1-1-2012

New digital interactions with John Cage's Variations IV, V and VI

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ABSTRACT

To celebrate the centenary of John Cage's birth in 1912, Western Australian new music ensemble Decibel undertook the realization of the American composer John Cage's (1912 – 1992) complete Variations I – VIII. *The works offer a unique insight into the development of Cage's approach to composition practice, aleatoric approaches, spatial arrangements and the use of electronics. Entitled the "John Cage Complete Variations Project", Decibel created a performance of the eight pieces in around an hour. The preparation and reading of the scores that make use of transparent sheets (*Variations I, II, III, IV and VI*) has been adapted using digital score creators and readers. This permits real time generation of measurements and graphics, as well as the assemblage of performance symbols, that can occur during the actual performance of the works. This paper examines the approach to the* Variations *whose instructions result in the employment or creation of maps:* Variations IV *(1963),* V *(1965) and* VI *(1966).*

1. INTRODUCTION

John Cage's eight *Variations* composed between 1958 and 1967 are a varied collection of compositions prepared in very different ways. They take score forms that range from very precise instructions (*Variations I, II, III, IV, VI*) to reflections on early performances (*Variations V*), handwritten sketches (*Variations VIII*) or only few words (*Variations VII*). The works encapsulate Cage's interest in maps, astronomy, system design, spatial sound production and multimedia. They at times incorporate similar orchestrations to his *Imaginary Landscapes* series (five works composed between 1939 and 1952) such as radios, tapes and oscillators. The *Variations* introduce new equipment to Cage's composition toolbox – antennas, light sensitive resistors and telephony. As David P. Miller suggests, the *Variations* offer "a trajectory away from self-contained concert pieces (*Variations I* and *II* in particular) and culminating in theatrically ambient works that draw on an increasingly broad range of source material" [1]. In addition, the approach to notating and communicating Cage's ideas undergoes a dramatic development throughout the *Variations.*

Despite a number of performances of individual *Variations* (though surprisingly few it would seem), *Variations IV* and *VI* have been performed the least. This may be due to a number of factors; the complex and rather convoluted instructions provided for *Variations VI* and the possibility of unperformable arrangements or outcomes in *Variations IV*.

Transparent plastic sheets are provided with the scores in *Variations I, II, III, IV* and *VI*. *Variations V* and *VII* and *VIII* use text only, and appear more of a record of a past performance than as an instruction per se[1]. Text features heavily in all the *Variations* scores: however, even with the transparent sheets provided in the score folders, detailed instructions as to what is to be done with these sheets are provided and are often difficult to interpret[2]. Yet the key distinguishing qualities of *Variations IV* and *VI* is the requirement to generate specifications for the placement and directions of sounds in the space. More information is provided about the where the sound should be produced, than how to produce it. As such, they have offered up different challenges for real time digital score generation when producing what Miller has called 'performance scores'[1]. *Variations IV, V* and *VI* create performance 'maps' rather than scores, and performing them involves a process of exploration and discovery.

Decibel has been working with graphic, mobile and real time screen scores for some time, and the *Complete Variations Project* has provided a possibility to apply experience and expertise gleaned from the creation of new works to the realization of historic pieces [23]. Each of the *Variations* has a performance score produced digitally, and realized in real time, where the computer performs cut ups, random placements, measurements, joining up of figures and realisation of the resulting score onto a computer screen or projection to be read by performers[3].

As part of its performance strategy, Decibel distributes scores in MaxMSP devised players to multiple Apple MAC laptop computers over a wireless network, driven by a master computer. This made it necessary to synchronize score events by linking all the required data for sending across the network. As certain networking protocols, such as User Datagram Protocol (UDP) transmission do not ensure that information is received in the same order as it is sent, concatenating the information into a single matrix data structure ensured that the order of information remain intact. To facilitate this networking and allow troubleshooting, a network utility has been developed by James to facilitate and monitor network traffic in MaxMSP, the interface of which can be seen in Figure 1.

[1] Cage subtitles *Variations V* on the cover page with "thirty seven remarks re and audio visual performance" and footnotes the scores with references to a certain performance of it (the premiere)[14].

[2] An admission shared by David P. Miller in his paper on the *Variations* [1].

[3] *Variations V, VII* and *VIII* do not require scores at all, as performance notes are all that are required [13,16,17].

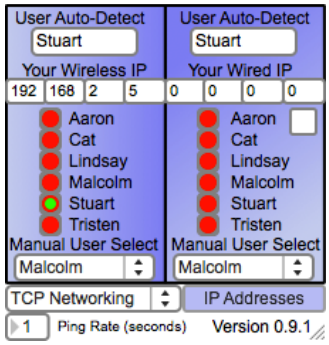


Figure 1: The interface for the Decibel network utility has the ability to be used for TCP and UDP networking, on wireless and wired networks.

This has meant that all the scores created for the *Variations* project are visible to each performer at all times, as required. This also means that any projections of the scores may come from any performers computer. The generation of data required for creating and displaying the scores of *Variations IV* and *VI* was carried out using a combination of Max/MSP and Java programming by Decibel members Stuart James (MaxMSP), Lindsay Vickery (MaxMSP) and Aaron Wyatt (Java). The premiere of the Variations project was held in was a projection room at the Goethe Institut in Palermo, Italy in early 2012 [21].

2. VARIATIONS IV (1963)

Variations IV has been dubbed the pivotal work in the *Variations* series of works, because "it takes the distribution of sound sources within and outside a given space as its primary point of interest, laying the ground for the commitment to total environments that marks *Variations V* and *VII* (and arguably *VI*)"[1]. Cage's ongoing interest in new technology seems to have been directed towards an environment that would allow him to map sonic space by "allowing access to the full range of all the specific parameters of sound"[2]. Here Cage refers not only to parameters such as timbre, dynamic, pitch and so on, but also spatialisation.

Variations IV is the second part of a group of three works of which *Atlas Eclipticalis* (1961) is the first and 0'00" (1962) – also know as 4'33" No.2 - is the third. The sequence relates to HideKazu Yoshida's interpretations of Japanese Haiku poetry, and aligns lines of the poetry to different psychological states: *Atlas Eclipticalis* represents 'nirvana', *Variations IV* represents 'samsara', (the turmoil of everyday life) and 0'00" 'individual action' [3]. This 'turmoil of everyday life' could be considered realised twofold in *Variations IV*. The placement of performers around and outside the space, away from the stage or concert hall brings the musicians into the world, away from the theatrical presentation of the stage. In addition, the reluctance of Cage to give specific instructions as to what sounds be produced, going as far as to suggest that "a performer need not confine himself to a performance of this piece. At any time he may do something else"[13]. Both these parameters offer up risk and uncontrollability, much more than in previous *Variations*. Here, Cage is moving closer to a different paradigm for music altogether, where performers are removed almost completely.

The actual location of the performers - playing or 'doing something else' - is clearly marked by way of the score. Continuing the use of transparencies as in the first three *Variations,* Cage provides a sheet with seven points and two circles to be cut into separate parts. One circle is placed on a map of the performance venue, to be provided by the performers. The other eight remaining points and circle are dropped "inside or outside" the map and lines then are drawn from the fixed circle to the points [13]. The second circle only becomes operative when a line intersects with it. Cage then instructs that "sounds to be produced at any point on the lines outside the theatre space"[13]. An intersection with the dropped circle indicates a sound producing system inside the space. The instructions are tailored according to a theatre space, a multi floor building, apartment, cave or outdoor space. Decibel worked in a theatre for the first performance. In *Variations IV*, the provided symbols are not to be 'performed' as in previous *Variations*, or even given musical parameters at all. Rather, the performance score provides arrangements for the placement of the sounds in particular space, providing another major shift in Cage's compositional approach and the beginnings of his interest in spatialisation.

A recording of *Variations IV* recorded by America's KPFA Radio for the birthday of Cage's long-term collaborator David Tudor in 1965 produced a work some thirtyone minutes long. It features loudspeakers placed in hallways outside the performance space that interacted with speakers inside the space [5]. The performance features a range of radio announcements, radio static noise and music, which come to the listener from different areas of the space, and heard as different timbres and dynamics on the recording. An earlier 1964 performance in Los Angeles' Feigen-Palmer Gallery went for some 6 hours, and featured two rooms fitted out with complete sound systems that included recording and mixing equipment, numerous radios, tape players and record decks [7]. In this performance, microphones were placed strategically inside and outside the building (one was suspended above the bar, another out in the street to catch the passing traffic)[6].

Decibel developed upon earlier performance score engines created for *Variations I – III* to compile *Variations IV*[4]. Due to low processing overheads *Variation IV* was implemented solely in MaxMSP. All scored elements were drawn using the quickdraw primitives found in the jit.lcd object, permitting the

[4] For a detailed examination of what was involved in the creation of the first three *Variations*, see Vickery, Hope, James. (2012). "Digital adaptions of the scores for Cage *Variations I*, II and III" [4]

creation of all necessary objects referred to in Cage's score: the circles, lines, points, and the lines to be drawn between them. A map of the venue was attained and inserted into the program, which then complied the data and superimposed it over the map[5] (see figure 2).

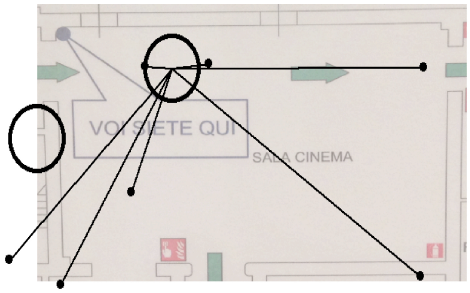


Figure 2: The score generated for the first Decibel performance of *Variations IV*. In this version, all points and lines were accessible to the performers.

A series of random coordinates were generated for determining the location of the two circles, seven points, and resulting lines. These random numbers are then used to instruct jit.lcd to draw these objects to the screen, emulating the 'dropping' of the cut up transparency. There are three layers of jit.lcd with a differing transparency assigned to each, allowing the superimposition of the graphics over the venue map. A threshold mechanism was employed to control the amount of transparency applied to each layer, allowing an organic control of the way visuals appear and disappear in the real time realization of the score, fading in and out.

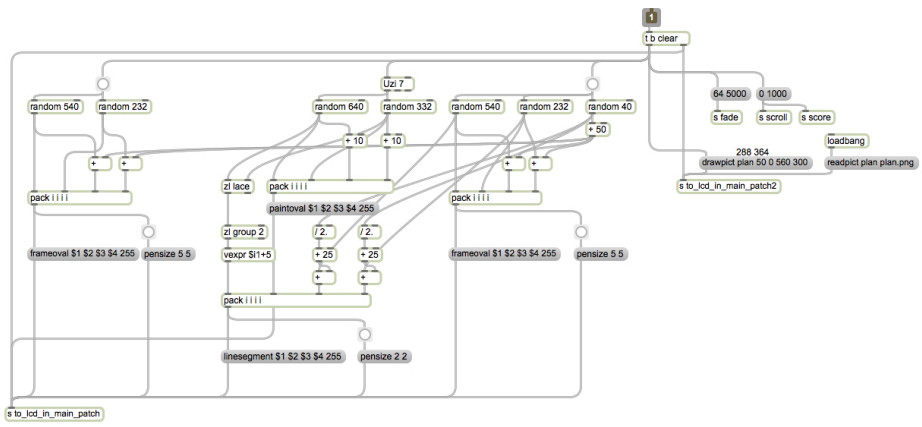


Figure 3: The MaxMSP patch used to generate the score for Variations IV.

As the graphics are 'dropped' randomly over the map, it is possible for certain outcomes to be less successful than others, depending on the venue and the portability of equipment. For example, some venues have inaccessible rooms encircling them, meaning it is difficult to get outside the building and still be audible, though I'm sure Cage would approve all the same. Often certain venues have areas that could be deemed interesting to use and this systems enables some flexibility in including them in the performance. The realtime generation of the lines on the map enables a quick turnover of different performance score options if desired, until a satisfactory result is achieved (figure 4).

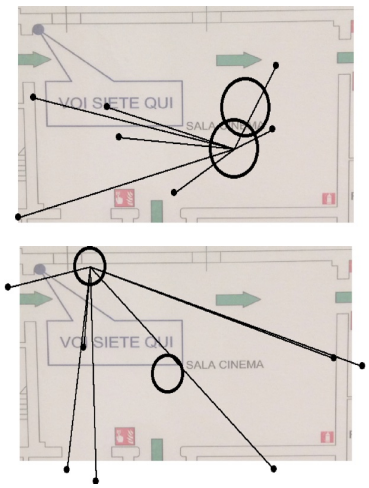


Figure 4: Two other iterations of a possible score for *Variations IV* at the premiere performacne. Here, certain impossible arrangements have resulted, such as behind walls that are not accessible.

Decibel generated some five or six arrangements before settling on one thought to be workable, as shown in Figure 2. Figure 4 shows two other possible options. Six performers situated themselves on the map. Unlike early performances using radio and tapes, Decibel engaged viola, electric cello, spoken word, bass flute (which ended up in a bathroom) and one performer dedicated to 'doing something else'. In addition to these roles, the performers walked about, talked to each other, opened and closed doors, flushed toilets and other took part in other activities. As can be seen in Figure 2, the second circle was not engaged and as such a 'sound system' was not employed. Unlike some early performances of *Variations IV* by Cage and Tudor, dance did not make part of this performance[6][13]. The score was projected onto the empty stage, and a series of

[5] For the premiere, it was a photograph taken of the fire exit map beside the stage.

[6] Merce Cunningham's choreography for *Field Dances* (1963) and *Cross Currents* (1964) was featured [5, 20].

versions were generated until one that was achievable given the resources available was attained[7].

3. VARIATIONS V (1965)

Cage does not provide a score for *Variations V*, instead he offers the possibility for the performers to obtain a star chart and to use it "as though there were a drawing of the controls available and – on transparency – transcription from astronomical atlas which (if it were superimposed) would give suggestions for use of controls" [14].

Decibel chose the chart shown in Figure 5 (which resembles Cage's own score for his *Fontana Mix* (1958)). During the performance the chart is continuously repositioned, moving smoothly in the vertical and horizontal dimensions, jumping to particular new positions and expanding and contracting. The performers realize the work by interpreting the components of the score that are framed by a circle, colour-coded to correspond to each player, as "suggestions for use of the controls". Each performer's circle also moves freely around the screen[8]. As in Variations IV, all programming was completed in MaxMSP.

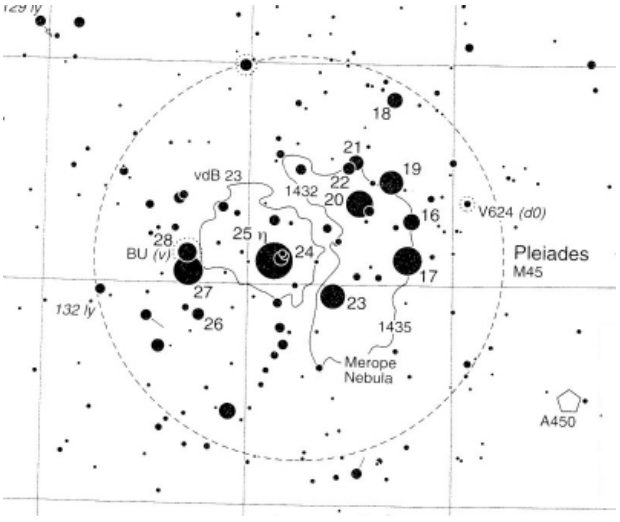


Figure 5: The Astronomical chart used for Decibel's version of *Variations V*.

The trajectories of the circles are programmed so that their movements are indeterminate, but permutate between a range of contrasting behaviors: wander – in which the movement of the circles are completely independent; follow – in which the trajectory of the one circle is mirrored by the remaining ones; and converge in which the (moving) position of the one circle is the circles converged upon by the others. In addition to these behaviours, each circle is programmed to grow in size at indeterminate points in the performance, indicating that the corresponding performer should take a more soloistic role. These behaviours are illustrated in Figure 7.

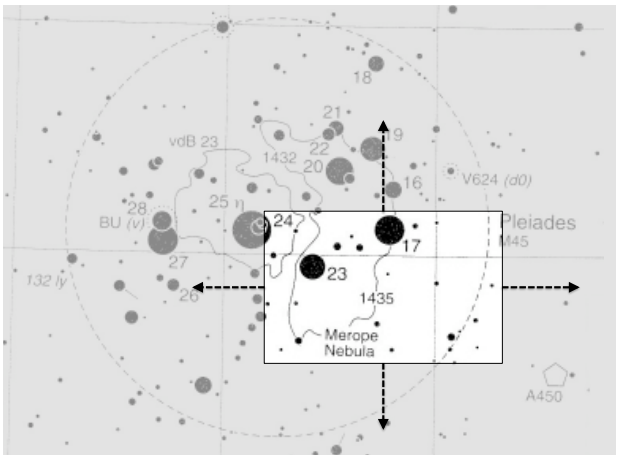


Figure 6: A representation of the relationship between the mobile score and the visible score that appears on the performer's screen (shown here as the opaque rectangle in the lower left-hand corner). The visible portion of the mobile screen is continuously repositioned during the performance.

The movement of the score and the behaviours of the circles provide a focal point of the performers reading the score. The performers are left to interpret the meaning of the symbols in relation to the electronic control parameters at their disposal. Therefore the structural outcome of any particular instantiation of the work is extremely indeterminate, relying as it does upon indeterminate trajectories both of the score and the circles as well as the performer's interpretations.

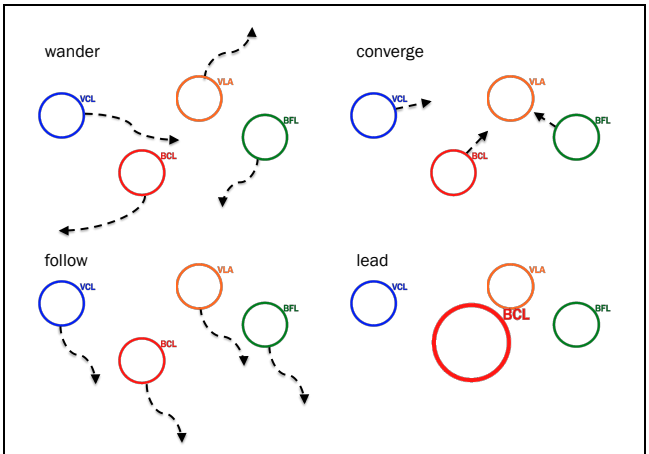


Figure 7: A graphical representation of the behaviours of circles in *The Talking Board.*

[7] The premiere performance had many restrictions on accessing outside space, and the speakers were not easily moved, and had very short cables. As such a few different versions were generated as part of the performance.

[8] A similar arrangement was employed by Decibel in Cat Hope and Lindsay Vickery's work *The Talking Board* (2011), with a collaged image created by the composers.

4. VARIATIONS VI (1966)

Like all the *Variations* after *V*, *Variations VI* is characterized by "the unpredictable interactions of multiple simultaneous systems"[8]. After the very open nature of *Variations V*, *Variations IV* returns to the methodology of transparencies, yet now generating a different range of instructions for the performance score. Much of Cage's writing on music in the 1950s focused on the identification of frequency, amplitude, timbre and duration, yet here in *Variations VI*, he has a different range of sonic territory to explore [8]. Terms such as 'varied' and 'unvaried operations' are the only 'musical' instructions provided [15]. All other information pertains to arrangements of various elements that are available be used in the performance.

The period between *Variations IV* and *VI* was not prolific for Cage, but did feature works where electronics were becoming prominent[9]. As Miller points out a key to the iteration of *Variations VI* is the requirement to decide what is what Cage calls a 'sound system', and how one may articulate and arrange components within that [1]. One of the most liberating elements about *Variations VI* is the way the score works to fit what is available, rather than the need to provide what is demanded. The

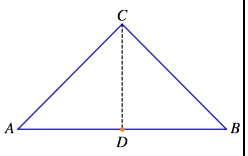
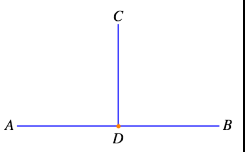
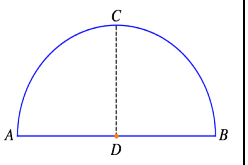
Cage's parameter name	Cage's symbol	Decibel's assignment	Decibels generated symbol, showing the co-ordinates measured
loudspeaker	Hand drawn triangle	amplifier	
component	Hand drawn Bisected short lines	Effects, effect pedals	
Sound sources	Hand Drawn Half circle	performer	
Sound system	Straight line	Total combination of the above	

Table 1: A list of symbols and assignments used in Decibels performance of Variations VI.

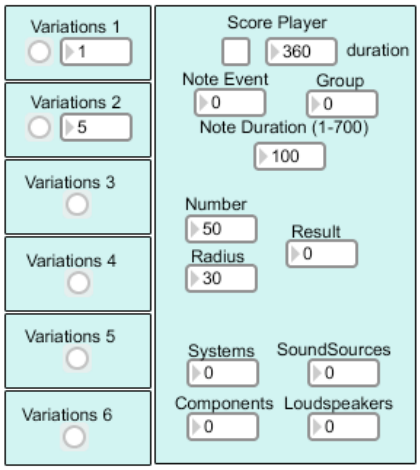


Figure 8: The master control panel for Decibel's realisation of the Cage Variations. The selections for the number of each parameter required in Variations VI are inputted bottom right.

interface that controls all the electronic score generation for each of the *Variations* provides easy input of the parameters required to generate the performance score – sound sources, components, loudspeakers and the aforementioned sound systems (figure 8)[10]. Where the performance score for *Variations IV* provides only spatial arrangement information, *Variations VI* dictates equipment arrangements and some minimal musical direction. Cage's goal of composing "notations that circumscribed a field of musical possibility out of which an unrepeatable stream of unique sounds and actions could emerge" had become a reality[10].

In terms of curating a varied and engaging *Variations* program, the orchestration of *Variations VI* is pivitol. It is framed by the two most chaotic and large scale works (*Variations V* and *VII*) and as such requires careful consideration of pace and orchestration to maintain audience engagement. After the first four variations being presented as acoustic in nature, and *Variations V* using a range of electronic sound producing tools, it was decided to make the instrumentation of *Variations VI* electronic, reflecting the direction Cage was taking with

his compositions at that time. Decibel members Cat Hope (noise bass guitar) and Malcolm Riddoch's (noise guitar) instrumental and effect set ups were nominated the 'sound systems'. In this way, the experienced improvising performance styles of these musicians offered a contrast to the more chaotic and 'style-free' approaches in the neighbouring *Variations*, and offered a framework in which to read *Variations VI*.

[9] This period saw the composition of Electronic Music for Piano (1964), Rozart Mix and Variations V (1965).

[10] Variations VII and VIII were not included, as they have no score to generate. For Variations V we used an astronomical atlas as suggested, and developed a mechanism to 'read' the map in realtime. Thus it was included in the master control panel.

Provided with the score instructions for *Variations VI*, are symbols on a transparent sheet intended to be cut out and dropped onto a sheet of paper with a vertical line drawn vertically down the middle. Each of these symbols signifies what we will call a different 'arrangement parameter' as allocated by Cage. These arrangement parameters instruct how to group parts that make up a unit. They differ from the instructions provided on how to read the resulting performance score. The random placement of the cut out symbols on the lined sheet signifies how different arrangement parameters are to be allocated and interpreted. These parameters are listed in Table 1, showing what Cage provides as material, and how Decibel has re generated the meanings and the actual symbols digitally.

Decibel programmed an environment in MaxMSP where it was possible to virtually 'drop' the symbols onto the computer screen (being the 'non transparent sheet' described in the score) in realtime, a similar process that was used to realise *Variations IV*. The final column in the table above shows how the symbols were measured and categorized to enable their digital rendition and behavior. Each of these symbols were derivative of the same structure and dimensions, and a geometric transformation was applied to the coordinates A, B, C and D, giving a random distribution of rotation and translation to each symbol when they 'drop' onto the screen. The distance from each of these symbols to the straight line is measured and grouped differently depending on their proximity. The perpendicular distances are measured according to the vector equation:

$$d = \frac{\left|\left(x_2 - x_1\right)\left(y_1 - y_3\right) - \left(x_1 - x_3\right)\left(y_2 - y_1\right)\right|}{\sqrt{\left(x_2 - x_1\right)^2 + \left(y_2 - y_1\right)^2}}$$

The digital replication of the cut out symbols provided on the transparency was achieved using Java. The symbols are grouped based on the extent of their proximity to each straight line or system with the following code:

```
private void assignGroups()
{
  double minDists[] = new double[shapes.length];
  for (int i = 0; i < minDists.length; i++) {
    minDists[i] = inlets[0] + inlets[1];
  }
  for (int i = 0; i < lines.length; i++) {
    for (int j = 0; j < shapes.length; j++) {
      double dx = lines[i].getX(1) - lines[i].getX(0);
      double dy = lines[i].getY(1) - lines[i].getY(0);
      double m = dy / dx;
      double c = lines[i].getY(0) - (m * lines[i].getX(0));
      double px = ((dx * shapes[j].getX(3)) + (dy *
      shapes[j].getY(3)) - (dy * c)) / (dx + (dy * m));
      double py = (m * px) + c;
      double distSquared = pow(shapes[j].getX(3) - px, 2) +
      pow(shapes[j].getY(3) - py, 2);
      double dist = sqrt(distSquared);
      if (dist < minDists[j]) {
        minDists[j] = dist;
        shapes[j].setGroup(i);
      }
    }
  }
}
```

The program also included the ability to extend the lines, as requested by Cage, and seen in Figure 9; "Drop each reserved symbol on the non- transparent sheet. Two adjacent straight lines which converge (or would if extended) or cross symbolize a sound system or systems" [15].

There were a number of reasons for adopting Java. There was need for the fast creation of both recursive structures and management of arrays or lists to enable the drawing of the symbols. A lower level language is more adept at intensive number crunching and list management tasks than a higher level graphical language such as MaxMSP which is based on a scheduled paradigm, where particular care must be taken in relation to ordering of events. MaxMSP provides considerable documentation on procedural management and message ordering, including the right-to-left and bottom-to-top approach to the arrangement of objects in a patcher window. However, when combining this with the construction, deconstruction and permutation of lists recursively, it became apparent that these are better implemented using a programming language such as Java or C. This had been tested in the score generation for Variations II, a score that requires many measurements to be taken into consideration. In realtime score generation, time is key. The real time generation of the data processing for *Variations II* took 6.27 milliseconds computational time in Java as opposed to 1860 milliseconds computational time in MaxMSP, a significant difference. This involved sequential tasks such as list construction, permutation, deconstruction, geometric algebra, and storage of relevant results into a Jitter matrix. The Jitter Application Programming Interface (API) is accessed directly from the main patcher window.

The information enabling the rotation, placement and gouping of the symbols is then sent over the network to any computers for displaying the score. The score information is formatted in a specific way, and consists of a single list of numbers starting with a header describing the variation number, display information such as transparency, the number of systems, components, sound sources, and loudspeakers that appear, and an interleaved list of x and y cartesian coordinates for generating all of the required symbols followed by a group number. The group numbers are used to color each symbol in the score differently, making it clear which objects relate to which system. Figure 9 shows the score generated for Decibel's premiere performance of *Variations VI,* where two elipses were added manually after the symbols were 'dropped'. These indicate the grouping of symbols relating to the each of the sound systems avialable, rather than the colouring of the symbols, as the

performance took place before the colouring of symbols has become available.

The rotation of each object was then interpreted by the performers live. The vertical or horizontal tendencies of each symbol represented how much a particular system is varied or not varied, respectively. The musicians interpreted these in their performance style, reading the score from a project in any direction they chose, following the symbols as indications to different degrees of change in a performance that lasted some eight minutes.

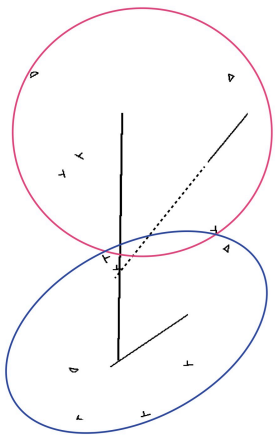


Figure 9: the first iteration of Variations VI with manual groupings indicated by a red (upper) and blue (lower) ellipse.

Cage notes that the distribution of sound in space is indicated by the relationship of the 'dropped lines' to the fixed line of the screen by noting "the orientation of the converging straight lines with respect to the non transparent (vertical) line may suggest distribution of sound in space' [15]. As a response to this instruction, the amplifiers were directed to project the trajectory as specified in the score, and shown in Figure 10.

Figure 10. Decibel members Cat Hope (bass) and Malcolm Riddoch (guitar) performing Variations VI in Palermo. Photo by Davide Carozza.

5. CONCLUSION

DeLio points out that Cage has provided "a significant attempt to introduce various notions of multiplicity into musical discourse" [18]. The *Variations* epitomize this intention. Yet the impetus behind Decibel's realisation of these works has been principally performative: to create practical tools for the realisation of the works, that retain both indeterminacy and the precision of the Cage's specification yet allow an open performative involvement characterized by the groups skills. The digital rendering of these works aims to provide performance scores where accurate performances are more likely, and avoid the problem of so called 'faking it').

The digital rendering of the performance scores enables multiple precise realtime instantiations that can become an efficient part of the very performance of the works. It enables performers to choose an almost indefinite range of possibilities for performance, but also provides the ability for performers to choose the best of a series of possible performance scores, particularily in regard to *Variations IV*. The network utility enables trouble shooting where score coordination is an important consideration.

This *Cage Variations Project* is a work in progress where performance plays an important part of the research methodology [22]. Each performance opens up new possibilities, ideas and problems to solve. The current phase of development heading towards the second performance involves making the score players function on iPads, replacing the quickdraw protocol with Quartz 2D drawing tools, and the adoption of OSC for network facilitation. This will lead to the development of a 'Cage Variations Performance Score Generator' as a stand alone application that will combine the score generators, players, network facility and management in a single application. And then, Cage's important compositional traits as exemplified in the *Variations* will become available and easier to use than ever, through a wide distribution for use on the latest consumer end technology.

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