Hidden grids: paths of expressive gesture between instruments, music and dance

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In his work *Contropasso* (1998–9) Michelangelo Lupone collaborates with Massimo Moricone in the dance showcase *piegapiaga* achieving direct interaction between dancers and live electronics performance. The choreography takes advantage of acoustic events as generated by three dancers and further elaborated on via computer by the composer through use of granular algorithms and digital filtering, allowing the construction of the musical events to occur in real time. The live electronics performer changes sound parameters in relation to the dancers' movements by use of the program SDP – Sonorous Drawing Plane (S. Lanzalone) – created specifically for the control of different synthesis algorithms allowing them to be processed on systems such as Fly30 (CRM) and Mars (IRIS). SDP reads and converts computer mouse data as the operator creates lines corresponding to performance gestures, thus creating both visible and audible output. This software allows a single gesture to control more than one parameter, thus creating complex changes in the audio programme output. The article deals with different compositions, performances and didactic situations the author has experienced using SDP.

1. PREMISE

The relationship between man and machine, seen from the point of view of live electronics, can be seen as a search for freer, more versatile ways in which to use a computer as an actual 'instrument' in the classic sense of the word. In this relationship, the computer would use the operator's actions (or gestures) to create sounds in real time. The concept of 'instrumental performance' includes the concept of 'gesture', a concept that electronic music, be it analog or digital, has ignored for some time. It is now possible to reintroduce the concept of gesture through the use of realtime electronics. In order to extemporaneously explore through gesture, one needs an effective, efficient environment that allows control of as many independent sound parameters as possible while presenting the user with an uncomplicated interface. There is also need to allow for the interaction of gestures (giving the operator feedback generated by the actual acoustic events) allowing there to be alteration and interaction at even the most detailed levels.

The interactive performance experiences described in this article derive from the use of SDP (Sonorous Drawing Plane) software that I developed in order to better manage live electronics. This software environment has been used in different ways by three composers underlining different ways in which the program can be useful, from music–dance interaction to other problems that deal with the man–machine interface.

2. THE BODY AS A SOUND SOURCE AND INTERNAL SOUNDS, THE INTERACTION BETWEEN MUSIC AND DANCE: THE PERFORMANCE OF *CONTROPASSO* BY MICHELANGELO LUPONE

In his piece *Contropasso* (1998–9) for realtime computer and three dancers, Michelangelo Lupone worked in close collaboration with Massimo Moricone. The piece was first performed in September 1998 in Milan at the Teatro Out Off and later repeated in Florence in October of the same year at Teatro Rifredi, as well as in Rome at the Rome Aquarium.[1] The latest version was performed in Rome in September 1999 at Teatro Il Vascello.[2] One of the basic goals that Moricone tried to achieve in his choreography was to stimulate audience perception through the use of different language codes challenging the audience to shift their perceptive rhythms constantly between the languages of music and dance. He attempted to 'hear the dance as music of the body'.[3] The choreography explores the relationship between man and machine by starting with an analysis of 'the way that the body as an art object is being transformed by technology giving us a new definition of the body as well as of reality'. By mechanising the movements of the body, the 'flow of breathing stimulated by motor movement becomes a simulation of organic life'. In this way the body of the dancer does not lose its 'body memory'.

The movements of the dancers as instruments were based on these observations of the mechanics of movement. Insertions of 'rhythms and anti-rhythms' attempt

[1]Dancers: Laura Agnelli, Annalisa d'Antonio, Beatrice Magalotti. Live electronics: Silvia Lanzalone.
[2]Dancers: Laura Agnelli, Monica Lavezzari, Beatrice Magalotti. Live electronics: Silvia Lanzalone, Maurizio Alfonsi.
[3]In this paragraph the expressions in inverted commas are by Massimo Moricone.

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to solidify 'the movement through space that is dance'. This idea of the body as an instrument is further underlined by the 'score' created by the three dancers as the sounds of their breathing and body movements interact with the sound material created by the composer and as they are acted upon by the computer operator. These body-generated sounds become part of the music as well as the dance. In traditional dance these body sounds have always been ignored or hidden; *Contropasso* uses these sounds as an integral part of the composition.[4] The rhythmic and arrhythmic aspects of body movement are heightened by the different types of costumes worn by the dancers (metal-heeled shoes, plastic clothing) as well as different materials used in the staging (metal risers, cement tiles). These techniques are used to heighten the acoustical–musical elements of the dance. The dragging or striking of the wooden, metal and stone staging elements, the different rhythmic and arrhythmic breathing sounds and the emission of short phonetic sounds and the sounds generated by their costumes all become part of the musical event.

2.1. The visual and audio fields: the installation

The actions and sounds of the dancers have an enormous symbolic and expressive impact on the presentation. The choreography takes place in and around a surreal blue garden.[5] Dramatic tension is heightened by the use of symbolic staging elements and gestures (the crucifixion, a chalice filled with blood, bandages wrapped around the dancers knees, etc.). Woman is first shown as a mechanical body whose jerky movements invoke tradition female roles (the woman–executive, the woman–doll). As she takes over more and more of the magic garden, her vital qualities are revealed (see figure 1).

If the staging is considered in a horizontal plane, that is by occupying the width and the depth of the stage, the acoustic space occupies all spatial dimensions including the vertical.

The sounds generated by the dancers are played back through eight small directional Galaxy loudspeakers which emphasise the midrange band from 500–5,000 Hz. These speakers are placed in front of and behind the audience (four + four) at a height of three metres. The rear array is fed a signal that is 20 per cent less powerful than the front array. The computer-generated programme material is played back through four UPA Meyer Sound loudspeakers placed on the ground at stage level. Two more are located along the side walls six metres above the floor, above the heads of the listeners.

The use of two different speaker systems makes it easy for the listeners to differentiate between the different sound sources thus achieving two sonic planes. Reverberated sound, fed to both speaker systems, helps create a unified sound identity.

Two subwoofers (passband at 200 Hz) are placed on the ground in front of the audience. In relation to the vertical plane, the speakers are placed at three levels: two UPAs at ground level, eight Galaxys at mid-height and two UPAs above the audience. With respect to the length of the listening environment, the speakers are also arrayed at three levels: four Galaxys behind the listeners, two UPAs at mid-point and four Galaxys + two UPAs in front. This provides homogenous sound dispersion throughout the acoustic environment. This speaker layout creates an effect of up-and-down sound movement when sounds are moved from left to right.

The sounds of the dancers are captured by five cardioid-pattern condenser microphones placed at stage level around the garden area. Figure 2 shows the speaker and microphone placement used by Michelangelo Lupone at the Teatro Il Vascello in Rome in September of 1999.

2.2. Performance interactivity: the story of a complex gesture

In *Contropasso* the concept of the human body as an instrument brings up other questions regarding the interaction of dance and music. Michelangelo Lupone responds using new expressive solutions. Classical dance has always denied the relationship between dance gesture and musical gesture: the dance was always inserted into the musical event. The music stood on its own and the dance articulations always followed the music. In popular music the relationship between music and dance is somewhat closer. Making music and dance synchronous by creating musical gestures in direct relation with those of the dance is the ideal that Lupone explores in *Contropasso*. This linking is possible if one re-examines the relationship between man and machine *vis-a-vis* realtime processing. This linking is not always desired throughout the entire work. At times the two are distinct entities which give way to some very complex structures. Neither is this relationship one way. The intention is to create an ambience in which it is equally possible for the dance to influence the music as well as for the music to influence the body movements. These interactions are made possible by the use of SDP. Different performance techniques would not have worked as well: prerecorded material would constrain the time of the interactivity; the use of passive sensors would allow the dancers to influence the music but would not afford the music the same possibility.

[4]In the previous work *Controfiato*, 'performance in real time on one dancer's breath' (1997), Michelangelo Lupone and Massimo Moricone experimented with sound materials derived from the dancer's breath. The breath, generated by the aspirated action of the body, was processed and transformed into sound. The concept of *body sound* has been developed since then.

[5]Costumes and scenes by Alessandro Ciammarughi.

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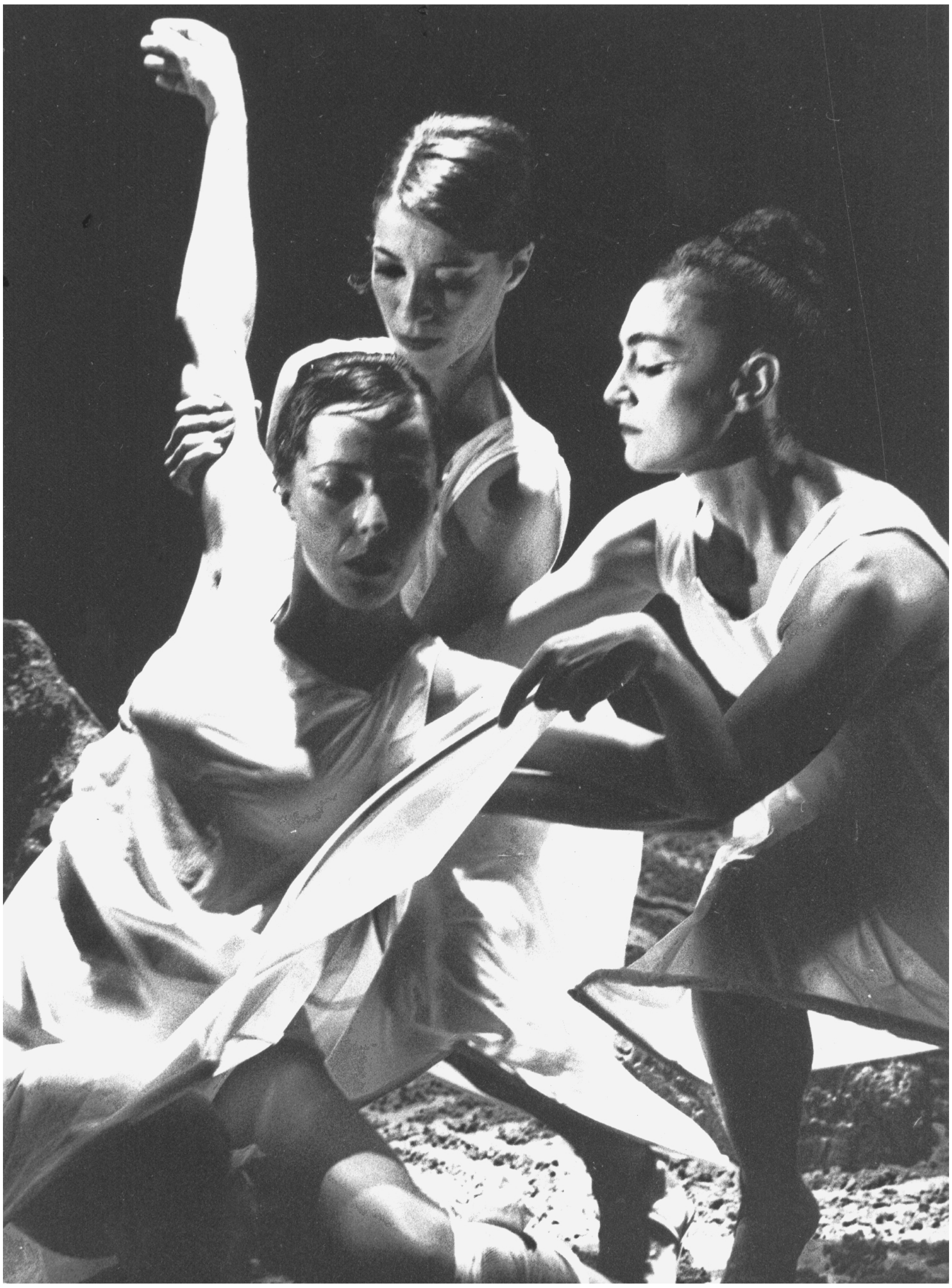

Figure 1. *Contropasso*, a moment of the performance at 'Acquario Romano', Rome 1998. Dancers: Laura Agnelli, Annalisa d'Antonio and Beatrice Magalotti.

The kind of gesture and flexibility of interpretation that are integral to the program for the management of live electronics were utilised in full by the composer to many ends, not the least of which was to give new creative impetus to both the music and dance elements and allow experimentation 'in the field', i.e. during rehearsals and the preproduction phases as well as throughout the performances themselves. This also allows the computer operator to be extremely flexible in his/her reaction to gestures allowing the aforementioned linking between music and dance. The choreography in the last performance was subdivided into approximately twenty 'frames' with the music following the form closely. This rigidity of form was in fact not rigid at all: it allowed continuous changes to the dance and music to be made. In this way the working methods and compositional techniques lent themselves well to the use of SDP.

2.3. The manipulation of body music: algorithms for sound processing

Sound processing was used only on the sounds made by the dancers. Different algorithms were used to create granulation and digital filtering effects. The computer

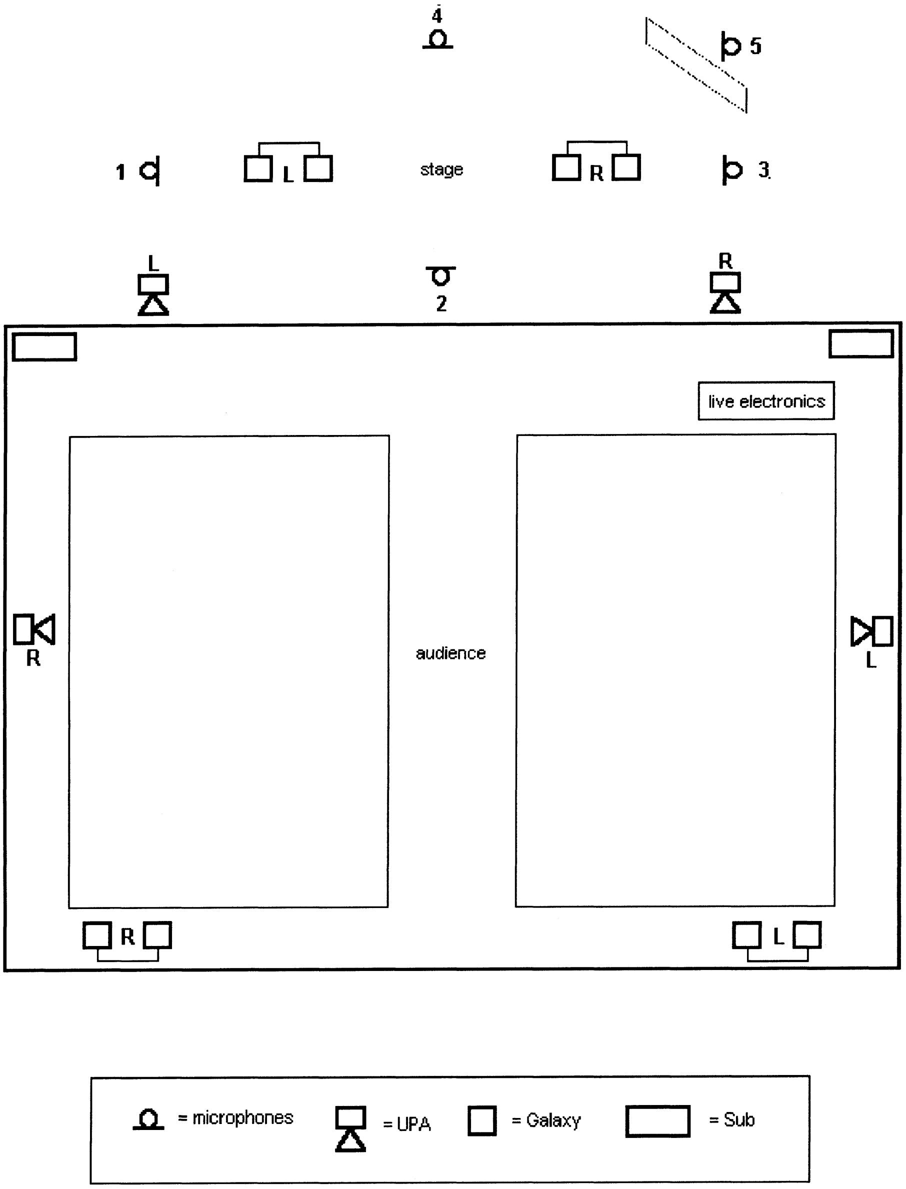

Figure 2. *Contropasso*, acoustic scene. Roma, Teatro Il Vascello, 1999.

operator/interpreter was able to move the parameters used in the live electronics by use of SDP which in turn controlled the Mars (IRIS)[6] system (used for granular synthesis) and the Fly30 (CRM)[7] system (used to create the filtering effects). These two systems are dedicated music systems. They consist of hardware and software systems powerful enough to create realtime effects with no appreciable time delay. The hardware consists of an extremely powerful digital signal processor and a personal computer which controls the algorithms and provides the user interface. SDP was used on both systems in order to give each its own set of algorithms according to their individual system architecture: the use of between 8 to 64 MB of RAM and the high speed of the X20 processor of the Mars unit make it possible to use a large quantity of wavetables while the floating point 32-bit processor in the DSP TMS320c30 used by the Fly30 system makes precise calculations and complex algorithmic constructions for digital filtering possible without loss of definition.[8]

The algorithm used for granular synthesis by Michelangelo Lupone and programmed into the Mars made possible the use of successive resynthesis of each grain. The signal was memorised and resynthesised in real time by altering the following parameters:

- the memory bank from which the wavetable reads the sound,

[6]The Musical Audio Research Station (Mars) is a system designed and constructed at IRIS of Frosinone. Sound processing is realised with the processor X20, designed by Giuseppe Di Giugno.
[7]The Fly30 is a system operating in real time, designed and realised at CRM, Rome. It is based on the floating point processor TMS320c30 by Texas Instruments.

[8]X20 is a 24-bit processor.

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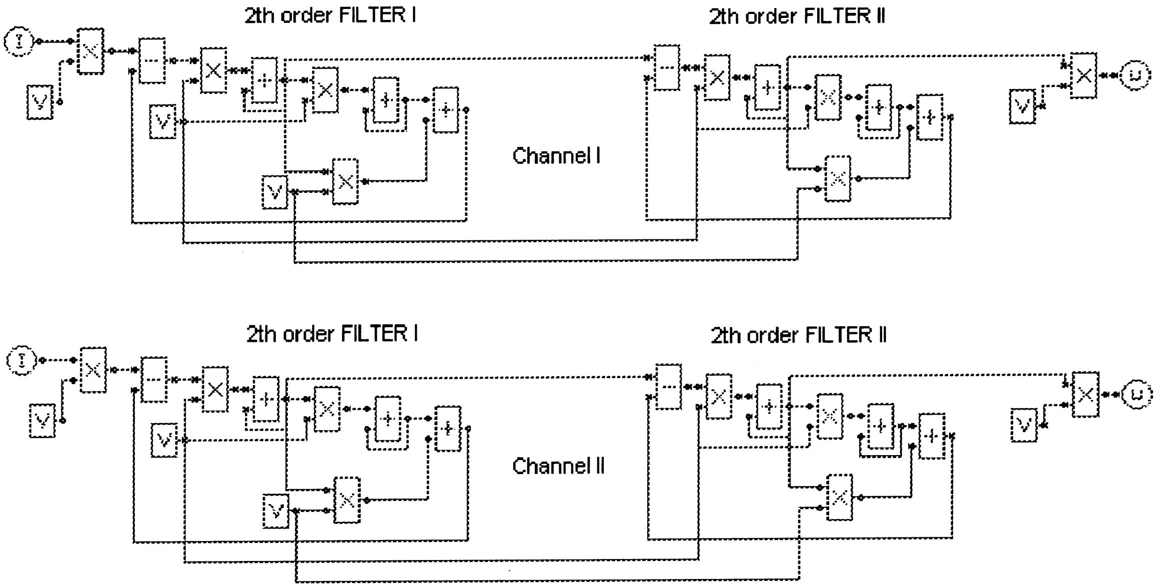

Figure 3. *Contropasso*, algorithm for sound elaboration.

- cycle to the next wavetable,
- type of envelope used in the wavetable,
- distance between cycles, i.e. the amount of silence between grains, and
- the number of consecutive reading cycles of grains between each silence.

Each algorithm is duplicated eight times, creating different tables in order to create ‘clouds’ of grains. These grains are used to create filter resonance. The filter algorithm, as shown in figure 3, used on the Fly30 system by Michelangelo Lupone is based on an algorithm created by Giuseppe di Giugno for the 4x system.[9] This algorithm consists of a second-order (12 db per octave) filter that provides BP (band-pass), LP (low-pass) and HP (high-pass) outputs. The algorithm used by Lupone used two second-order filters in cascade (24 db per octave) with only one BP output. This enharmonic granular material is processed by the filters which bring out certain sound formants.

There are two types of sound sources on which the algorithms act: (i) pre-acquired material stored in 16 kWord wavetables (371.52 ms at a sampling rate of 44,100 Hz) containing the sounds of the dancers’ steps, and (ii) sound material acquired in real time and modified according to a third algorithm created by the Fly30 using wavetables with different envelopes and filters. The operator acts on these sounds in real time. The wavetables with pre-acquired sounds increase the efficiency of the system which would otherwise have to deal with an enormous number of complex parameters.

[9]The 4X was the first system for sound synthesis in real time designed by Guiseppe Di Giugno in 1981 at Ircam, Paris.

2.4. Sonorous Drawing Plane (SDP): a program that allows the execution of music directly from the computer

I developed SDP to allow the creation of computer music in real time thus enabling the computer operator/performer to react to and influence the work as it is unfolding. This allows interpretation to become an integral part of the electronic composition. The program, written in Visual Basic, interfaces with the Mars and Fly30 systems by calling up external procedures contained in DDL (Dynamic Link Library) files created by IRIS and CRM. These files extend the functionality of the system allowing, for example, the assignment of an event when it reaches a certain algorithm.

This assignment of data is controlled by mouse data as it operates within the white background that delimits the user interface. The mouse movements (or gestures) are seen by the system as excursions along the x (horizontal) and y (vertical) axes. As it moves, the mouse creates a graphic representation of its path giving the user visual feedback. Before passing this data to the algorithms, the software translates the single *x*–*y* coordinates into numerical values that the chosen algorithms can understand. It interacts with the parameters according to three conditions pre-selected by the user:

- the axis associated with each parameter,
- the relationship between the length of the axis and the variation supplied by the data itself within a predefined minimum and maximum range, and
- the mathematical function associated with each parameter. If an exponential function is used, a linear movement of the mouse will create a data series that varies according to an exponential movement.

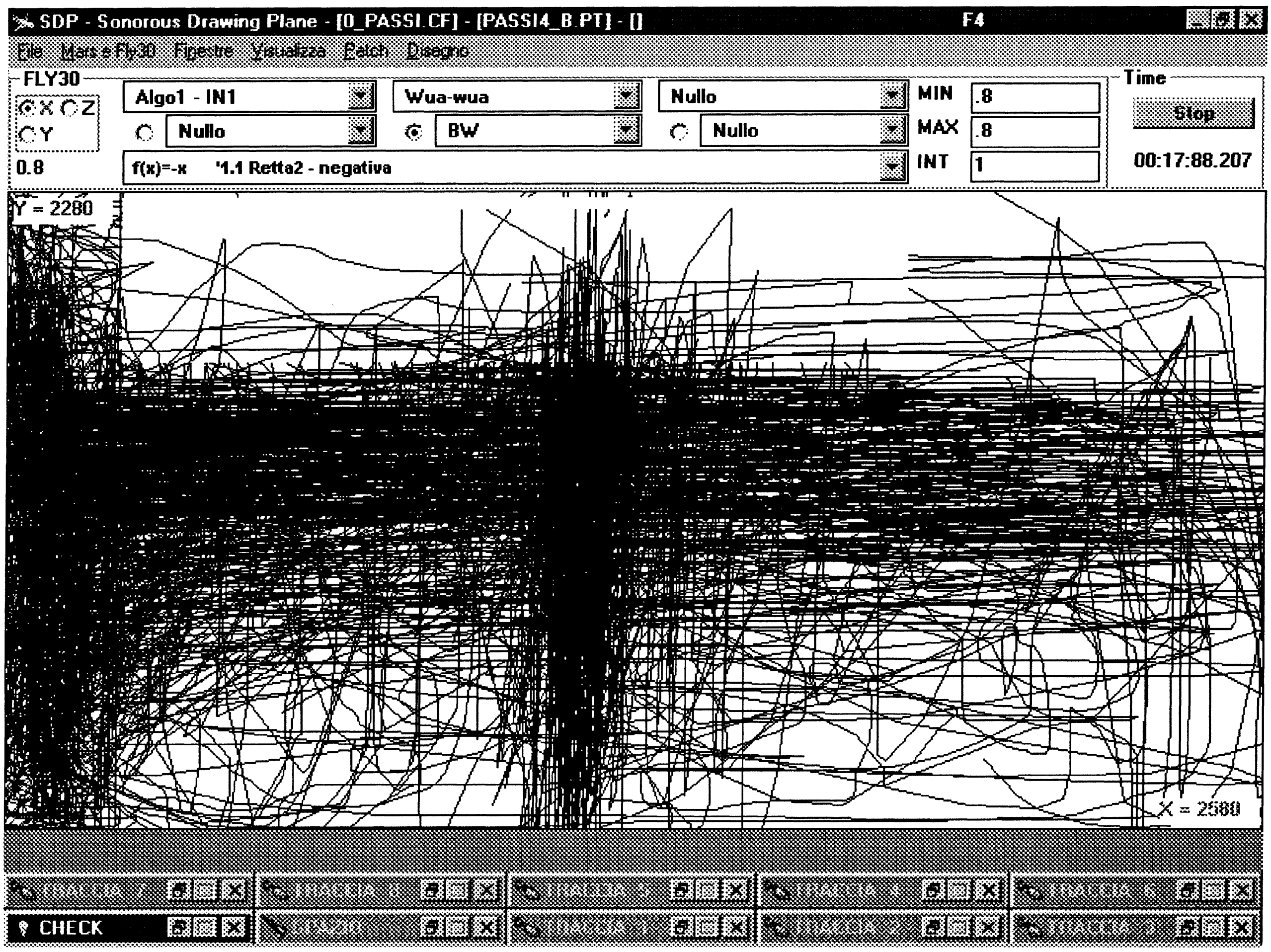

Figure 4. *Contropasso*. SDP executive environment (ver. 1999).

This last function is extremely powerful allowing the independent control of more than one hundred parameters while creating a framework that allows interaction between the different parameters. Figure 4 shows a screen shot of SDP.

Assigning the axis, functions and limits to each parameter (decided before the performance) is called a configuration, and these configurations can be called up at the keyboard by using the f-keys. Calling up a new configuration does not interrupt any processes already under way. This means that the operator can switch configurations at any time without causing glitches in the audio. The speed with which the operator moves the mouse affects the processing speed of the system adding another dimension to the sound quality. This is all done without any appreciable time delay. When the mouse stops moving, the values of the parameters remain constant.

2.5. A hypothesis for the symbolic representation of gesture: a new kind of musical score

The construction of an SDP configuration depends on the type of gesture desired. Some configurations can be relatively static in which large gestures create small variations in the sound. In contrast, one can also program a configuration in which a small mouse movement corresponds to large variations in the sound parameters. This last condition (most configurations use values that fall between the possible minimum and maximum) makes it very difficult to define the gesture accurately. The form that the score must take in order to accurately describe the execution in a musical context becomes extremely complex. Classical musical notation cannot describe the incredible variance of parameters of which SDP is capable. Unlike the performance gestures available when using a keyboard, an audio mixer or a pedal (which have no real spatial characteristics and which vary only in terms of speed and quantity (amplitude) of movement), the characteristics of a mouse gesture are much more complex. They include:

- the spatial coordinates of the gesture,
- the direction of the gesture,
- the length of the gesture,
- the speed of the gesture, and
- the succession of all gestures.

Not all of these variables are easily defined in a way that can be understood by the operator: The resulting representation on the computer monitor can show the form, length and starting and ending points, but cannot

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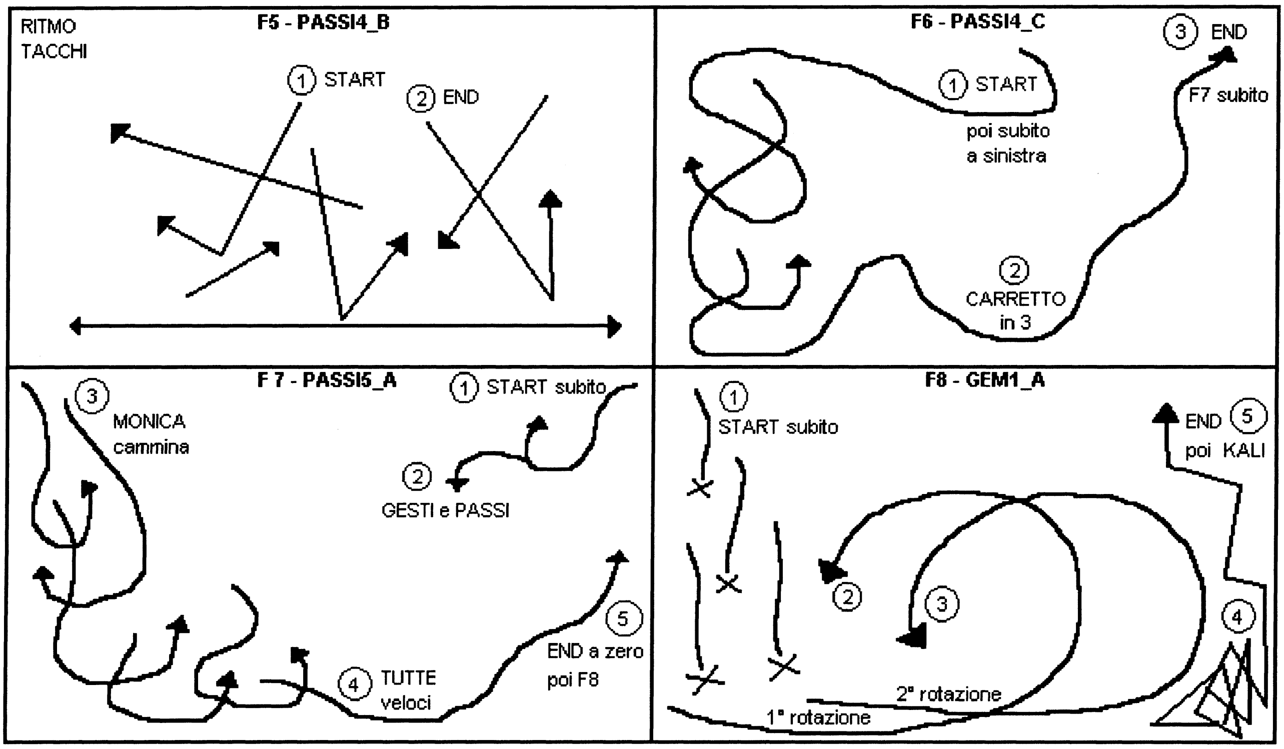

Figure 5. *Contropasso*. Four configurations of the score (ver. 1999).

describe direction, velocity and events that precede or follow the gesture. It is possible to modify the programs creating a multi-coloured grid allowing a clearer representation of the gesture on the screen. It would also be useful to be able to memorise the different gestures so that they can be seen in sequence.

The notation used for the score of *Contropasso* included:

- graphic representation of the actual SDP screen showing only the necessary information: length, *x*–*y* coordinates and type of gesture, and
- indications of speed, direction and sequence of gestures distilled to a simple series of icons that the operator can easily read.

Figure 5 shows a part of the score for the final performance of 'Contropasso' at the Teatro il Vascello in Rome during September of 1999. Each of the dance 'frames' corresponds to one or more sections of the score. The definitive score is still being worked on.

3. THE STORY OF COMPLEX GESTURE: OTHER COMPOSITIONS

The 'story of complex gesture' has evolved through several compositions (including the one above), each one of which explores different aspects of gesture. The first composition using SDP was *Rhysmos – sounds in movement for real-time systems* (1998).[10] The composition makes use of a computer performer who controls Fly30 and Mars systems via SDP in real time. I modified the software for this piece. The acoustic ambience recalls the atomistic world of ancient Greece as represented by the word that describes movement: *rhysmos*. The *àtomon* (that which cannot be divided further) is a quantum particle, a particle without weight. Infinite numbers of different kinds of atoms move without pause, coming together and separating, creating multiple combinations, giving birth to different bodies. The musical idea is one of changeable sound material in constant evolution. Performance flexibility is dependent on the flexibility of the software used to create it. The dialogue between sound elements is constantly interrupted and mechanised by the performers' gestures which impose direction on the outcome of the work creating a metaphor of a universe with certain boundaries. The piece can last from ten to twenty minutes.

The computer performer interacts with a percussionist in *Tracciati* for percussion, planephones and live electronics, which I wrote in December of 1998.[11] The work was inspired by the book *The Invisible City* by Italo Calvino:[12] the percussionist and the computer operator are explorers in an imaginary city as they follow paths created through use of different timbres according to criteria which oppose, exchange, assimilate and fuse as the

[10]Premiere: September 1998, L'Aquila, *Corpi del Suono*. International Festival of Contemporary Music, Istituto Gramma, Auditorium of Santa Caterina. Computer operator and sound direction: Silvia Lanzalone.

[11]Premiere: December 21, 1998, Firenze *Novecentomusica*, Centro Tempo Reale, Marino Marini Museum. Percussion: Johnatan Faralli; computer operator: Silvia Lanzalone.

[12]Calvino, I. 1993. *Le città invisibili*. Mondadori Edns, Milan.

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piece progresses. The percussion is divided into three set-ups spread throughout the hall. These set-ups are based on the construction materials used in the instruments, wood, metal and membranes. The planephones corresponding to each set-up are constructed of similar materials. These planephones (designed by Michelangelo Lupone and constructed at CRM, Rome) are panels made using different construction materials that are set in vibration by the use of transducers attached to them.[13] The wood, plastic and metal from which they are constructed impart different sound qualities coherently to the materials.[14] Different construction materials can also be used together to create varied timbric qualities. The percussionist is free to move between the different positions ensuring a different outcome at each performance. The score consists of nine non-numbered pages, each page corresponding to different materials and therefore different sonorities.

The performers can decide to perform any of three to nine pages in any order creating performances of different length and complexity. The percussion sounds are altered by diffusion through the planephones and by the use of the Mars system. The Mars system is controlled via SDP and contributes another sound element to the composition. This material remains audible when the percussionist changes stations. Formal flexibility is reflected in the interpretive freedom given to the performers. They interact freely, creating a dialogue that is further amplified as the percussionist carries on his interaction with the live electronics.

An interesting and unique relationship takes place between magnetic tape and computer operator in *Melodie II* for magnetic tape and realtime computer intervention (1998) by Fausto Sebastiani.[15] The piece explores the possibilities of interaction between magnetic tape and realtime computer through the use of SDP. The work uses FM synthesis created in CSound and real (concrete) musical instrument sounds processed by using nonlinear algorithms thereby creating distortions on a Fly30 system. The synthetic sounds are used as a unifying element which interacts with the concrete elements creating a sort of ‘sound frame’. The piece lasts about fifteen minutes. The live electronics uses the magnetic tape as a sound source creating a dialogue between the sounds present on the tape and the processed sound in real time. The realtime elaboration consists mostly of the manipulation of cello and percussion samples (roto-toms and chimes of various types). This interaction between the prerecorded material and live electronics ensures a different emotional impact each time the piece is performed, much like a piece written for magnetic tape and musical instrument. The ability to create different configurations enables the composer to experiment with different possibilities (three were used in this particular piece).

Dis-trazioni, an interaction for two realtime computer set-ups (1999), is a piece I wrote for two different realtime systems each using SDP, Mars and Fly30 systems. One of the performers pronounces certain keywords and manipulates his own voice in real time. The second performer uses more complex sound sources created through analog synthesis. The speaking of the keywords corresponds to certain sound fluctuations: the basic material is divided into multiple images creating chaotic sound passages and distractions. Before and after the speaking of the keywords the sound returns to linearity while conserving certain aspects of the distractions. The performance requires close collaboration between the performers as they manage the different sound materials in pre-established though flexible paths. These paths constitute the direction and the form of the piece while the speed of execution is entirely up to the performers. The concept of lengthening and shortening applies to the time of execution. The contradiction implicit in the title, which denies a concept while at the same time defining its very existence, expresses the dialectic that comes about when concepts are taken to extremes. This dialectic, independent of the elements to which it is applied, is expressed not through criteria of opposition or discord, but through a system of balances which are taken to the edge of stability until they explode. The moment of laceration is determined by excessive manipulation of the sound materials and the definitive alteration of the forces at play which eventually spin out of control causing the collapse of the system and, finally, breakdown.

4. A LABORATORY FOR SOUND DESIGN: MUSICAL COMPUTER GAMES FOR CHILDREN

The relationship between movement, computer mouse and sound can be startling, so much so that it suggests other uses for SDP, including games for children in which they use the computer to create electronic compositions. At the Laboratory for Computer Music (Laboratorio di Informatica Musicale), in collaboration with musician Fausto Sebastiani and teacher Sandra Fortuna in June 1999 for the Music Festival at the Il Punto di Svolta art gallery, SDP was used in an experiment with children between the ages of four and ten years of

[13] ‘Planephones’ are vibrating sound systems consisting of panels of different materials (wood, metal, plastics, leather, etc.) and shapes designed by Michelangelo Lupone at CRM, Rome, for a coherent and harmonious installation in artistic venues, they differ from traditional loudspeakers, in that the sound acquires the timbral quality of the material employed and, in addition, by diffusing the sound homogeneously along the surface, permits the design of the accoustic space according to the architectural space.

[14] The panels, divided into three groups (metal, plastic, leather) are set on the stage beside the three stations of the percussion instruments.

[15] Premiere: L’Aquila, 20 April 1999, MUSPAC Experimental Museum of Contemporary Arts. Computer operator: Silvia Lanzalone; sound direction: Fausto Sebastiani.

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Figure 6. Laboratory *Il disegno sonoro*. Luca's drawing (child aged 7).

age. The children were encouraged to create a composition by making an abstract work of art. The goal was to expose the children to the language of contemporary music by exploring the relationship between gesture, design and sound.

As one uses the system, this relationship is easily understandable, often intuitive. The setting up of the system and creating the different configurations is not so intuitive. For this reason, the children were presented with a choice of preprogrammed sounds.[16] They could then use the mouse to change selected sound parameters. The children were asked to create a composition based on a drawing or the 'sonic background' for a cartoon.[17] The games were called Sonic Draw and Sonic Cartoon.

The children were instructed in three stages, the first two of which were aimed at helping the children to achieve an intuitive understanding of the way the system acted on the sounds and the effect that different gestures would have on these sounds.[18] In the third phase the children were left free to experiment on their own:

(1) The operator invites the children to make graphic designs on the screen while noting how the sound changes in relation to these designs. The next step is to take the children through each sound parameter one by one, enabling them to understand in more detail the effects their designs have on the sound. In this way the children discover which types of gestures they must create in order to achieve the results they want. Some gestures change pitch level while others affect intensity, density and timbre.

(2) Once they have understood the effect of various gestures, the children are invited to 'explore' the video screen and try out different graphic and musical gestures.

(3) In this final phase the children are asked to create a composition using the techniques they have learned. In this way they are able to create compositions that have both a visual and musical dimension.

[16]Sound configurations were excerpts from the composition *Contropasso* by Michelangelo Lupone.
[17]Compositions were based on improvisation techniques.
[18]The system of coordinates was completely configurable and allowed different solutions for associating gesture to sound.

Cartoon Sound was influenced by the audio tracks heard everyday on cartoon programs. Once the children had learned the possibilities available to them, they were able to create a sonic background to cartoons that were played for them on the computer monitor. Given the wide range of ages of the children, a suitably wide range of cartoons and sounds were provided. Each child chose three sounds which s/he used in the creation of a musical accompaniment guided by the emotional reaction to the images to which s/he was exposed. Figure 6 shows one such design (created by Luca, aged 7).

The object of this computer music laboratory was to show that children could make a symbolic sound event which to them had meaning while bypassing the formal study of conventional music theory. Now that it is possible to process sound in real time with the use of a computer, we now have at our disposal a tool that will enable us to use the language of sound in new contexts. A child uses speech and pictures before learning the 'rules' of language and art. In a similar fashion, s/he should be able to use sound elements as another language by creating spontaneous correlations between images, sound and meaning.

The SDP approach is intuitive and, above all, allows timbric manipulation through the use of simple gestures. This is a powerful tool since timbre is one of the aspects of sound that affects our perception and interpretation of emotion. By making these manipulations easy to achieve – by linking them to gestures – and divorcing them from traditional music study, it allows children to approach music from an improvisational point of view by leaving them free to explore the language as well as the substance of music.

5. THE FUTURE

Looking back on the experiments that have been done, I believe I have proven that an environment such as SDP is in fact a 'composing instrument' that can have an effect on form by including the use of gesture in the creation of electronic music. The program and its limitations are easily understood, an important factor when approaching a project in which one desires to enhance the possibilities of the 'instrument'. The traditional concept of 'musical instrument' implies the concept of 'technical limitations' that make writing for it difficult. I believe that future modifications of the program will include more comprehensive timbric manipulation and the improvement of the integration of gesture into performance. The interface will be modified so that other hardware input devices (such as graphic tablets, joysticks, keyboards, analog-to-digital converters, pedals and sensors of various kinds) can be used in the realtime manipulation of sound. One will be able to create gestures that will go far beyond the possibility of the simple computer mouse.

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