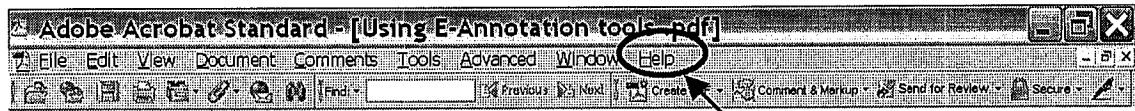
How to use it:

1. Select Tools > Drawing Markups > Pencil Tool
2. Draw with the cursor
3. Multiple pieces of pencil annotation can be grouped together
4. Once finished, move the cursor over the shape until an arrowhead appears and right click
5. Select Open Pop-Up Note and type in a details of required change
6. Click the X in the top right hand corner of the note box to close.

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