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Karlheinz Stockhausen's Stimmung and Vowel Overtone Singing

Wolfgang Saus, 27.01.2009

Karlheinz Stockhausen created STIMMUNG[1] for six vocalists in 1968 (first setting 1967). It is the first vocal work in Western serious music with explicitly notated vocal overtones[2], and is therefore the first classic composition for overtone singing. However, the singing technique in STIMMUNG is different from "western overtone singing" as practiced by most overtone singers today. I would like to introduce the concept of "vowel overtone singing," as used by Stockhausen, as a distinct technique in addition to the L, R or other overtone singing techniques[3].

Stockhausen demands in the instructions to his composition the mastery of the vowel square. This is a collection of phonetic signs, which describes the transitions of the vowels /u/−/a/, /a/−/i/, /i/−/œ/ and /œ/−/u/ on a quadrilateral.

"In this vowel square, each vowel has 2 numbers. They indicate the overtone which should dominate when the vowel is sung; the number below the vowel applies to low male voices (for example on the pitch 114 Hz), the number above the vowel applies to high male voices and low female voices (for example on the pitch 285 Hz). [...] The singers must therefore shift the overtone number depending on the register of their intonation (the higher the pitch, the smaller the mumber, i.e. the fewer of the prescribed vowels can be phonetically articulated)."[4]

Stockhausen uses the fact that the vocal formants represent pitches. They work like filters which always resonate when an overtone falls into the frequency domain of a formant. The overtone then can be heard prominently. The position of the formants is independent of the fundamental tone, it is only determined by the shape of the vocal tract. So it can happen that in a certain combination of fundamental and vocal timbre the formants do not meet overtones. When none of the overtones fall into the formant range, the tone colour seems more pale, softer, and less brilliant. Conversely, if one maintains the same vocal timbre and sings a portamento, then the formants remain constant on their pitch and the overtones emerge one after the other as their frequencies fall into the range of the vocal formant.

It is not immediately obvious from the score whether Stockhausen's numbering refers to overtones or partials. Since the fundamental is counted as partial number 1, the corresponding overtone position is always one lower. The 5th overtone is identical with the 6th partial. The tape chord of 7 sine tones mentioned in the performance material provides clarification. Its fundamental is indicated at 57 Hz, what corresponds to *B2* ♭ *−38 ct*. So Stockhausen's system is based on *A3* = 430 Hz, 38 cents lower than the common 440 Hz. However, he allows that the pitch is adapted to the vocal range of the singer provided that the 5th overtone is singable by everyone. The instruction "... the 5th overtone (here 285 Hz) must be singable by everyone..."[5] means: 285 Hz is the frequency of the 5th partial of 57 Hz. So Stockhausen's overtone numbers must be interpreted as partial numbers (harmonics).

Because of the numbering used, it must be assumed that Stockhausen indended the emphasis of the overtones by the second voice formant F2. No details are found in the score to corroborate this. Fig. 2 and 3 demonstrate how the vocal overtones meet the formants. The figures show the spectrogram of a complete vowel run by the vowel square. A creaking voice from a fast sequence of glottal stops was used which produces sound energy over the complete relevant frequency range. So the formants are displayed independent of overtones. As soon as the voice produces a tone, harmonic overtones arise in integer multiples of the fundamental frequency. This overtone scale is marked into the spectrogram exemplarily for two of the fundamentals from STIMMUNG, *B ♭ 2 −38 ct* (in the score noted as *B ♭ 2*) and *D ♭ 4 +48 ct* (5th partial of 57 Hz in the score written as *D4*). The prominent overtones result from the interfaces of overtones with F2 suitable for the respective vowel.

Fig. 2 and 3 also indicate interfaces of the partials with F1. The partials are stressed acoustically there too. However, the higher F2 is more dominant in our hearing and the partial in the F1 is more difficult to hear as an individal tone. It may be assumed also that Stockhausen rather heard F2 and used its resonances for the composition.

For any pitch on which overtones are demanded such a diagram

1 STOCKHAUSEN, K.: Stimmung "Pariser Version", Nr. 24 1/2, für 6 Vokalsolisten SSATTB : Universal Edition Musikverlag, 1968 – ISBN 978-3-7024-4555-3.

2 „STIMMUNG ist der historische Anfang des Obertonsingens in der Kunstmusik (mit Partitur, durchkomponierter Oberton-Notation, spezieller Vokaltechnik)“. " STIMMUNG is the historic beginning of overtone singing in art music (with score, through-composed overtone notation, special vocal technique). K. Stockhausen, in a letter to Martin Hebart (cited in a paper at the Johann-Sebastian-Bach-Gymnasium Windsbach 2001).

3 SAUS, W.: Oberton Singen. Mit Lern-CD: Das Geheimnis einer magischen Stimmkunst - Obertongesang erlernen mit dem Drei-Stufen-Selbstlernkurs. 3. Ed. Battweiler: Traumzeit Publishing House, 2008 – ISBN 3933825369.

4 STOCKHAUSEN, K.: Stimmung, S. IV.

5 STOCKHAUSEN, K.: Stimmung, S. II.

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can be prepared. This works particularly efficiently by using interactive sound visualizing software such as Overtone Analyzer (available at www.sygyt.com). With software help one can learn to practice and to check the tone colours and overtones very prcisely and independently of each other.

One can now easily comprehend the score and the vowel quadrilateral. The vocal timbre is adapted respectively so that F2 meets the figured overtone or "The singers must therefore shift the overtone number..." , as Stockhausen notices in the instructions to STIMMUNG,"...depending on the register of their intonation...". In other words, one selects the partial which meets the second formant, sappropriate to the vowel and pitch.

Notice that there are two vowels possible for most overtones in the vowel square which satisfy this condition (and still more, if one allows vowels also through the middle of the quadrilateral), with the exception of /i/ and /u/ which respectively represent extremes. With /i/ F1 is as low and F2 as high as possible. Both F1 and F2 are as low as possible with /u/. The variance comes from the fact that F2 is responsible for the overtone isolation and F1 can be positioned independently. A variable F1 in combination with a constant F2 creates different vowels or vowel nuances. An experienced overtone singer is able to accurately adjust F2 by means of the pharyngeal tongue (together with the epiglottis). One can also regulate F1 independently by the expansion of lips and jaw, as well as by the shape of the tongue blade in the anterior oral cavity. For overtone singers, the vowel overtone singing is precisely and consciously understood. The same understanding cannot be expected from classic singers, if their sound is based only on phonetic specifications.

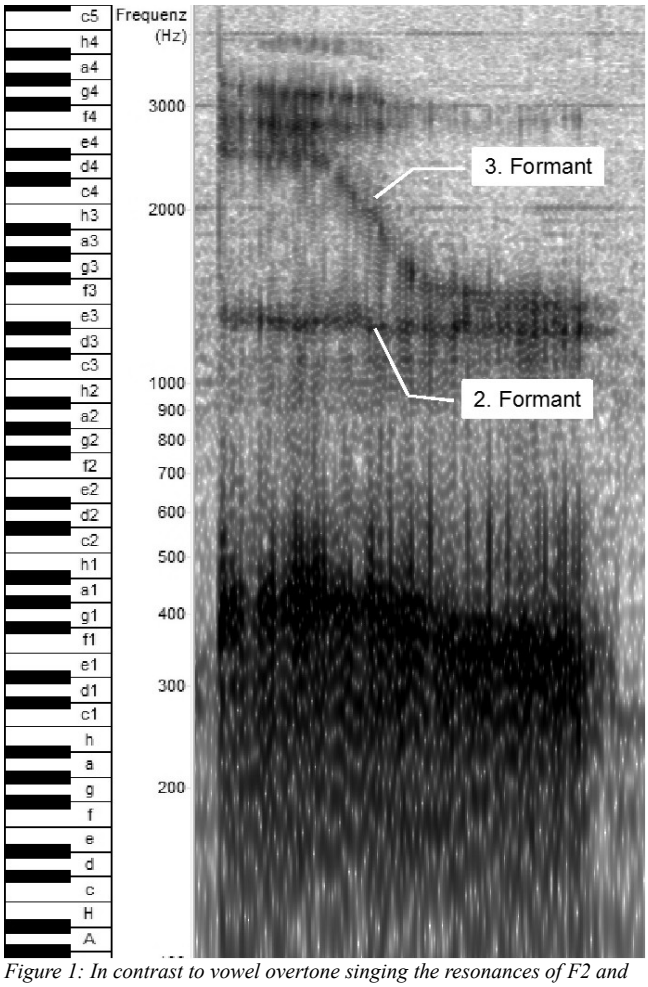

Figure 1: In contrast to vowel overtone singing the resonances of F2 and F3 are combined in „classical" overtone singing.

"Classical" overtone singing almost exclusively uses the vowel sequence /iyɪʏɨʉuuu/ which is indicated by moving F2. It is interesting that this sequence of vowels - right through from Stockausen's vowel square from /i/ to /u/ - does not occur in STIMMUNG. The overtones produced with /i/−/u/ vowels are particularly easy to isolate from the overall sound and make audible because all other formants are located as far away as possible from the second. Moreover, F3 is combined with F2 in overtone singing (fig. 1), in contrast to the vowel overtone singing in STIMMUNG. This is achieved by a post alveolar tongue position and a Helmholtz resonator produced under the tongue by means of a simultaneous lowered floor of the mouth. Thus the resonating overtone acquires the flute-like emphasis typical of overtone singing. This extreme acoustic separation of the overtone is not demanded in STIMMUNG. Stockhausen did not know of overtone singing when he wrote STIMMUNG[6]. Rather, he had discovered soft overtone melodies in vowel transitions during self experiments[7].

Secondary web links:

www.stockhausen.org
http://home.swipnet.se/sonoloco2/Rec/Stockhausen/12.html
www.universaledition-shop.com/shop/en_UK/1/show,97526.html
www.sygyt.com
www.oberton.org

6 In his own words in a letter.
7 http://home.swipnet.se/sonoloco2/Rec/Stockhausen/12.html

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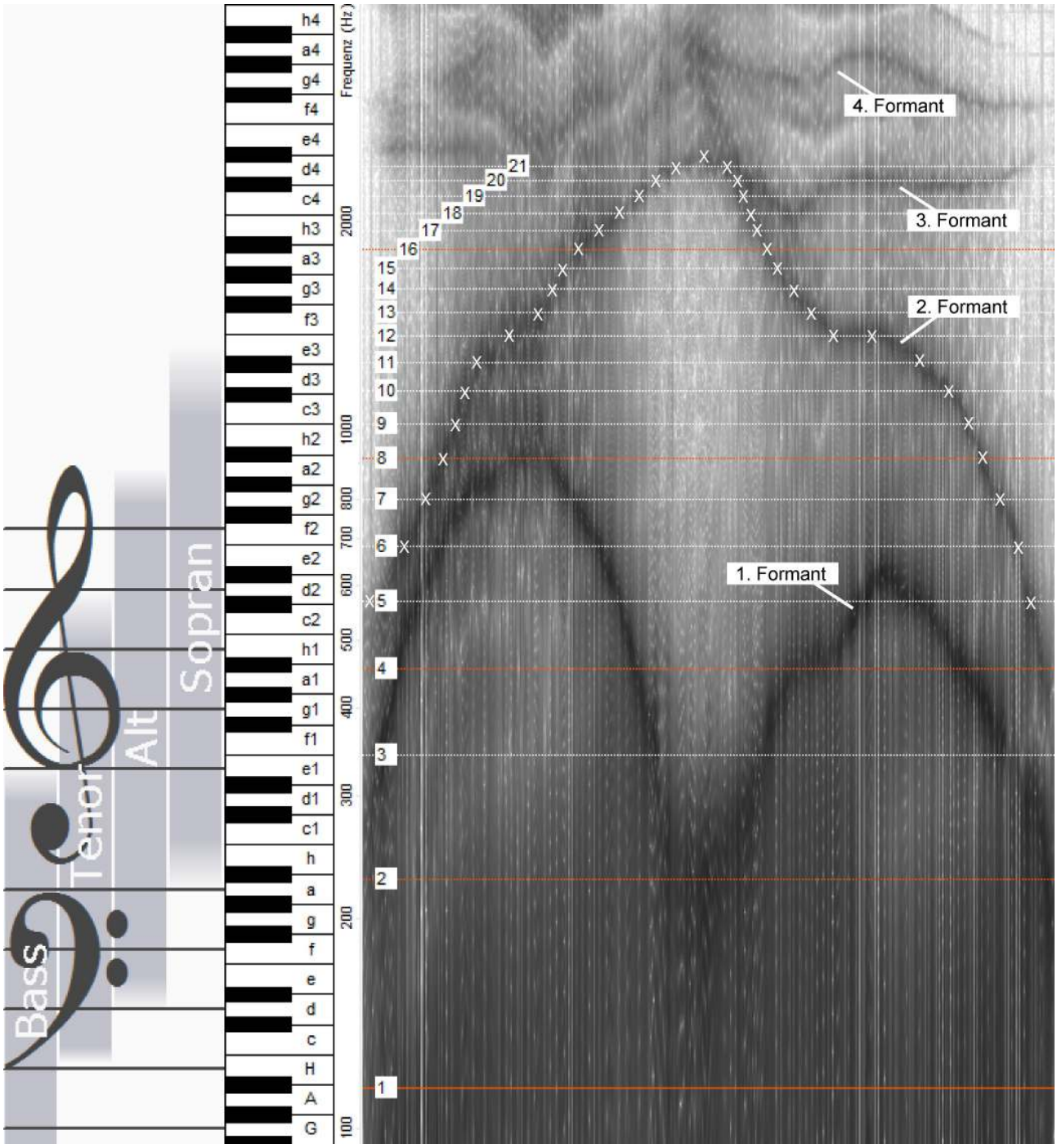

Figure 1: Bass B ♭ 2 −38 ct with selected intersections of the harmonics with the 2nd formant. The positions of the IPA Characters are in approximate position and to be understood as a guide only. (Created with Overtone Analyzer, www.sygyt.com).

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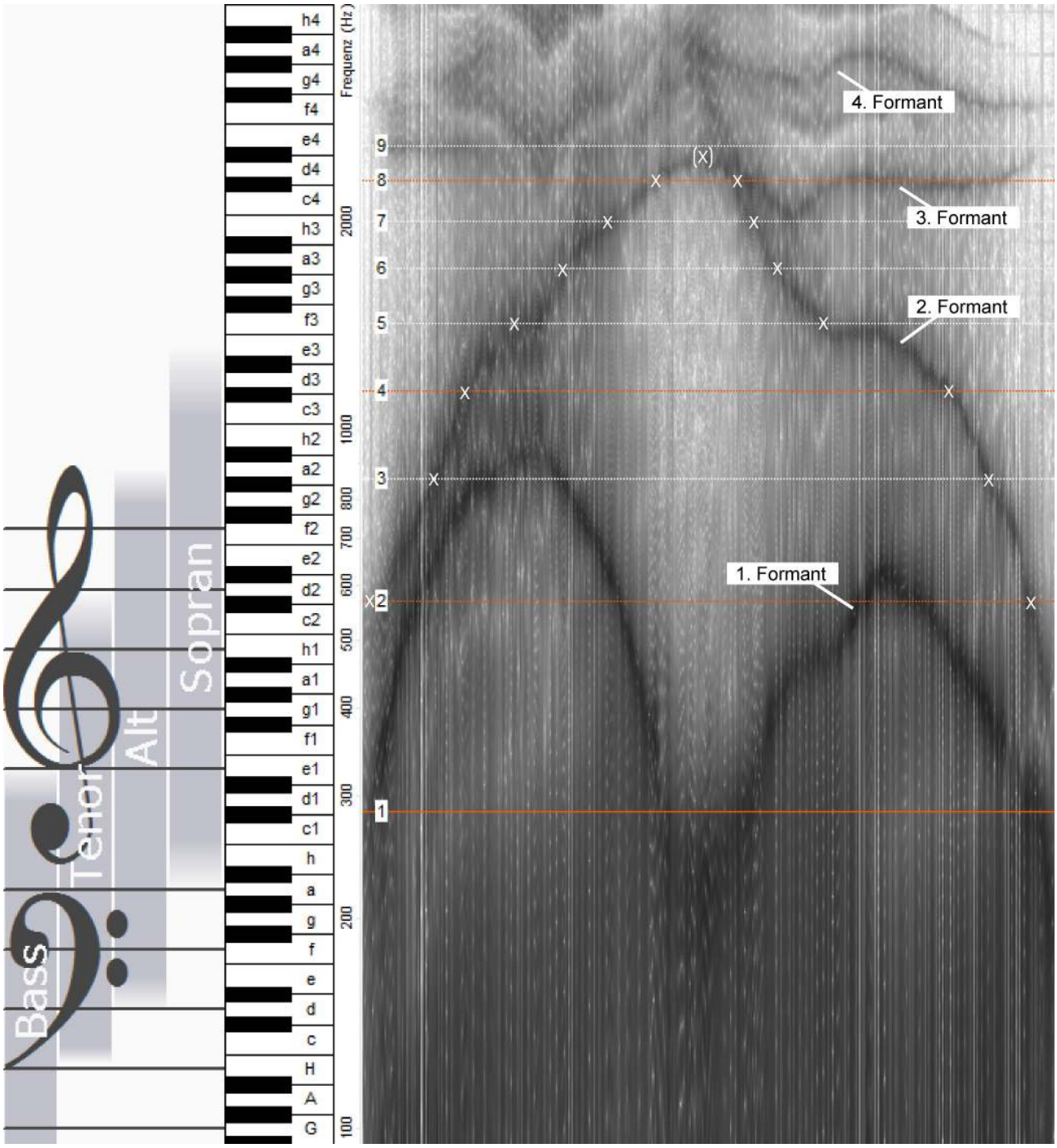

Modern:	u	o	ɔ	ɒ	ɑ	a	æ	ɛ	e	ɪ	i	y	ɨ	ʏ	ø	œ	ɐ	ɵ	ʊ	u
Stockhausen:	(u)	uo	[ɔ]	ɒɑ	(a)	æ	[ɛ]	e	ɪ	(i)	ɨ	y	[ʏ]	ø	(œ)	ə	ɯ	[ʊ]	ʉ	(u)
	2	3	4	5	6	7	8	10 (9)	12 (10)	10 (9)	8	7	6	5	4	3	2									

Figure 3: Soprano D ♭ 4 +48 ct, marked intersections of the harmonics with the 2nd formant. The positions of the IPA Characters are in approximate position and to be understood as a guide only. (Created with Overtone Analyzer, www.sygyt.com).