

Thai Sound System Teaching Tool for the Hearing Impaired

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Thai Sound System Teaching Tool

The Rajanagarindra Institute of Linguistics and Cultural Studies (RILC), Kasetsart University (KU) has launched a web based Thai Sound System (TSS) project which is available at <http://rilc.ku.ac.th/Thai%20Sound%20System%20Online/Home.html>

Tumtavitikul et al. CSUN 2012.

In general, this phonetically based multimedia web program is a self-access learning tool for interested second/foreign language learners

Tumtavitikul et al. CSUN 2012.

Specifically, it is designed as an assistive teaching tool for the hearing impaired, for the **correction and improvement of their basic oral language skill-- pronunciation,** which is also an important basis for reading/writing skills (www.asha.org)

Tumtavitikul et al. CSUN 2012.

This teaching tool may be more suitable for **formal learning**, either in **classroom instruction or self-access learning**.

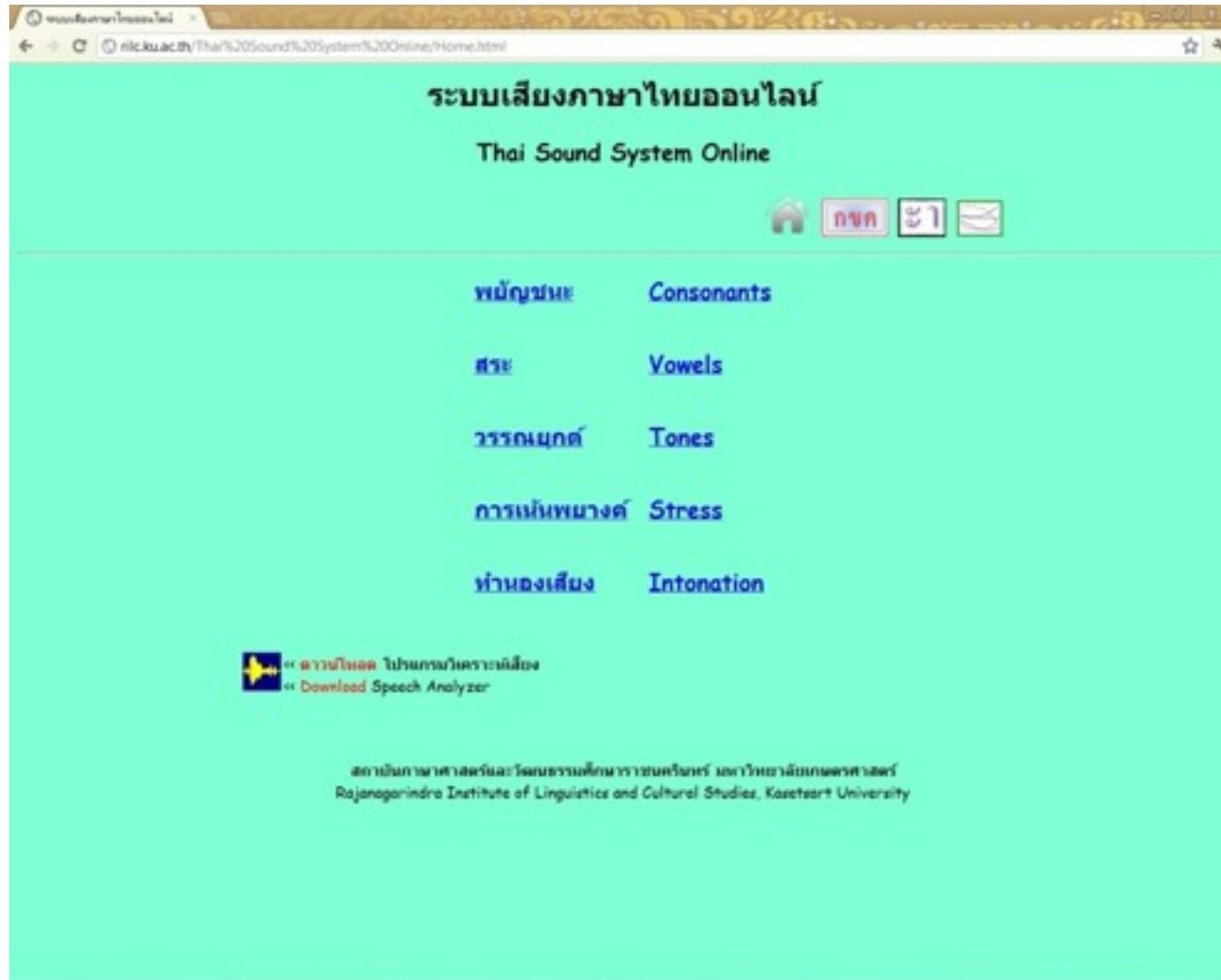
Teachers or parents of Deaf children, and Deaf persons with some knowledge of both Thai SL and Thai are the users in focus.

The program is **eclectic** consisting of **articulatory** as well as **acoustic phonetics** (McGurk and MacDonald 1976, Öster1995), **Thai orthography**, and **fingerspelling** (FS) (Tumtavitikul 2009). **FS is set to be the link between the Thai alphabet and corresponding consonant, vowel, or tone.**

Multimedia includes **audio clips**,
video clips of lip movement,
and **vocal cord vibration**. Simulation
of **articulatory movements**, **formant**
frequencies and **fundamental**
frequency displays are components
for visual enhanced learning

Visual feedback requires a free downloaded speech analysis program where linkage is provided (www.sil.org). A downloadable tutorial provides a guideline to self-access learning.

Thai Sound System Online



Tumtavitikul et al. CSUN 2012.

Theoretical basis for TSS

TSS is designed basing on articulatory and acoustic phonetics: **Lip reading as an important integration in perception for speech recognition according to McGurk and MacDonald 1976 and visual speech assistive tool basing on Öster 1995 and etc.**



Figure 1: A snapshot of lip movement video clip
for bilabial stops and nasals /b, p, p^h, m/
“บ ป พ ผ ม”

Tumtavitikul et al. CSUN 2012.

A video clip of lip movement for bilabial
stops and nasals /b, p, p^h, m/
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Tumtavitikul et al. CSUN 2012.



A video clip of lip movement for bilabial
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Tumtavitikul et al. CSUN 2012.

Since movement of internal speech organs in the vocal tract cannot be easily seen except with an x-ray movie or a laryngoscopic video, the movement within the **oral cavities are shown in simulation**

The **states of the larynx** for **voicelessness** is shown in a photo captured from a laryngoscopic video and vocal cords vibration for **voicing** is shown in a short laryngoscopic video clip

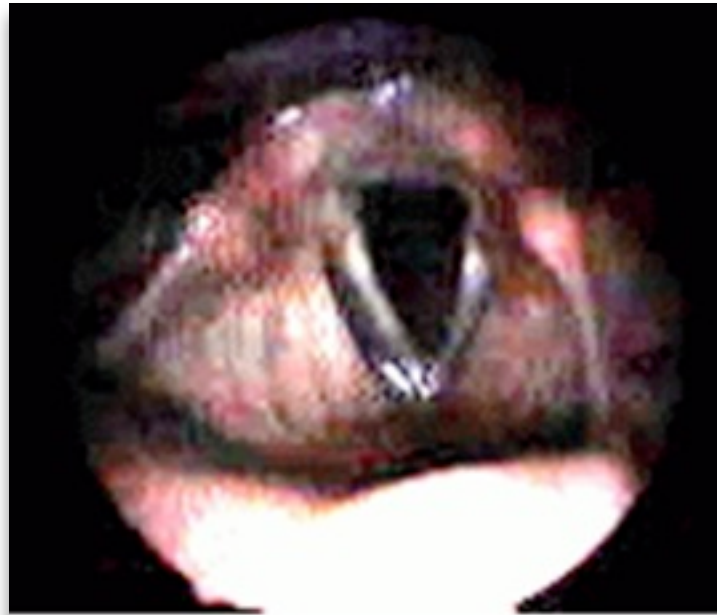
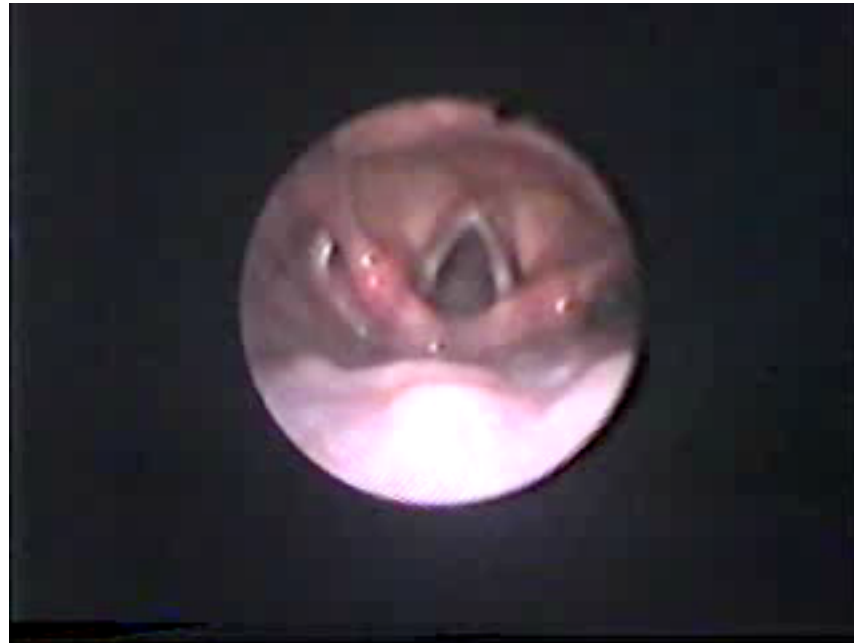


Figure 3: A snapshot of laryngeal state for voicelessness

Tumtavitikul et al. CSUN 2012.

a laryngoscopic video clip for voicing

Tumtavitikul et al. CSUN 2012.



a laryngoscopic video clip for voicing

Tumtavitikul et al. CSUN 2012.

In formal learning, place and manner of consonants are consciously learned. Acoustics of place and manner of articulation for consonants, **Voice Onset Time (V.O.T.) for stops (Abramson and Lisker 1970)**, waveforms for voicing and voicelessness will be implemented to enhance practices on consonant

For **vowel** production, **lip movement** video clips are shown as well as **First and Second Formant** frequencies for each vowel, and for all the nine places of vowel articulation for comparison

Tumtavitikul et al. CSUN 2012.

A snapshot of the video clip of the lip movement for the vowel /u:/, High Back Rounded long vowel “_u”

Tumtavitikul et al. CSUN 2012.



A snapshot of the video clip of the lip movement for the vowel /u:/, High Back Rounded long vowel “_u”

Tumtavitikul et al. CSUN 2012.

A video clip of the lip movement for the vowel
/u:/, High Back Rounded long vowel “u”

Tumtavitikul et al. CSUN 2012.



A video clip of the lip movement for the vowel
/u:/, High Back Rounded long vowel “ ”

Tumtavitikul et al. CSUN 2012.

Since Formant values are not absolute but vary from person to person as a function of vocal tract length. **The relative relation between F1 and F2, which is unique to each vowel and more or less, constant across speakers, is the target for each vowel production in TSS (Johnson 2006 cf. Fant 1960, Flanagan 1965, and Stevens 1972)**

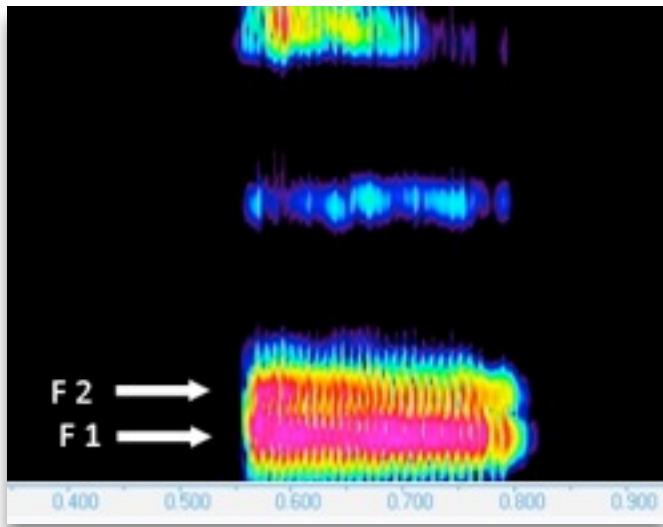


Figure 4a: Formant frequencies F1 and F2 of the short high back rounded vowel /u/ “ u ” (TSS male speaker)

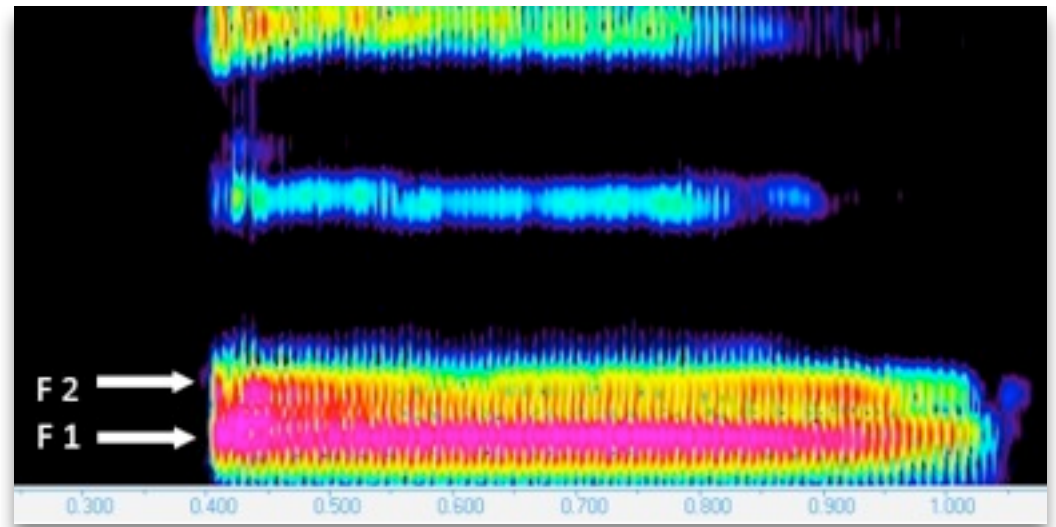


Figure 4b: Formant frequencies F1 and F2 of the long high back rounded vowel /u:/ “ u ” (TSS male speaker)

Thai Phonetics and Phonology for TSS

Model Speakers

A male and a female between 20-40 years old, both university graduates, born and raised in Bangkok, and graduates of prestigious high schools were selected to be TSS speakers and lip movement models.

Tumtavitikul et al. CSUN 2012.

Consonants

The place and manner of articulation of Thai consonants and IPA symbols in **TSS** are determined in compliant with **Tingsabadh and Abramson 1993**. Most controversial is the **alveolar trill /r/ “ร”** which is reduced to a flap [ɾ] /or merged with the lateral /l/ “ล” in speech.

In Thai schools, the consonant is taught as a trill. However, in actual speech either a flap or a lateral is used.

For preservation and correct pronunciation, the consonant is given as a trill in TSS. The simulation shows how a trill is produced with a brief explanation.

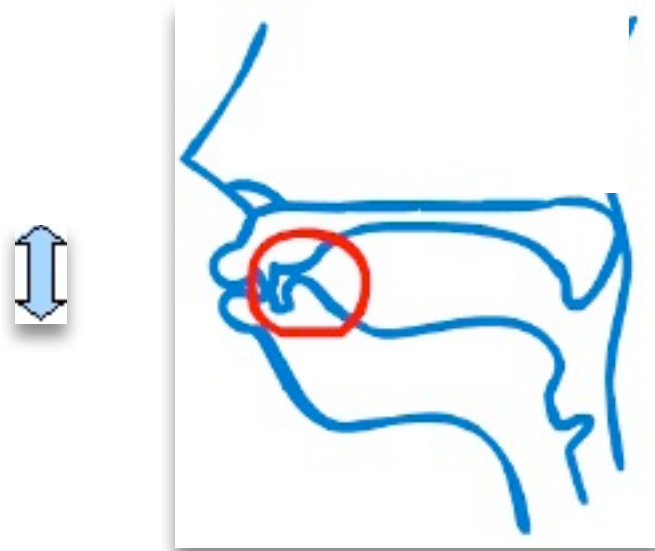


Figure 5: A snapshot of articulatory simulation for the Thai alveolar trill /r/ “ร”

Tumtavitikul et al. CSUN 2012.

It is natural that the sound will be reduced to a flap [ɾ] in casual speech. When the sound is mistakenly taught as a flap, it will be naturally reduced to a lateral and hence merges with /l/ “ล” in casual speech

Place \ Manner	Bilabial	Labio-dental	Alveolar	Post Alveolar	Palatal	Velar	Glottal
Unaspirated voiceless stop	[p] ป		[t] ต, ถ			[k] ก	[ʔ] ฮ
Aspirated voiceless stop	[pʰ] พ, ฟ, ภ		[tʰ] ท, ด, ถ, ฉ, ช, ส			[kʰ] ค, ข, ก, ฆ, ฉ, ช	
Voiced Stop	[b] บ		[d] ด, ต				
Unaspirated Affricate				[tʃ] จ			
Aspirated Affricate				[tʃʰ] ฉ, ช, ฉ			
Fricative		[f] ฟ, ภ	[s] ส, ซ, ศ, ษ				[h] ฮ, ฮ
Nasal	[m] ม		[n] น, ณ			[ŋ] ง	
Trill			[r] ร				
Lateral			[l] ล, ฬ				
Approximant					[j] ย, อย	[w] ว	



Figure 6: Consonant chart with IPA symbols, places and manners of articulation and corresponding Thai orthographic symbols

Vowels

The IPA vowel symbols in TSS are based on Tingsabadh and Abramson 1993, followed by Tumtavitikul 1996 as phonological vowels.

The acoustics of the vowels are in agreement with Abramson 1962 and Tumtavitikul 1996.

Tumtavitikul et al. CSUN 2012.

The controversial high and mid back unrounded vowels; /ɯ/, /ɯ:/ “” and /ɯ/, /ɯ:/ “” are shown to be acoustically closer to high and mid central unrounded vowels /ɨ/, /ɨ:/ and /ə/, /ə:/ in the IPA vowel chart respectively.

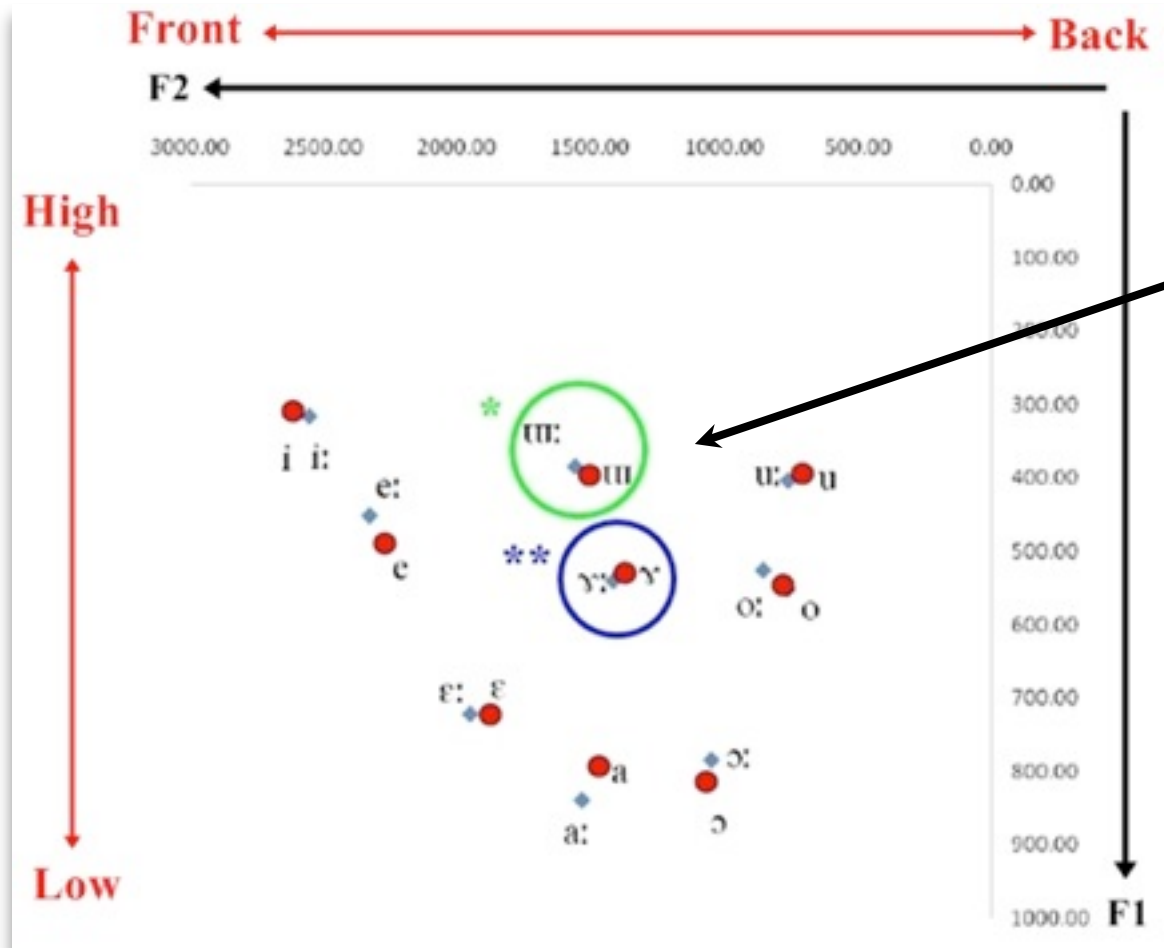


Figure 7: The relative relation among Thai vowels in the F/F2 acoustic vowel space (TSS male speaker)

Tumtavitikul et al. CSUN 2012.

Acoustic visual feedback is used in TSS to reinforce teaching/learning vowel production. All vowels are plotted in the **acoustic vowel space** to show the relative relation of the Thai vowels within the space which is quite constant across speakers

Tumtavitikul et al. CSUN 2012.

Tones

The five Thai tones categorized as **Mid, Low, Falling, High** and **Rising** are in general agreeable by linguists of Thai language.

A change on the shape of the high tone from high falling (Bradley 1910, Abramson 1962) to **high rising** (Gandour 1975, Abramson 1975, Tumtavitikul 1992, etc.) have been noted a diachronic change.

Tumtavitikul et al. CSUN 2012.

Mid and Low tones with F0 falls
have also been observed since
Bradley 1910. The extent of the
**F0 rise in high tone has become
much greater today**
(Teeranon 2007).

It is of interest that **in speech, F0 perturbation from adjacent tones** at both ends of the syllable occurs and the perturbation in Thai tones **is more highly preservatory than anticipatory assimilation** where prior tone takes effect into **over 50% of the adjacent tonal contour (Gandour et al 1994).**

Also, **tonal perception** is **greater at the third and fourth quarters** of the entire tone than the first two quarters due to relatively close F0 in the first two quarters among the tones resulting in confusion between Low and Rising, and High and Falling tones (Tumtavitikul 1992).

Tumtavitikul et al. CSUN 2012.

**Tonal contrast among the
five Thai tones are
maximized at the 50% end
portion of the tone**

Tumtavitikul et al. CSUN 2012.

The last 50% of the tonal contours is therefore, given emphasis in teaching/learning in TSS to enhance tonal distinction for effective communication.

Tumtavitikul et al. CSUN 2012.

Due to variations of **tonal contours** in individual speakers, the five tones are **displayed in normalized duration** for comparison. Since F0 values are not absolute and vary from person to person and from utterance to utterance, the overall shape for each tone is given emphasis with a fitted curve to enhance learning.

Tumtavitikul et al. CSUN 2012.

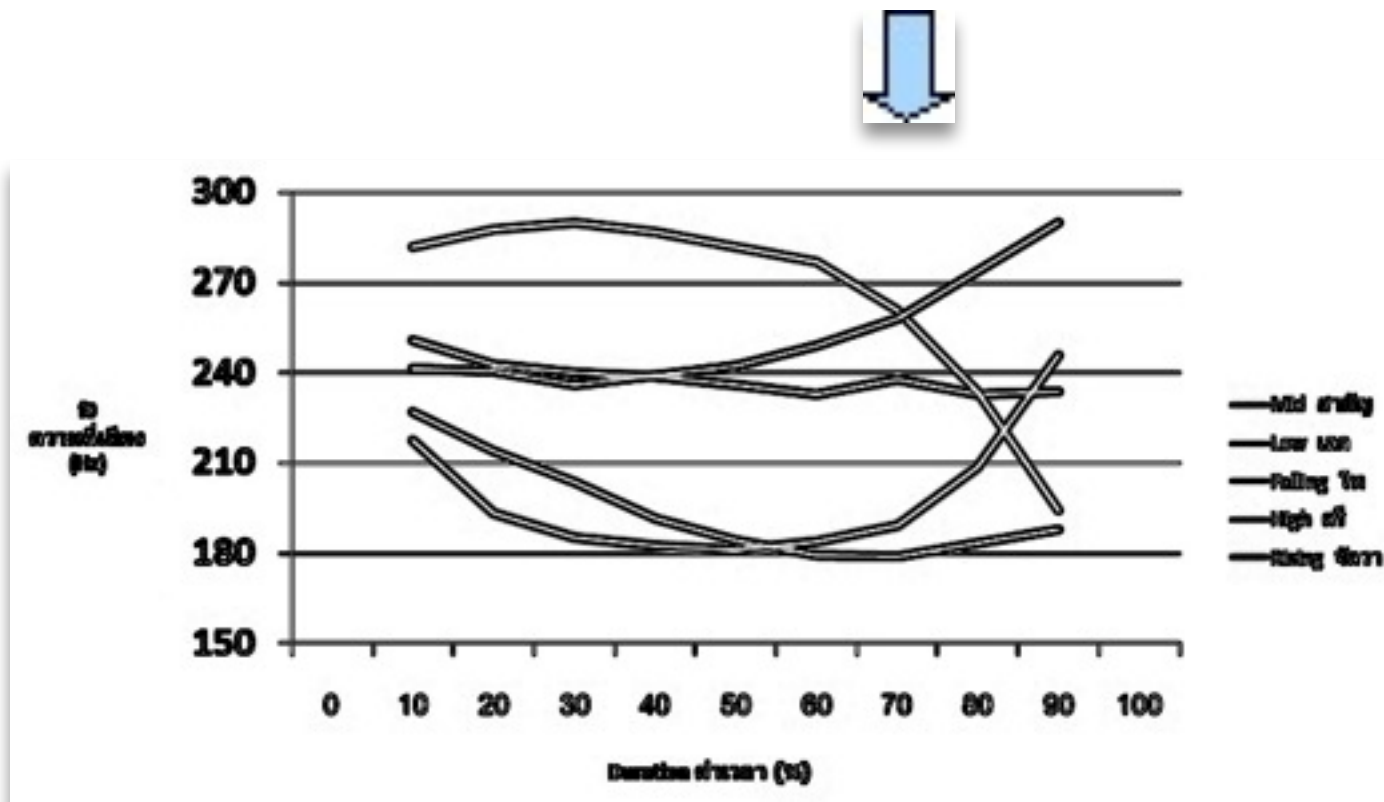


Figure 7: Five Thai tones in normalized duration with 10% at both ends trimmed to avoid effects of adjacent tones in speech. The five tones show maximal contrast at the last 50% portion of the tonal contours. The early 50% portion show comparable Mid and High (rise), and Low and Rising tone which may lead to confusion in perception. (Female speaker for TSS).

Tumtavitikul et al. CSUN 2012.

Thai Fingerspelling as an Add-on and Liaison

The uniqueness of TSS is the implementation of Thai Fingerspelling as the liaison between sound and written symbol, phoneme and grapheme.

This will simultaneously enhance basic reading and writing skills as learners learn sound production. A combination of sounds will automatically reinforce spelling in reading and writing alongside with fingerspelling.

**TSS modal is in line
with Multimodal
learning in facilitating
language learning
(Massaro 2012).**

It has been shown that the Thai
fingerspelling system
is based on phonetics, the
phoneme-grapheme
correspondences
in English, and English to Thai
sound correspondences
in Thai Romanization.

Tumtavitikul et al. CSUN 2012.

Handshapes in American Sign Language (ASL) fingerspelling are more than 50% iconic with regard to the English alphabet which is Latinate or Romanized (Koeher and Swanson 1994)

Without resorting to phonetics, the correlation between fingerspelling and Thai script is totally arbitrary and the 44 Thai alphabet letters for consonants and 32 vowel symbols will have to be all memorized with no or very little resemblance between handshapes and alphabet letters (Tumtavitikul 2009).

The correlation between
Thai fingerspelling and
Thai orthography is
simplified by articulatory
phonetics.

With the integration of a manual alphabet in fingerspelling, articulatory phonetics and orthography, learners will have both sound production as well as alphabet letters in correspondence with each other.

อักษรไทย (พยัญชนะ)	อักษรโรมันที่เทียบเคียงเสียง	
	ในตำแหน่งต้นคำ	ในตำแหน่งท้ายคำ
ก ข ข ฃ ฅ ฆ	k	k
ค	kh	k
ฌ	ng	ng
จ ฉ ช ซ ฌ ญ	ch	t
ฎ (ฎว)	s	t
ฌ ฌ ฌ	z	t
ญ	y	y
ฎ ฎ ฎ	d	t
ฏ ฏ ฏ	t	t
จ ฌ ฌ ฌ ฌ ฌ	th	t
พ ฟ	n	n
บ	b	p
ป	p	p
ฝ ฟ ฝ	ph	p
ฟ ฟ	f	p
ม	m	m
ย	y	-
ร	r	n
ล ล	l	n
ว	w	-
ห ฮ	h	-

ตารางที่ 1: เกณฑ์การถอดอักษรไทยเป็นอักษรโรมันแบบอักษะ (Thai Romanization) ๒๓1
 ราชบัณฑิตยสถาน 2542 (<http://www.rcgm.go.th/profile/index.php>)

Table 1: Groupings of Thai orthographic symbols for consonants and the corresponding English alphabet letters at syllable initial (2nd column) and syllable final position (3rd column). The correspondences are phonetically motivated.

Tumtavitikul et al. CSUN 2012.

Learners will not only learn the sound production of each consonant and its orthographic symbol in Thai writing system but its corresponding fingerspelling hand configuration as well.

**Multi-linear association
will result in facilitating not
only sound production basic
to speech but also, letter
combination basic to reading
and writing skills.**

Tumtavitikul et al. CSUN 2012.

Conclusion

Further development includes an updated self-access visual guide to cover acoustics of place and manner of articulation for consonants and **Voice Onset Time, stress** and **intonation** patterns as well as application for mobile devices for viable accessibility.

Tumtavitikul et al. CSUN 2012.

It is hoped that TSS will bring about improvement in basic sound production resulting in intelligible speech and better communication between the Thai deaf and the hearing, especially in critical situations when oral communication is called for.

Thai Sound System (TSS) at a glance

<http://rilc.ku.ac.th/Thai%20Sound%20System%20Online/Home.html>

Tumtavitikul et al. CSUN 2012.

Thank you

fhumalt@ku.ac.th

Tumtavitikul et al. CSUN 2012.