

Research and Technology in the Opera *Der Sprung*

Georg Hajdu

Hochschule für Musik und Theater Hamburg

Abstract

In this paper the opera *Der Sprung – Beschreibung einer Oper* is being discussed in light of its biographical, historical, musical and technological contexts. The opera is the result of a unique collaboration between librettist Thomas Brasch and the author. Its harmonic and formal structure is entirely generated from a short motto by Brasch, using advanced technology for spectral analysis and computer composition. Historically, the opera could be characterized as a late example of the exploratory phase in computer music.

Dieser Aufsatz diskutiert die Oper *Der Sprung – Beschreibung einer Oper* in ihren biographischen, historischen, musikalischen und technologischen Kontexten. Die Oper ist das Resultat einer außergewöhnlichen Zusammenarbeit zwischen dem Librettisten Thomas Brasch und dem Autor. Ihre harmonische und formale Struktur wurde mit fortgeschrittenen Verfahren zur Spektralanalyse und Computer-unterstützter Komposition aus einem kurzen Motto Braschs abgeleitet. Geschichtlich kann die Oper als spätes Beispiel der explorativen Phase in der Computermusik bezeichnet werden.

1. Introduction

The opera *Der Sprung – Beschreibung einer Oper* was the result of several intersecting lines - lines of biographical, historical, technological and scientific relevance with aspects of serendipity and hard work. In the following I will trace these lines and reconstruct the making of this piece, which took a decade to conceive and 4 years to complete.

The years 1984 to 1998 mark the beginning and end of this process, in which I mutated from a molecular biologist with a second major in music into a professional composer and music-school professor with continuous strong interests in computer technology and science.

Moreover, these years also witnessed technological advances, which went from the development of the first Apple Macintosh computer to the introduction of affordable computers that were fast enough to enable users to perform complex tasks such as DSP in real time with novel software.

Finally, these years also brought about a dramatic development of the areas of cognitive psychology and neurology, which elucidating the mechanisms of perception and cognition, are increasingly re-shaping the fields of music theory and composition.

2. The story

In 1992, when I decided to write an opera (at that time I lived in California as a recipient of a DAAD scholarship) I resorted to an article by Viennese journalist Erika WANTOCH WHICH HAD BEEN PUBLISHED IN THE AUSTRIAN MAGAZINE PROFIL IN MARCH OF 1984. She had written an impressive account of a philosophy student who in a mad fit had killed a professor and wounded his colleague a few weeks earlier. I had a clear recollection of the incident since it happened in my former hometown Cologne: My brother had almost witnessed this terrible crime committed in a university seminar he took for credit, but he had already shown more interest for his acting than for his Hebrew lessons,.

The next step was to find the ideal author with an interest in twisted stories. Again, it was my brother Daniel who played a crucial role in finding this very person, since as an actor he knew numerous theater people. He got me in touch with Thomas Brasch and, in 1993, I had the opportunity to meet and work with him twice for several weeks in San Francisco. I didn't know at the time though, that BRASCH (1999) was THE specialist for morbid topics (which he demonstrated with novels such as "Mädchenmörder Brunke.")

Besides my personal interest in the topic, it was apparent that the story also had a historical relevance. In West Germany, in the 1980s the society slowly opened up to facing the implications of the 3rd Reich and the Jewish holocaust (mainly triggered by a Hollywood film named *Holocaust*), while in the 1970s any curiosity was typically met with a wall of silence. These were the grounds off which the protagonist's mind had been feeding. Identifying with the Jewish trauma and even converting to Judaism, she had increasingly retreated into a state of paranoia, convinced that she had to eradicate the source of her discomfort: The German Christian professors who had been teaching Jewish studies at the Cologne Martin-Buber institute. She thus became some sort of lonely Ulrike Meinhof, fighting for the Jewish cause.



Figure 1. Thomas Brasch (on the right) and the author standing at a street corner in Berkeley, California (picture taken in 1993).

3. The making of *Der Sprung*

3.1 The libretto – result of a unique interaction

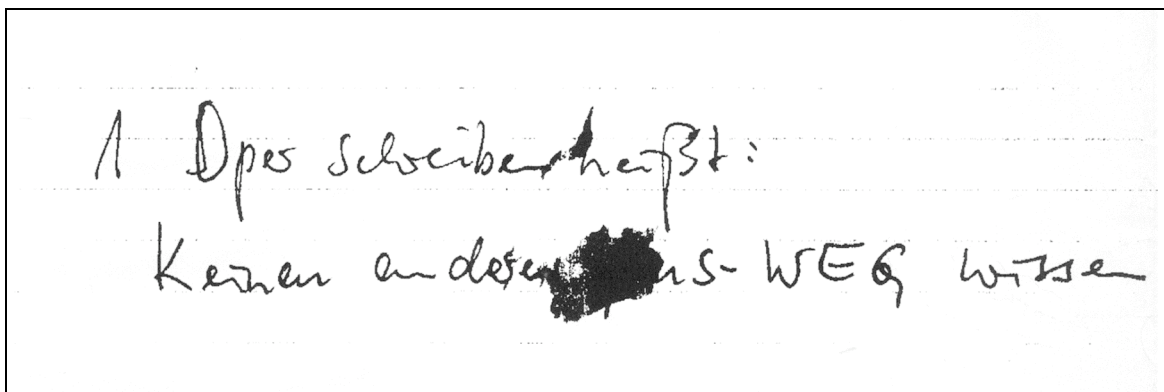
Thomas Brasch, a rebel and notorious celebrity in East Germany, author, poet and filmmaker, was born in 1945 in England to Jewish communist parents and grew up in the East-German nomenclatura. He protested the Soviet invasion of Prague in 1968, was thrown in jail and finally forced to leave his country in 1973; he died in 2001 at the age of 56. Brasch had an instant knack for the story. He was impressed by its depth which reached from a Dostoyevskian murder novel, aspects of guilt and redemption in post-war Germany (East and

West), the mad woman opera topos to questions of Jewish and German identity and the Rolling Stones singer Mick Jagger as the personified devil¹.

Thomas Brasch also embraced my approach to base the opera on a computer-generated process, which was consistent with the fact that the protagonist had felt remote-controlled by a computer in the period leading up to the assault. During his stay in San Francisco and the months afterwards, we had a fruitful exchange in such manner that every step in the creation of the opera was the prerequisite for a new step.

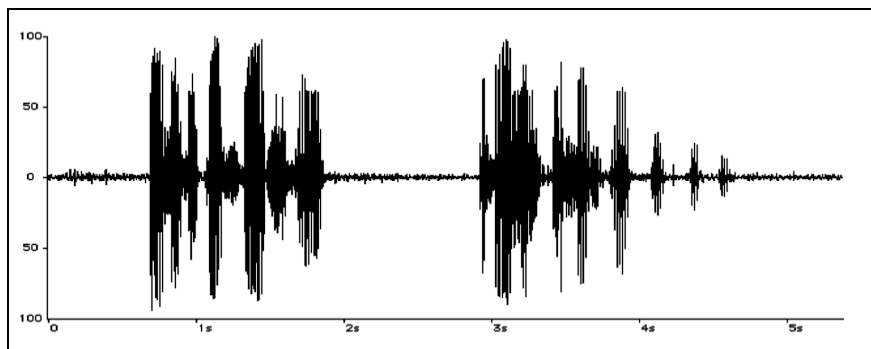
While in traditional operas, the librettist delivers the text to the composer which he or she turns into a musical score (a two-layer process), seven consecutive steps can be distinguished in the making of *Der Sprung*:

a. A written motto (Brasch)

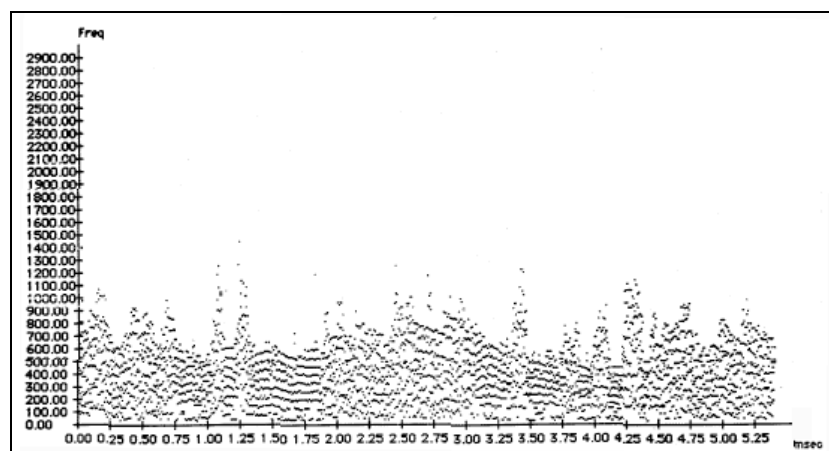


¹ Obviously, there are also interesting neurological implications in *Der Sprung*. The protagonist may have suffered from an imbalance called Fregoli's delusion (CARTER 1999). With this type of delusion the sufferers usually lose the ability to tell foreign faces from familiar ones, which can lead to a highly paranoid state of mind.

b. The recording of the motto onto an answering machine (Brasch)



c. Frequency and temporal analysis of the sample (Hajdu)



d. The formal plan derived from the analysis (Hajdu)

Die Oper 30' Das Oper ständchen heißt, ist ein solches Antwort vokal.											
Prolog 11'40" Stunde	1. Akt 11'40" Stunde										Intermezzo 11'40" Stunde
11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde
11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde
11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde
11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde	1. Akt 11'40" Stunde

e. The libretto derived from the formal plan (Brasch)

Prolog	1. Act	Intermezzo	2. Act	Epilog
Jetzt würde sie es schaffen...	Ich kannte sie, Herr Kollege...	Jetzt ist der Scheitelpunkt endlich erreicht...	Die Zuschauer wollten eine Erklärung...	Ich stürze ab...
	Wir hatten immer ein gutes Verhältnis zu ihr...		Sie habe mich schon früher gekannt...	
	Heute habe ich beschlossen...		Eine andere Sprache sprechen...	

	Die Waffe soll eine aus dem Mittelalter sein...		Die Grenze überschreiten...	
--	---	--	-----------------------------	--

f. Improvisation of “answering machine poetry” (Brasch)

Ja, das bin ich, Georg. Schade, dass Du das nicht aufzeichnest, aber ich versuch's trotzdem:

*Als wär' das Singen aller Menschen gut,
als könnte man doch wirklich eine Oper neu erfinden,
als könnte man wie schon früher singen,
als könnte man sagen: „Das ist eine Handlung!“,
und so als wäre es eine große stumme Wandlung,
als wäre es immer noch, als wär'n die Noten so gehetzt,
als müsste man von einer Frau, die schießt - und nicht genau -
so sagen: „Das ist zu schnell, das ist zu schnell!“*

g. The score based on the libretto (Hajdu)

The musical score is for a piece titled "The score based on the libretto (Hajdu)". It features five staves: FM Celeste, FM Bells, (Pedal), Tenor 1, and Bass 1. The FM Celeste staff has a treble clef and a key signature of one sharp (F#), with dynamics *mf* and *mp*. The FM Bells staff has a treble clef and a key signature of one sharp. The (Pedal) staff has a bass clef and a key signature of one sharp. The Tenor 1 staff has a treble clef and a key signature of one sharp, with a dynamic of *mf*. The Bass 1 staff has a bass clef and a key signature of one sharp. The lyrics are: "Ich kann - te sie, Herr Kol - le - ge, als ei - ne bril - lan - te Den - ker -". The score includes various musical notations such as triplets, slurs, and dynamic markings.

3.2 A word on contemporary opera

Since Morton Feldman's *Neither* the notion of opera is open to dispute. As a composer I wondered: Why not writing an opera in which the scenery is created in the mind of the listener, facilitated by the use of videos and audio samples; an opera that doesn't even need singing? I imagined the writing of an evocative music — a music that was able to tell a story solely by using stylistic allusion similar to John Zorn's *Kristallnacht*. I asked Brasch explicitly to not write a text in dialog form. But in the end, it was due to the evocativeness of the human voice that I didn't do away with singing after all; there are even allusions to the operatic genre. For instance, I wanted to keep the differentiation in recitative and aria. Only, the recitatives were turned into radio plays framing the two acts. It is the radio plays that advance the opera by yielding information. The acts with its two times four numbers create atmosphere and ambience. Though, I did abandon the unity between the singer and his/her role: Since, as I stated before, the opera was supposed to be created in the mind of the listener, a singer was allowed to personify several roles (HÜPPE 1999).

While composing the scenes, I was confronted with a particular difficult task: Giving each scene its own stylistic identity, while keeping the coherence of the whole. I solved the problem by deriving an omnipresent, time-stretched stream of sound from Brasch's recorded motto "Writing an opera means having no other way out." In the next step I adapted the spectral harmony (i.e. chords derived from the overtones of Brasch's speech) to the compositional requirements of the scenes in question: In the first scene of the first act, I approximated the sounds to a microtonal scale which subdivides the perfect twelfth into 13 equal steps. In the second scene I employed bird songs—sampled songs and melodies stylized by Messiaen, which I approximated to the spectral harmonic progression. In *Intermezzo*, the spectral chords, enriched by scalar pitches, serve as the basis for an algorithmic, interactive process, in which the choir is treated like an acoustic synthesizer. In the second scene of the second act, following an episode with Klezmer music, a surreal waltz is built out of transposed spectral pitches. In the third scene, the pitches of an ever-descending 19-tone scale collide with and are subsequently harmonized by overtones, while, at the end of the fourth scene, motives of the preceding scenes are recapitulated—once again adapted to the corresponding notes of the spectral chord progression. Hence, Brasch's motto, which is heard in fragmented form during the last scene's electronic episode, permeates inaudibly almost every compositional detail – very much like Stockhausen's formula composition technique.

3.3 Spectral analysis

The total duration of the sentence Brasch spoke onto my answering machine was 5.4 seconds. The sample was subject to a McAulay-Quatieri² type of Fourier analysis (MCAULAY and QUATIERI 1986).

A FFT frame size of 10 ms yielded 540 continuous spectra with 100-200 partials. Their temporal succession was expanded by a factor of 1000 to *Der Sprung*'s total duration of 90 minutes. Of the over 200 spectral components, only the 24 strongest were retained and used as pitch material. After time stretching, each frame's duration is 10 seconds. Thus, the succession of the 540 frames, i.e. 540 chords, determined the harmonic rhythm as well as the formal structure of the entire opera.

Frequency analysis also revealed the existence of two types of spectral material, which had far-reaching structural consequences:

- a. Phonetic material (deterministic) based on vowels and consonants was worked into two acts with 4 scenes each. These scenes are characterized by operatic gestures, quotations and pastiches.
- b. Statistic material (derived from answering-machine noise; indeterministic) was worked into radio plays (*Prolog*, *Intermezzo*, *Epilog*)

² "Using overlapping windowing methods similar to standard short time analysis, the MQ method computes Fourier transforms of the individual windows. The peak frequencies of each window (the partials) are found and their amplitudes and phases are extracted. The partials for each window are linked to those in the following window in order to develop a trend in the progression of frequencies (their amplitude and phases). We call each progression a track." (www.owl.net.rice.edu/~elec301/Projects02/lorisFor/mqmethod2.html).

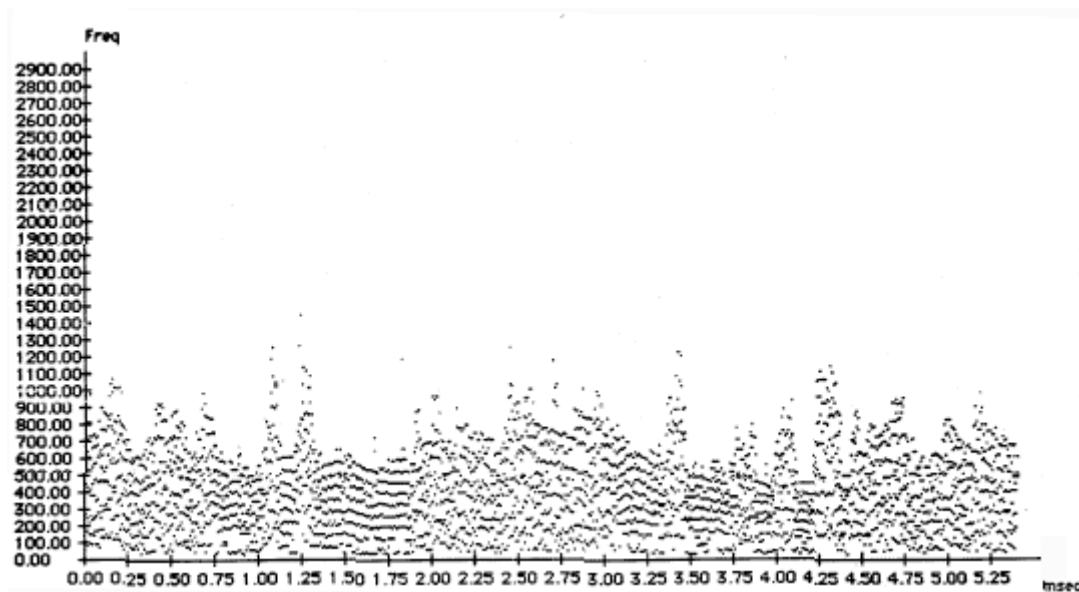


Figure 2. Spectrogram of the eight strongest components. Notice the nearly perfect alignment of the partials in segments with harmonic content (vowels).

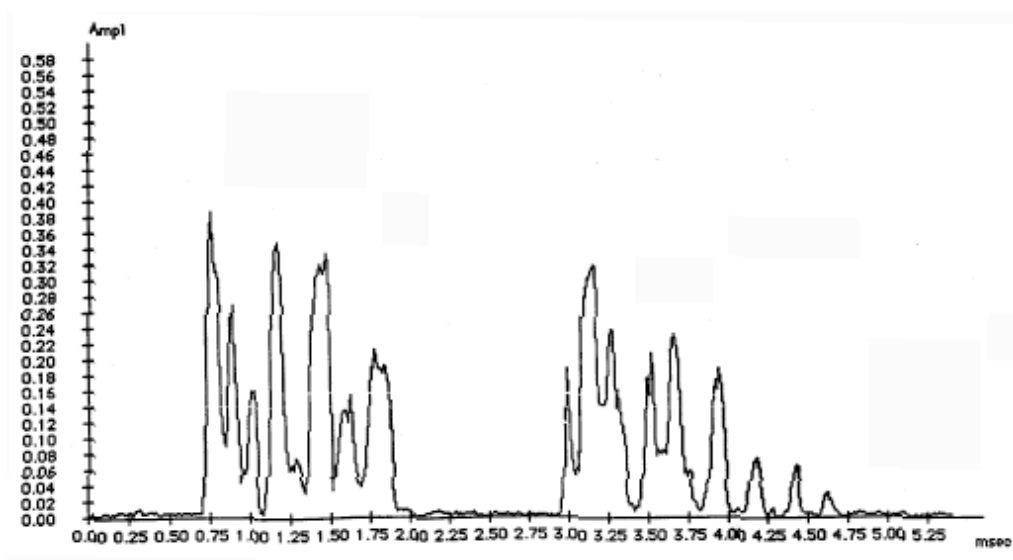


Figure 3. Summing up the amplitudes for the partials shows the boundaries between the sonic events. These events were turned into parts, scenes and sections. The flat areas correspond to the answering machine noise.

BRASCH (2002) wrote his libretto strictly adhering to the given structure: The texts entitled A., B. and C. (see appendix) differ from the rest in that they feature the inner monolog of the protagonist, whereas the other eight texts are more descriptive.

Before subjecting the harmonic material to a composition process, the numerical data had to be translated into musical notation in three steps: Frequencies and amplitudes were converted into MIDI cents³ and key velocities and finally into (eighth-note) notation. The translation

³ MIDI cent values are derived by combining absolute MIDI key numbers with the relative cent scale, by multiplying key numbers by 100 and adding an offset in cents.

was achieved by using applications I wrote in the programming environment Max and modeled after the composition environment PatchWork (later renamed to OpenMusic).

Table 1 lists typical spectra from five different regions (format: index, frequency amplitude).

Spectrum # 27	Spectrum #150	Spectrum #200	Spectrum #299	Spectrum #501
1, 102.73 0.000406;	1, 42.32 0.002289;	1, 56.15 0.002908;	1, 189.11 0.002685;	1, 99.36 0.000246;
2, 189.54 0.000287;	2, 161.38 0.001966;	2, 159.42 0.00169;	2, 286.35 0.008844;	2, 236.98 0.000443;
3, 247.48 0.000388;	3, 240.71 0.010502;	3, 229.97 0.000474;	3, 411.55 0.009397;	3, 298.09 0.000206;
4, 325.56 0.000149;	4, 281.04 0.019742;	4, 319.48 0.000824;	4, 509.98 0.02783;	4, 356.08 0.000239;
5, 402.96 0.000556;	5, 393.35 0.006564;	5, 497.84 0.000304;	5, 599.31 0.005647;	5, 546.65 0.000311;
6, 515.69989 0.000255;	6, 461.66 0.004629;	6, 614.63 0.000134;	6, 691.43 0.0057;	6, 577.84 0.000107;
7, 588.77002 0.000127;	7, 510.61 0.00339;	7, 623.52 0.000237;	7, 815.32 0.010416;	7, 732.05 0.000123;
8, 664.969971 0.000114;	8, 614.60 0.001719;	8, 700.92 0.00012;	8, 920.34 0.005869;	8, 830.30 0.000073;
9, 741.52 0.000261;	9, 672.34 0.001289;	9, 784.03 0.000063;	9, 942.91 0.005315;	9, 905.47 0.000065;
10, 898.90 0.000138;	10, 746.16 0.001492;	10, 851.21 0.000117;	10, 1056.31 0.006888;	10, 976.90 0.000082;
11, 1074.25 0.000335;	11, 819.02 0.000481;	11, 959.19 0.00022;	11, 1202.61 0.004601;	11, 1085.23 0.000093;
12, 1080.84 0.000185;	12, 918.42 0.000719;	12, 1054.93 0.00011;	12, 1353.10 0.009476;	12, 1317.03 0.000038;
13, 1208.52 0.000104;	13, 980.44 0.000744;	13, 1107.14 0.00004;	13, 1439.47 0.003693;	13, 1397.47 0.000047;
14, 1243.73 0.000142;	14, 1035.26 0.000924;	14, 1304.76 0.000122;	14, 1530.75 0.021652;	14, 1504.69 0.000072;
15, 1384.01 0.000168;	15, 1115.85 0.001549;	15, 1418.68 0.000059;	15, 1558.65 0.004553;	15, 1598.52 0.000066;
16, 1491.96 0.000103;	16, 1211.43 0.001399;	16, 1481.14 0.00006;	16, 1683.80 0.003261;	16, 1690.39 0.000029;
17, 1578.68 0.000113;	17, 1265.98 0.001934;	17, 1644.00 0.000039;	17, 1749.76 0.003415;	17, 1933.15 0.000064;
18, 1640.39 0.000176;	18, 1353.09 0.000955;	18, 1890.64 0.000038;	18, 1830.10 0.002067;	18, 2104.56 0.000037;
19, 1857.25 0.00009;	19, 1522.85 0.000251;	19, 1993.53 0.000054;	19, 1917.61 0.001172;	19, 2435.38 0.000036;
20, 2215.92 0.000108;	20, 1579.85 0.000252;	20, 2065.57 0.000039;	20, 2076.85 0.003231;	20, 2668.31 0.00003;
21, 2293.81 0.000117;	21, 1657.92 0.000465;	21, 2335.64 0.00004;	21, 2169.67 0.00357;	21, 2782.48 0.000034;
22, 2294.10 0.000103;	22, 2232.92 0.000277;	22, 2797.28 0.000039;	22, 2248.68 0.002475;	22, 3123.71 0.000035;
23, 2696.56 0.000101;	23, 2254.14 0.000577;	23, 3122.45 0.00005;	23, 2326.06 0.002285;	23, 3792.86 0.000031;
24, 2766.48 0.000097;	24, 2326.82 0.000346;	24, 3260.09 0.000038;	24, 2874.72 0.001436;	24, 4111.43 0.000029;

Translation into MIDI cents and key velocities, a logarithmic scale such as dB, yields the next table (negative key velocities belong to partials below the hearing threshold; data format: index, MIDI cent velocity):

Spectrum #200			
1, 3336 41;	7, 7504 4;	13, 8498 -21;	19, 9516 -17;
2, 5143 33;	8, 7706 -5;	14, 8782 -5;	20, 9577 -21;
3, 5777 14;	9, 7900 -14;	15, 8927 -15;	21, 9790 -21;
4, 6346 23;	10, 8042 -5;	16, 9001 -15;	22, 10102 -21;
5, 7114 8;	11, 8249 3;	17, 9182 -21;	23, 10293 -18;
6, 7479 -3;	12, 8414 -6;	18, 9424 -22;	24, 10367 -22;

And finally, MIDI cents data are converted into musical notation⁴:



⁴ Although this spectrum was extracted out of the answering-machine noise, it shows the typical characteristics of a harmonic spectrum: Large intervals in the lower frequency region and increasingly smaller ones towards the higher region. This is due to a desired artifact of the analysis program.

4. Excursion I: A new approach to composition

4.1 Spectral composition

At this point, it seems necessary to open up a parenthesis in order to further elucidate the compositional and theoretical contexts of *Der Sprung*. The term *spectral composition* is usually associated with the names of French composers Gérard Grisey and Tristan Murail, who founded the new music ensemble *L'Itinéraire* in 1973 (DUFORT 1979). Grisey and Murail, among others, were searching for novel ways to organize music harmonically, deriving harmonies from harmonic and inharmonic spectra of instrumental sounds and re-orchestrating them for acoustic and occasionally electronic instruments, thus the term *spectral composition*. Among the major pieces written in this technique are *Les Espace Acoustiques* (1973-85) for ensembles of varying size by Gérard Grisey, and *Gondwana* (1980) for large orchestra by Tristan Murail. Spectralism is rooted in the tradition of French music going back to Messiaen and Debussy.

Clarence Barlow took a slightly different approach in his ensemble composition *Im Januar am Nil*, (1984) in which he orchestrated spectra derived from speech. For this, he invented a number of nonsense phrases limiting his choice of phonemes to vowels and consonants, avoiding fricatives and plosives—phonemes with high-frequency noise components.

4.2 IRCAM

The *Institut de Recherche et Coordination Acoustique/Musique* was founded by Pierre Boulez in 1974 as a place where musical and acoustic research and artistic creation were supposed to form a symbiosis. Since its foundation it attracted many great minds, which have invented, designed and composed groundbreaking works. Among these inventions are the *4X* (1981), one of the first real-time sound processors, the *IRCAM Signal Processing Workstation ISPW* (1990) and the programming and patching environment *Max*, written by Miller Puckette in 1986, for the purpose of controlling the *4X* computer. Other important developments are the *OpenMusic*, *Modalys*, *Diphone* and *Audiosculpt* software applications. One of IRCAM's outstanding researchers is Xavier Rodet who has been working on countless projects involving analysis and resynthesis of sound. His residency at CNMAT (UC Berkeley) has spurred the development of sound analysis tools, which were the basis of *Der Sprung*. His collaboration with CNMAT's Adrian Freed (WRIGHT et al. 1998) also led to the creation of the flexible *Sound Description Interchange Format (SDIF)*.

OpenMusic is a visual music programming environment developed by Carlos Agon and Gérard Assayag (ASSAYAG et al. 1999) on top of the programming language *LISP*. Despite its similarity to *Max/MSP*, it is a non-real application mainly created to facilitate the design of compositions. It disposes of numerous libraries for spectral and algorithmic composition, a constraints library and the *maquette* patching window for modeling compositional processes. *OpenMusic* also possesses a number of import and export functions which make it an ideal interface between different applications such as *Diphone*, *Max/MSP*, and the music notation program *Finale*.

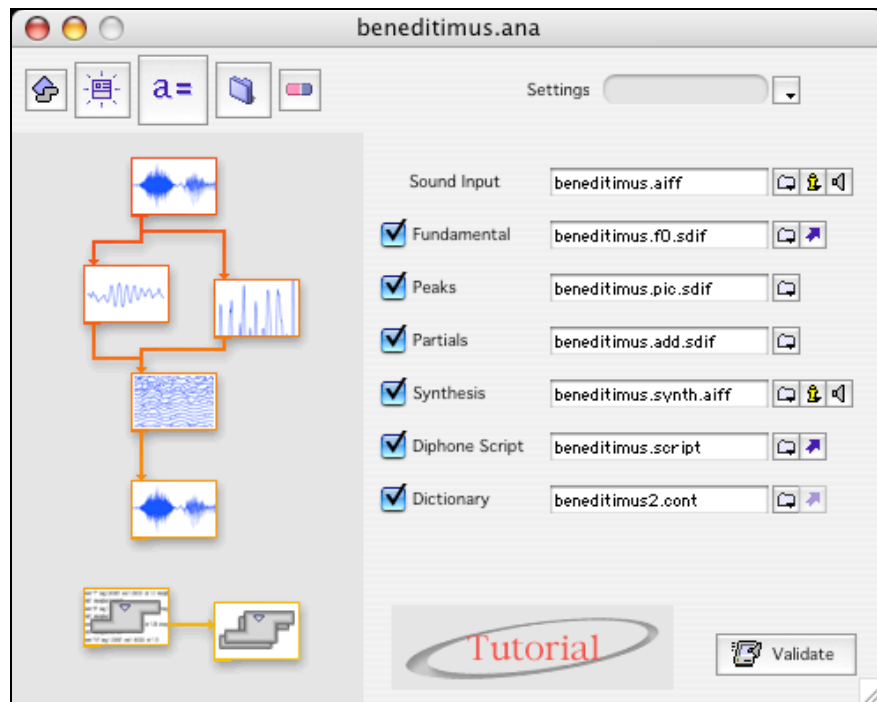


Figure 4. Screen shot of *AddAn*: The *Diphone* release contains *AddAn*, an application similar to the program employed in 1994 for spectral analysis of Brasch's sentence.

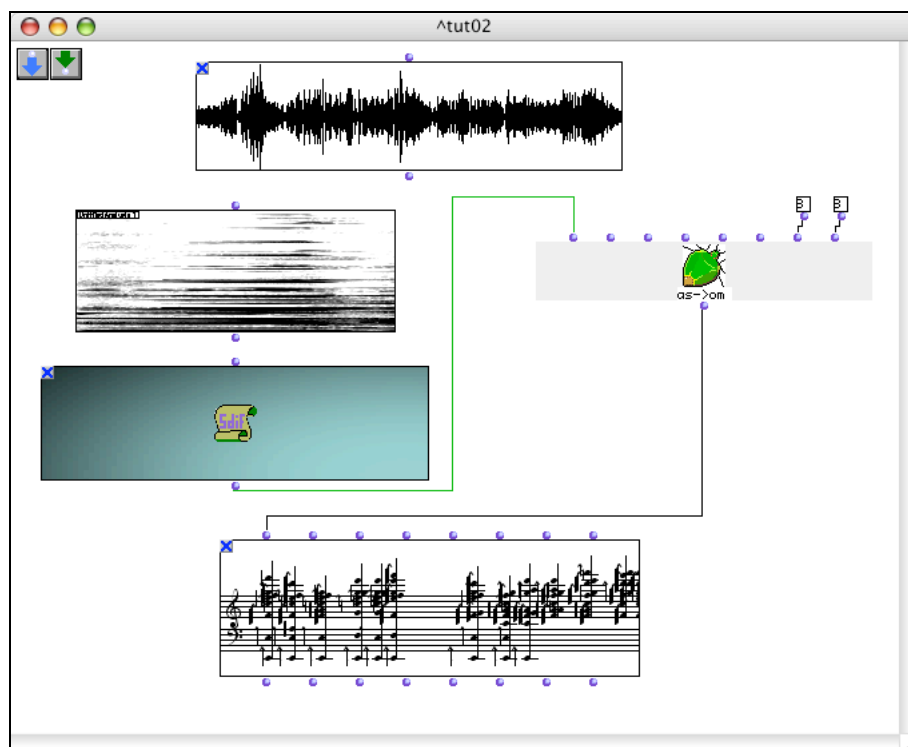


Figure 5. Screen shot of an *OpenMusic* SDIF tutorial window demonstrating its built-in music notation capabilities.

4.3 Max/MSP

As mentioned before Max was originally designed to control the IRCAM 4X. It's ingenious open architecture and graphical user interface proved to be an ideal development tool for real-time music applications and has become a sort of lingua franca of computer music with its two dialects *PureData* and *jMax*. The environment consists of numerous internal and external objects and can be expanded by third-party development. There are countless objects for MIDI control, signal processing, matrix operations, neural network simulation, network communication, and, most recently, interfaces to programming languages such as LISP and Java.

4.4 Microtonality

Spectral composition refocused the attention to higher, “out-of-tune” overtones such as the 7th, 11th and 13th partials. Notating such sonic events requires higher resolution than traditional notation of pitches. For instance, in his piece *Prologue* (1974), Grisey employs eighth-tone notation to approximate the partials to 48-tone equal temperament (48TET), a notation with a maximum error of 12.5 cents (a 16th tone). In my paper “Überlegungen zu einer neuen Musiktheorie” (HAJDU 2004) I described the use of three grids for composing and notating microtonal music:

1st grid: Pitches of arbitrary frequencies such as harmonic or inharmonic spectra

2nd grid: A filter to approximate these pitches to a stable set of pitches such as 19TET or the rather exotic Bohlen-Pierce scale.

3rd grid: A filter to approximate and notate the pitches yielded by the second grid; the first scene of the first act of *Der Sprung* being an example of this strategy.

My preference for scales and tuning in *Der Sprung* was driven by my theoretical reasoning I elaborated in my paper “Low Energy and Equal Spacing” (Hajdu 1993). This paper also describes how the application of quantitative methods to the problem of interval concordance yields results that are in sync with the “hard facts” of music history and theory.

4.5 Neural Networks

Another fascinating technology introduced to music research, theory and composition is neural network simulation. Originally invented in the 1940s to mimic the behavior of nerve cells, it was first abandoned in favor of Artificial Intelligence and expert systems before it made its re-entry into the academic realm. Michael LEE (1991), a graduate student at CNMAT in the early 1990s, wrote a *MaxNet* neural net object for the Max programming environment (later renamed to MLP, which stands for Multi-Layer Perceptron). During my time at CNMAT, I was involved in developing a number of applications using the mlp's pattern recognition and interpolation capabilities.

5. In-depth analysis of selected moments

In the following I will analyze selected scenes of the opera in light of the methods and strategies outlined earlier.

5.1 Spectral mapping

The first scene of the first act features a fictitious dialog between the two professors who were shot by the philosophy student; one is fatally wounded - the other survives. The latter, puzzled by her crime, praises her intellectual accomplishments while his moribund colleague tries to get his attention.

The scene was written entirely in the Bohlen-Pierce scale, a consonant scale that subdivides the interval of a twelfth in thirteen equal steps. As this scale, not having any octaves, is an intellectual achievement in itself, it symbolizes the abstract, academic world of a university department.

This part is based on the syllables "Ei-ne" and consists of mainly two parts, a short instrumental overture and a duet in which the professors are accompanied by two microtonal keyboards followed by a short coda.

Stufe	Reine Stimmung			Gleichschwebend temperierte Stimmung		
	f_n/f_0	cent	hekt	f_n/f_0	cent	hekt
0	1/1	0	0	1,0000	0	0
1	27/25	133	91	1,0882	146	100
2	25/21	302	206	1,1841	293	200
3	9/7	435	297	1,2886	439	300
4	7/5	583	398	1,4022	585	400
5	75/49	737	504	1,5258	732	500
6	5/3	884	604	1,6604	878	600
7	9/5	1018	696	1,8068	1024	700
8	49/25	1165	796	1,9661	1170	800
9	15/7	1319	902	2,1395	1317	900
10	7/3	1467	1003	2,3282	1463	1000
11	63/25	1600	1094	2,5335	1609	1100
12	25/9	1769	1209	2,7569	1756	1200
13	3/1	1902	1300	3,0000	1902	1300

Table. The Bohlen-Pierce scale described independently by German engineer Heinz BOHLEN (1978) and Stanford professor John Pierce (MATHEWS et al. 1984) is characterized by an extraordinary number of unusual, yet consonant intervals in close approximation to small odd integer ratios.

As in my piano composition *Fingerprints* (1993), I experimented with the ratio 3:5:7:9 on a metric level, creating an analogy between meter and harmony. I decided to base the overture on 3 different elements:

A fast ascending melodic figure was based on the "strong" intervals of the scale. A kind of crescendo was achieved by asymmetrically subdividing the theoretical time span between successive entries of this motive—with 6 occurrences as the result of the interpolation between 3 and 9; a slow trill between a and b quarter tone flat with a rhythmic counterpoint (5

occurrences); and spectral chords derived from Brasch's sentence and approximated to the Bohlen-Pierce scale, in chronological order, mostly arpeggiated (7 occurrences). Other elements are sampled sounds of breaking glass and pouring water (symbolizing the injury of the human body) and a short sample from Monteverdi's *Orfeo* ("Tu se morta...").

In the ensuing duet, the tenor and bass lines of the two professors as well as the keyboard accompaniment were first written in standard tuning based on triadic harmony, stylistically somewhere between Kurt Weill and Alban Berg. This texture was then translated into the Bohlen-Pierce scale by mapping the voice and keyboard lines to the closest scale steps of the approximated speech spectra (which were used in free order). The coda closes this part with a harmonic and melodic ascent followed by the sound of a flushing toilet.


The image shows a musical score for a scene. It consists of two systems of staves. The top system has a vocal line (tenor and bass) and a keyboard accompaniment. The lyrics are: "in, ih - re Schlußfol - ge - run - gen die jung - frau - li - che Na - tur bei He - gel be - tref - fend". The bottom system is a continuation of the same, with additional annotations like "16" and "15 14 12 8" on the left. The score is heavily annotated with circled numbers (80, 92, 98, 80, 92, 82-83) and various musical notations including notes, rests, and dynamic markings like "pp" and "f".

Figure 6. An intuitively composed line was mapped to spectral pitches in Bohlen-Pierce tuning in the 1st scene of the 1st act. The circled numbers refer to spectra within the 540 spectral-chord progression.

While the first act deals more with the events leading up to the crime, the second act introduces a new element: the element of contemplation and self-reference, thus the subtitle *Beschreibung einer Oper*. In the first scene of the second act, Brasch describes the unsympathetic reaction of fictitious spectators being exposed to the very same opera that is unfolding in front of the real audience.

For this scene, I invented eight short comments and exclamations (partially based on reactions I received from opera people and radio editors before the opera was finished). In analogy to the composition method applied to the entire opera I performed spectral analysis on the texts

spoken by mezzo-soprano Annette Kleine and myself. Again, I derived the rhythmic and melodic material from these analyses, albeit without time stretching. The material was translated into musical notation using a cascade of algorithmic processes. Two types of textures are discernible: One using the spectral content in a quantization of 62.5 msec, and another employing the rhythmic structure formed by the temporal envelope of the spoken texts.

Since playing 32nd notes at  seemed an almost impossible task I removed the shorter pauses from the music and asked the musicians to quasi improvise their parts.

The rhythmic sections performed by the two percussionists grant even more freedom: the choice of instruments and the exact rhythmic elaboration of the music written in space notation is up to the performers themselves.

The scene is based on the syllables "k-ei-nen" and, therefore, consists of three parts. The first part carries over from the real intermission by using the recorded sounds of background chatter, interspersed with the rendering of those eight comments by professional actors, so that the real intermission seems to continue well into the opera. The second part features the libretto whispered (and thus made unintelligible) by the choir, whereas the third part consists of a succession of the "spectators' utterances" orchestrated for orchestra, percussion and electronics. The singers, now acting as if they were the audience, react to this by clapping, laughing and cheering.

Video: Ich bin froh
Soundfile: Pausengespräch

MIDI file: Ich bin froh

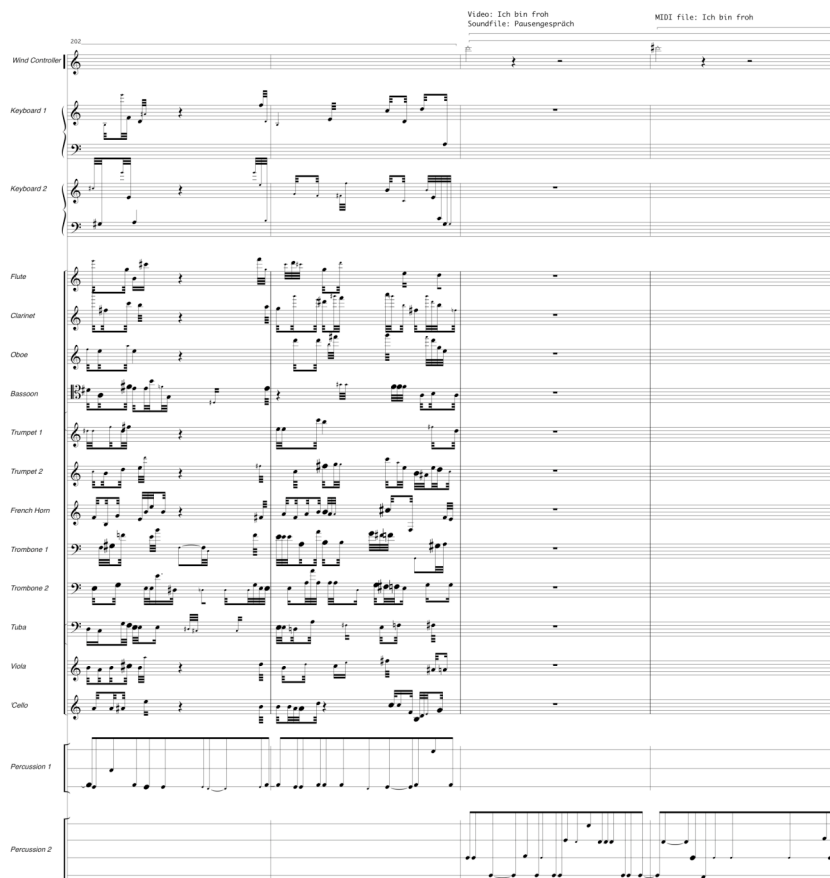


Figure 7. Excerpt from the 1st scene of the 2nd act.

5.2 Neural composition

In the third scene of the first act which features excerpts from a fictitious diary (including a section with four female voices signifying the multiple personalities of the protagonist) two compositional approaches were taken and their results transformed into a popular musical idiom: A spectral one, utilizing further analysis material, and a connectionist one, featuring a set of neural networks. In the latter approach the networks were trained to either quotations from historical or popular sources or to the spectral material itself.

This scene is based on the syllables "sch-rei-ben," "sch" representing an independent sonic event. Since "rei" is further divided in two distinctive parts, the overall form is quaternary. The first part consists of the playback of the same word "schreiben" stretched by a factor of 220 accompanied by saxophone, electric guitar, double bass and percussion. The gigantic expansion of the short sample reveals microscopic details such as the long *portamento* from c# to g and thus yields the pitch material for the acoustic instruments.

After a short transition, a fast section unfolds featuring slowly arpeggiated spectral chords in ascending motion. The spectral pitches are reached by suspensions that resolve either upwards or downwards.

The third part and fourth parts are composed using neural networks for melodic interpolation employing melodies from the opera itself (H), from a CD with Sephardic songs from the middle ages (S) and a piece by the Rolling Stones⁵ (R).

Inspired by the idea of seamless melodic interpolation (exemplified in Clarence Barlow's composition *1981* for piano trio), I trained a whole battery of Max *mlp* objects to these melodies with their respective accompaniments which allowed me to move freely through melodic space, thus generating countless new melodies (with varying similarity to the originals).

Melodic interpolation is far from being a trivial problem (POLANSKY 1992). The intervallic space in which interpolation is performed is characterized by at least two distinctive properties: pitch distance (magnitude) and harmonic distance. While pitch distance is usually a function of the frequency ratio of the two fundamentals, harmonic distance is more complicated to formalize and depends a great deal on intuition and experience.

I found that the circle of fifths represents a viable compromise between the two principles, in which the circularity of the chroma circle (SHEPARD 1964) is preserved and harmonic relationships are allowed to come into play.

⁵ Mick Jagger was an important figure in the protagonist's personal mythology, remarkably playing the role of a modern reincarnation of Jesus Christ. There is even an account of her visit to Jagger's mother and inquiring about a scar on his stomach (WANTOCH 1984). The religious implications are even more outlandish considering Jagger's occasional self-stylization as devil, and the fact that she had left out the words "Jesus Christus" in a paper she had been asked to copy.

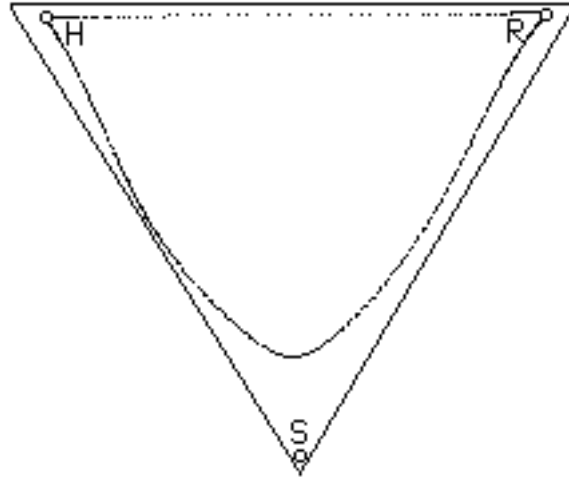


Figure 8. The actual interpolation involved three melodies (H, S and R) located at equal distance in the corners of a triangular melodic space and was performed over a total period of three minutes. The graph shows the interpolation path at a resolution of 1000 sample points. For the graphical plot, another network was trained to translate the input data into spatial coordinates.

My paper “Circularity in neural computation and its application to musical composition” (HAJDU 1995) offers a concise explanation of the mathematical methods and the training process pursued.

Figure 9 shows three systems of musical notation for a scene. Each system includes five staves: Percussion 1, Percussion 2, Saxophone, Electric Guitar, and Ampl. Bass. The first system starts at measure 194, the second at 197, and the third at 200. The notation is complex, featuring many beamed notes and rests. The third system ends with a '2 x' marking, indicating a repeat.

Figure 9. The last part of the 3rd scene composed with neural net simulation

5.3 Machine-man interaction in Intermezzo

“Wobei es eine schöne Form ist, eine Sache nicht aufzuschreiben, die einen Ton haben muss.” (Thomas Brasch)

Intermezzo is scored for keyboard, “wired” choir, narrator and electronics. The term “wired” refers to the interaction between the computer and the choir (the singers reproduce the pitches they hear in headphones). Spectral analysis determined this part of the opera to last 17.5 minutes; and being its longest part, it represents the psychological climax of the opera. It covers the moment when the protagonist “snaps” which is symbolized by the plunge she’s about to take.

17.5 minutes equals 105 frames, which, by chance, is the product of 3x5x7—numbers already used in the first scene. In analogy, I based the scene on a macro rhythm that was characterized by the equally spaced occurrence of three ascending events (glissandos or ascending clusters),

five text events (answering machine texts or live narration of the libretto) and seven choral entries.

As in the previous scenes the material consisted of spectral chords (pseudo-harmonic spectra extracted from answering machine noise) consisting of the 24 strongest partials.

105 different scales containing up to 130 pitches were derived from these chords by a pseudo-equidistant subdivision of chord intervals, based on 17 TET. This was achieved by filling the gaps between partials with additional pitches at a mean interval size of approximately 71 cents.

Brasch's quote "While it's a nice form not to write down something that ought to have a sound" indeed set the tone for this part of *Der Sprung*. The goal was to compose the entire score non-symbolically, i.e. without music notation. This was accomplished by means of real-time composition: Using the programming environment Max/MSP to send its output to a sampler as well as to the eight singers.

The real-time processes are listed in the tables below:

Electronics	
Type	Description
random	Stochastic control of pitches, dynamics, durations and onsets
arpeggios	Arpeggiated chords, pitch range and delta time is controllable
glissandos	Chordal pitches determine beginning and ending of glissandos.
swarm	Ascending clusters; successive scale tones
patterns	Metric hierarchies for meters with 3, 5 and 7 pulses and their products are stored in tables and used as indices for scale tones. Tempo, range and the amount of silent notes can be controlled in real time.
melodies	A melody generator using scales as input material. Rhythm and meter are influenced by event density, event length and
RandSeg	In contrast to the generators described above, RandSeg is a modifier. It receives its input either directly from the keyboard or from the generators. The input data are stored and recalled by a random walks.
thru	In addition, it's possible to play the chordal and scalar pitches directly from the keyboard using the thru setting. The keyboard range can be divided in three zones each with a different timbre.

The choir performs (fixed, i.e. non-randomized) variants of the instrumental processes. The eight singers receive their input from headphones on eight different audio channels using the multi-channel audio system.

Choir	
Type	Description
chords	Analogous to thru for the "instrumental" processes

random	Fixed pitched with random character
glissandos	Upward and downward portamentos
patterns	Short composed patterns
arpeggios	Eight-part arpeggios of spectral harmonies

	0'00"	0'10"	0'20"	0'30"	0'40"	0'50"	1'00"	1'10"	1'20"	1'30"	1'40"	1'50"	2'00"	2'10"	2'20"
Frame	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204
Text															
Keyb															
Layer															
Layer 1															
Layer 2															
Layer 3															
Chor															
	Cresc./Decresc.														

	2'30"	2'40"	2'50"	3'00"	3'10"	3'20"	3'30"	3'40"	3'50"	4'00"	4'10"	4'20"	4'30"	4'40"	4'50"
Frame	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219
Text															
Keyb															
Layer															
Layer 1															
Layer 2															
Layer 3															
Chor															
	Random														

	5'00"	5'10"	5'20"	5'30"	5'40"	5'50"	6'00"	6'10"	6'20"	6'30"	6'40"	6'50"	7'00"	7'10"	7'20"
Frame	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234
Text															
Keyb															
Layer															
Layer 1															
Layer 2															
Layer 3															
Chor															
	Random														

	7'30"	7'40"	7'50"	8'00"	8'10"	8'20"	8'30"	8'40"	8'50"	9'00"	9'10"	9'20"	9'30"	9'40"	9'50"
Frame	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
Text															
Keyb															
Layer															
Layer 1															
Layer 2															
Layer 3															
Chor															
	Random														

	10'00"	10'10"	10'20"	10'30"	10'40"	10'50"	11'00"	11'10"	11'20"	11'30"	11'40"	11'50"	12'00"	12'10"	12'20"
Frame	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264
Text															
Keyb															
Layer															
Layer 1															
Layer 2															
Layer 3															
Chor															
	Random														

	12'30"	12'40"	12'50"	13'00"	13'10"	13'20"	13'30"	13'40"	13'50"	14'00"	14'10"	14'20"	14'30"	14'40"	14'50"
Frame	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279
Text															
Keyb															
Layer															
Layer 1															
Layer 2															
Layer 3															
Chor															
	Random														

	15'00"	15'10"	15'20"	15'30"	15'40"	15'50"	16'00"	16'10"	16'20"	16'30"	16'40"	16'50"	17'00"	17'10"	17'20"
Frame	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294
Text															
Keyb															
Layer															
Layer 1															
Layer 2															
Layer 3															
Chor															
	Random														

Figure 10. The temporal structure of *Intermezzo*

5.4 Quintet.net

Upon completion of *Der Sprung* in 1998, I was increasingly intrigued by the idea of network composition, i.e. having musicians perform under the control of a central server. The rise of the Internet and its associated protocols provided the tools to realized the interactive, networked performance environment *Quintet.net*. The ongoing development started in the summer of 1999. *Quintet.net* extends ideas present in *Intermezzo*, but adds a symbolic layer facilitating the interaction of performers over large distances. Being an open environment,

several pieces or parts thereof have been realized with it, the Munich Biennale opera *Orpheus Kristall* by Manfred Stahnke among them (HAJDU 2003).

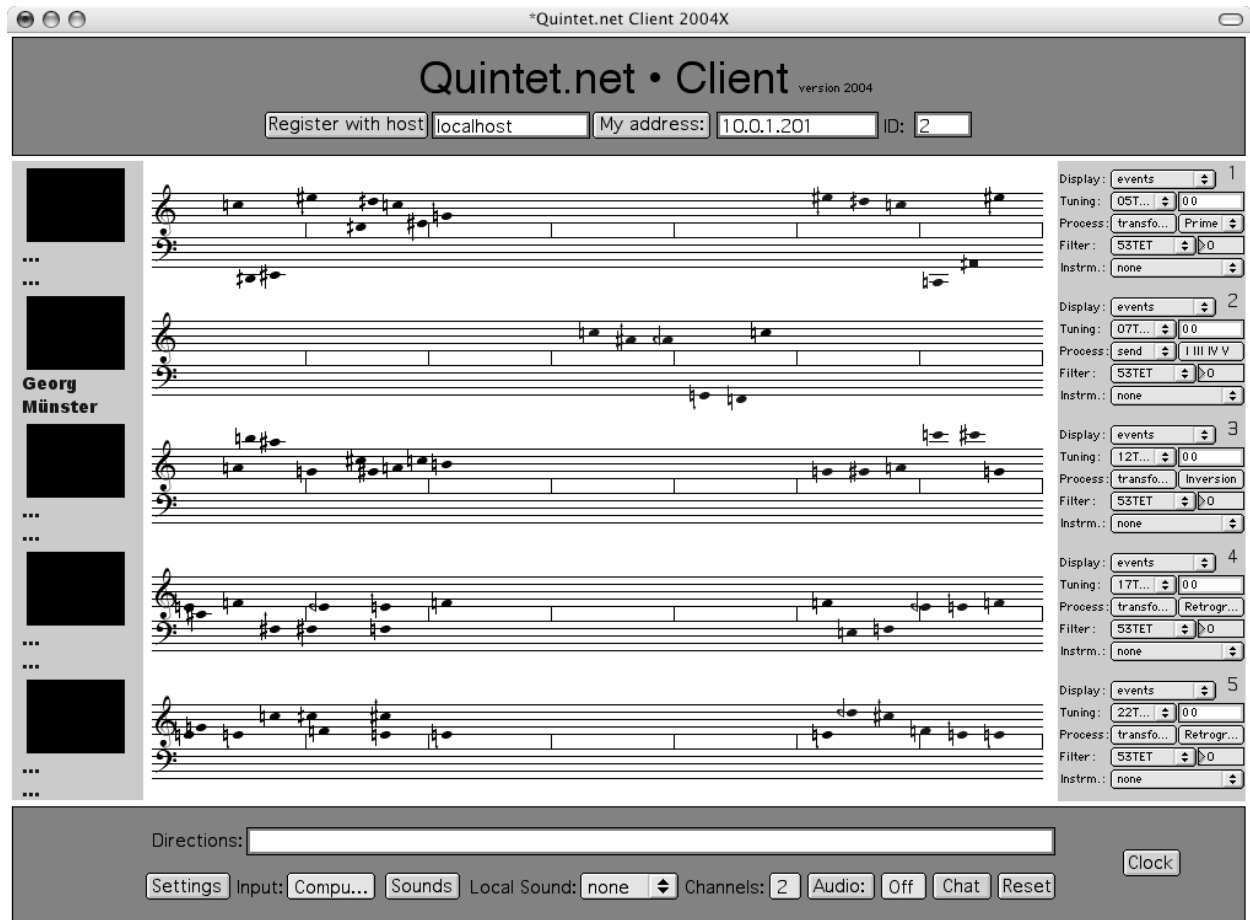


Figure 11. Screen shot of the Quintet.net Client's graphical user interface.

6. Conclusion

One interesting question remains to be discussed: How to situate *Der Sprung* in its historical context and to extrapolate future developments in the field of computer composition. In retrospect, three stages can be discerned, which I will call the *speculative*, the *exploratory* and *interactive* stages.

The *speculative* stage (from 1950-1970) was characterized by a lack of knowledge in psychoacoustics and cognitive psychology as well as a serialist stance towards the treatment of musical parameters such as timbre and meter. The early electronic works of Stockhausen and algorithmic works by Xenakis were typical for this approach. Recognizing that certain parameters evaded successful formalization and serialization, a phase of intense research ensued leading to important discoveries in cognitive psychology and the development of groundbreaking tools for computer composition. Researchers and composers would typically meet at interdisciplinary institutions such as CCRMA (Stanford) or IRCAM and commonly work on realizing a piece. An example for this *exploratory* phase (from 1970 to 2000) is Clarence Barlow's piano piece *Çogluotobiüsisletmesi* (1978) and my opera *Der Sprung*. In the most recent stage, the *interactive* stage, we are witnessing the rise of a different type of artist disposing of the most highly developed tools (*Max/MSP/Jitter*, *Pure Data*, *OpenMusic*, *Reason* and *Reaktor* just to name a few) enabling them to work intuitively and interactively without deep knowledge of what's behind scenes, i.e. the graphical user interface. The large

research studios also had to respond to this shift of paradigm: Anyone can now own equipment many times as powerful as the most advanced gear available in the early 1990s at a small fraction of the cost. IRCAM for instance gets considerable revenues by selling software through its user groups. Open source software is available to anyone over the Internet. Hence, music development tools are no longer confined to certain universities or research centers but are distributed freely and mixed at will by artists. The increasing importance of real time also leads to a disappearance of the distinction between composition and improvisation, or composer and performer. On the other hand, we are also observing a similar paradigm shift among music researchers who are more and more intrigued by the findings of neurological research and imaging techniques allowing a glimpse of a musician's or listener's brain at work—in real time.

While we will still see collaborations between researchers and musicians in the future, they will probably not be as typical as in the *exploratory* stage. On the other hand, I expect a dramatic change of what constitutes music theory in pedagogical institutions: A more general and quantitative theory based on the findings of psychoacoustics and cognitive psychology will finally replace the constrained and historical theories developed in and for the Golden age of tonal music.

7. Appendix

7.1 Newspaper article (from the Jerusalem Post, January 26, 1984)⁶

Woman kills professor in German 'Buber centre'

COLOGNE (AP). – A woman armed with 16 pistols fatally shot a 49-year-old professor and wounded the director of Cologne University's Martin Buber Institute of Jewish Studies, police reported yesterday.

The shooting occurred on Tuesday afternoon, but was announced by the police only after professor Hermann Greive, an expert on Theodor Herzl, died yesterday morning in a Cologne hospital.

The 32-year-old assailant, identified only as Sabine G., was a student at the institute. She was held for murder and two counts of attempted murder.

Dieter Fricke chief of the Cologne police homicide division, said the motive for the shooting was under investigation. He told reporters yesterday that the woman had not given a statement to police.

The assailant took a master's degree in philosophy and Jewish studies at the institute two years ago and had worked since then as an archivist at Cologne University, police said.

Police sources said earlier that investigators were probing reports of a possible religious conflict between the woman and the professor.

Greive was shot in the left temple while giving a course in basic Hebrew to 12 students.

Fricke said the woman then ran out into the hallway and fired at institute director Johann Maier, 51, when he tried to intervene. The shot grazed his skull, and he was able to overpower her after she fired at and missed another professor in the hallway.

Maier, who is one of Europe's best-known experts on Judaism, was treated at a hospital for the wound and released.

In addition to the murder weapon, police confiscated 11 more muzzle-loader pistols from a toilet at the institute. The weapons, calibre 35 to 45 millimetres, were found in four plastic bags and a briefcase.

The police found five more muzzleloaders and a gas pistol in a van parked outside the institute. They said the assailant had rented the vehicle.

The pistols - replicas of old weapons - can be purchased in sporting-goods stores and do not require a licence. The police said a Cologne dealer said the woman bought several of the pistols at his shop last week.

A psychiatric examination of the assailant yesterday morning failed to turn up evidence that she was mentally deranged, the Cologne prosecutor's office said.

A political motive in the shooting has been ruled out, the office said.

Police sources said the woman was living alone following a divorce.

She was believed to be Jewish, but it was not clear if her parents are Jews or whether she adopted the religion, the sources said.

They said the woman reportedly had complained to fellow students about non-Jewish professors' teaching at the Institute. Neither Greive nor Maier are Jewish, the sources said.

Itim last night identified the woman suspected in the slaying as Sabine Gerhardt, aged 32.

Quoting Kol Yisrael radio's correspondent in Bonn, Itim said Gerhardt was a convert to Judaism and had studied in Israel.

One of Gerhardt's grandmothers was Jewish and her parents were Christians.

⁶ The much longer and more accurate article by Erika Wantoch states the correct name of assailant and claims that no member of her family was actually Jewish.

7.2 Libretto (English translation by Susanna Spiro)

A.

Now she would do it: Standing here above, observed by all those below, who had not believed her capable of it: of leaving this ridiculous GDR, where no one understood, neither at school nor at the gym, that she had it in her to surpass them all, of leaving this ridiculous GDR and starting anew, they had not thought her capable of it, of abandoning her place as a pitied, average high-diver at this tiled provincial swimming pool, which those below take to be the world, and they will not venture onto the 11-meter diving board, because they believe that 10 meters would be the limit, only because they can't see what she sees, these spectators of their own lives, who had not thought her capable of this, of becoming the star, of leaving her position as an animal caretaker and becoming a doctor of philosophy, of proving, as the best student, to these Germans, who believed she was one of them, just because she was German, of proving to them who Kant is, of proving to this professor, whom she had loved, that she would be perfectly capable of forsaking love and going over to hatred, as easily as going from East to West, as if there were no wall, these Catholics who thought she was Catholic, just because father and mother were, who believed her incapable of becoming a Jew, one of the community of victims, she also wanted to become one of them; Now she would do it, from her 11-meter diving board, after she had left behind her name, her profession, her character, her place of residence, her religion, her sex, her desire for the other sex, for the answer-after she had finally left all of that behind her, like the gaping spectators down below, now after she had ascended from being a spectator to being the star, ascended this tower of glory, ever higher and farther beyond reach, with this plunge.

1.

I knew her, my dear colleague, as a brilliant thinker, her conclusions concerning virginal nature in Hegel and its parallelism to the commonwealth, my dear colleague, were unsurpassed; how can such an intellect become so deranged, I knew her, my dear colleague, as a logical reasoner, how can such sense in a woman deteriorate so completely, I knew her, my dear colleague, as a helpful assistant, how can charity become so distorted into hate, I knew her, my dear colleague, as an animal-loving creature, she could not know enough about every lab rat and parted painfully from each one.

I, my dear colleague, have been struck dead by her fucking gun, for you it was only life-threatening, you will survive, I thought so, you always had a better relationship with the dean, you, my dear colleague.

2.

We always had a good relationship with her, here in the house, until she brought the turtles home with her, the frogs, the amphibians, the sod, the wading pool, until she had made her apartment into a terrarium and an aquarium as well, until the water began to come through the ceiling and the television was destroyed, until every night up there she began to quack like a duck, bark like a dog, snort like a horse, until she began to shriek in a voice like an unknown bird and we could no longer get any sleep, which had left her, we always had a good relationship with her, here in the house.

A schoolteacher moved into her apartment, who looks a little bit like her, with the big glasses and the thin mouth. Sometimes we think that it's really her, she's back, but that cannot be, she is in jail or in the madhouse now.

The schoolteacher often sings at night.

3.

May 16

Yes, today I decided to begin my career as a high-diver at the "Mermaid" swim club, which will take me to the Tokyo Olympics.

September 22

Yes, today I decided to learn to knit or, better, to perish from an unknown disease.

July 4

Yes, today I decided never to speak another word to Mick Jagger, to throw away my Rolling Stones albums, and to become a Jew or a drug addict.

May 9

Yes, today I decided to publicly revoke my dissertation and to inform my aunt that there is not a single Jew in the Institute for Jewish Studies.

December 3

Yes, today I decided to renounce language and practice only deeds.

4.

The weapon should be from the Middle Ages, the weapon should be symbolic, the weapon should be deadly, the weapon should be an enigma, the seller of the weapon should be a Jew, the seller of the weapon should be unsuspecting, the seller of the weapon should be a swindler, the buyer of the weapon should be a student, the buyer of the weapon should be educated, the buyer of the weapon should be innocent, the murderer should be the weapon, displaced from the Middle Ages into the present moment, from the outskirts of the ordinary into the center of fear.

B.

Now the climax has finally been reached: To escape their stares with this plunge, how could she do that, they will say, buy a gun and go into the university, where they presume to stain my Jewish identity with their stares, where they presume to continue to call me by my old name instead of saying Sara, where they presume to doubt that I am the true wife of Mick Jagger and have seen the scar on his stomach, the scar, the healed stab wound, from which he unfortunately recovered, after I left him that night, but the professors will not recover from these two shots with which I shot them out of their unworthy German existence and shot myself upward into the heaven of Einstein and Freud, I, the new formerly German Anne Frank, who did her deed for the Jewish people who cannot defend themselves against the appropriation of their history by uncircumcised professors of Jewish Studies, this people, to whom I have attached myself and now go before them, because they need someone who can lead them on the long journey through the darkness and here I stand on the 11-meter tower, in the spotlight of history, and yet suspended high up with my gun in my hand, in order to look down upon you, ever higher and ready to shoot, you two will be given over to the Dead Sea, through which we had to go, I am flying and destroying your construction and the newspapers will write about me, as though it were only in my head, not in the world, this plunge.

1.

The audience wanted an explanation for what they had to look at, to listen to, to report and gathered to consider whether this description of an opera was about the presentation of the documented case in which in the eighties a professor of Jewish Studies was killed and another badly wounded by a student, the audience did not come to any conclusion, except one: the observer, the listener sees and hears nothing, if he does not let himself go. So they went back into the viewing room of their history, to the person who was supposed to tell them what they could not understand, for the observer sees nothing.

2.

She had known me before, she said suddenly, no, no this is not our first encounter, didn't I remember, it was true that I had had a different appearance and a different name, but I had revealed myself to her, I had been her married Jewish lover and she had threatened to shoot my son if I would not immediately leave my wife, but fortunately I had exchanged my identity and had run to her, to the big shalom. Meanwhile I could never see her eyes. She seemed to me to have turned completely inward. So I ran out and never wanted to see her again. I sensed something.

3.

To speak another language, one that only the speaker understands, behind which he is completely concealed, behind which no one can discover him, to mingle the language of the victims and the perpetrators into a violently tender web, like that of men and women, of lunatics and children, of pale cowards and stony mummies, a language like a dance, that satisfies itself before an orchestra without instruments under a sky full of violins, disguised as machine guns, to learn to speak the language of a speechless protagonist, whom one did not encounter except on paper, on the piano. To learn to speak her scream.

4.

The boundary crossed from rage into coldness, from motive into action, from terror into paralysis, from eagerness into absence, the boundary crossed from ambition into decline, from intention into chance, from diligence into rest, from sentence into word, from melody into sound, from din into noise, from drawing into line, from history into moment, the boundary crossed with one leap, which stands still, one foot on this side, the other on the far side over the edge, with one leap, which leads no farther.

C.

I crash down, they lead me away, they transport the corpses away, they write me off in the newspapers, they take a picture of me at the prison doctor's, they pick me up like for a KZ, they dismiss me like a lunatic, they replace me as the star, they tear down my 11-meter tower, they bolt the door behind me, they pull the audience out, they reject my statement, they cut off my hair, they again take away my Jewish name, the Jews turn away from me, my body turns away from me, my classmates turn away from me, Papa and Mama turn away from me, they dismiss me, they tear up the swimming pool, they let the water out, I crash down, 11 meters deep I crash down, they turn off the music, they turn off my thoughts, they turn off the light, they stop my plunge, I crash into the sea of silence, my plunge, I am broken up. I will be broken up, after I had closed, I was treated and finally described. I don't want to go under, there's no water here, turn off these noises, turn off these words, I am crashing down, so short was the plunge, I am crashing and turning myself off.

8. References

- Assayag, G., Rueda, C., Laurson, M., Agon, C., and Delerue, O.: Computer Assisted Composition at Ircam: PatchWork & OpenMusic. *Computer Music Journal*. 23(3) (1999)
- Brasch, Th.: Mädchenmörder Brunke. Frankfurt am Main: Suhrkamp. 1999
- Brasch, Th.: Liebe Macht Tod: Der Sprung. 297-309. Frankfurt am Main: Suhrkamp. 2002
- Bohlen, H.: 13 Tonstufen in der Duodezime. *Acustica*. 39/2, 76-86 (1978)
- Dufourt, H.: *Musique spectrale* (1979). In: *Musique, pouvoir, écriture*. 289-294. Paris: Christian Bourgois 1991
- Hajdu, G.: Low Energy and Equal Spacing; the Multifactorial Evolution of Tuning Systems. *Interface*. 22, 319-333 (1993)
- Hajdu, G.: *Fingerprints* (1993). Score. Hamburg, New York: Peer.
- Hajdu, G.: Circularity in neural computation and its application to musical composition. *Proceedings of the International Computer Music Conference 1995*, Banff Centre for Arts, Banff, Canada, 363-365 (1995)
- Hajdu, G.: *Der Sprung* (1994-98). Score. Hamburg, New York: Peer.
- Hajdu, G.: *Quintet.net* - an environment for composing and performing music on the Internet. Manuscript. 2003
- Hajdu, G.: Überlegungen zu einer neuen Theorie der Harmonie. In: *Mikrotöne und mehr - für György Ligeti*. Manfred Stahnke (ed.): Series: "Musik und". Hanns-Werner Heister and Wolfgang Hochstein (eds.). Hamburg. 2004
- Carter, R.: *Mapping the Mind*. 119-124. Berkeley, Los Angeles, London: University of California Press 1999
- Hüppe, E.: Fragmentarische Überlegungen zu Georg Hajdu's "Der Sprung". *MusikTexte* 81/82, 135-36 (1999)
- Lee, M., Freed, A., and Wessel, D.: Real-Time Neural Network Processing of Gestural and Acoustic Signals. *Proc. of the Int. Computer Music Conf.*, Montreal, 1991.
- Mathews, M. V., Roberts, L. A. and Pierce, J. R.: Four new scales based on nonsuccessive-integer-ratio chords. *J. Acoust. Soc. Amer.* 75 (1984), S10(A)
- McAulay, R.J. and Quatieri, T.F.: Speech analysis/synthesis based on a sinusoidal representation. *IEEE Transactions on Acoustics, Speech, and Signal Processing ASSP-34*(4). 744-754 (1986, August)
- Polansky, L.: More on morphological mutation functions. Recent techniques and developments. *Proceedings of the ICMC (San Jose)*, 57-60. 1992
- Shepard, R.N.: Circularity in judgments of relative pitch. *Journal of the Acoustical Society of America*. 36, 2346-53 (1964)
- Wantoch, E.: Wahn, wo ist Dein Sinn. *Profil*. 10/5, 56-60 (March 5, 1984)
- Wright, M., Chaudhary, A., Freed, A., Wessel, D., Rodet, X., Virolle, D., Woehrman, R. and Serra, X.: New Applications of the Sound Description Interchange Format. *Proceedings of the International Computer Music Conference*, Ann, Arbor, Michigan. 1998

Prof. Dr.(USA) Georg Hajdu
Tornquiststr. 8
20259 Hamburg
Germany
Phone: +49 40 23517610
Fax: +49 40 428482 770 (!)
Email: hajdu@musikhochschule-hamburg.de

