Chapter 5 - ALGORITHMIC CHOREOGRAPHIES

This fifth Chapter will focus upon a series of examples that express choreographic knowledge by digital means. In contrast to the examples previously mentioned, these choreographic expressions result from algorithmic procedures that, as particular cases of solution to the problems of choreographic transduction, were automated digitally. The first case to be discussed (Section 5.1) is the "*Gesture Follower*", a software built into the digital expressions of the "*Double Skin/Double Mind*". As the name indicates, this is a software apt to recognize and follow the performance of gesture. This will allow for essaying a distinction between the dancing body and the gestural body and, from the perspective of digital algorithms, discuss once more the relationship between dancing and writing in the constitution of choreographic knowledge. The following Section will unfold by considering a series of choreographic algorithms retrieved from two distinct projects: the "*Motion Bank*" and the "*Reactor for Awareness in Motion*". Different aspects of the so called online scores, created in the frame of the first project, will be discussed in order to assess how, from different bodies of artistic work, the problems of choreographic transduction have been resolved into the algorithmic generation of digital expressions. These are the online scores of William Forsythe's "*One Flat Thing, reproduced*" (called "*Synchronous Objects*"), Deborah Hay's "*No Time To Fly*" (with the same name), Jonathan Burrows and Matteo Fargion's series of duets (called "*Seven Duets*"), and Bebe Miller and Thomas Hauert's strategies of choreographic improvisation (called "*Two*"). Insofar as the digital algorithms used in these scores synthesize instances of choreographic knowledge, their transductive capacity will be looked upon by considering instead the "*Reactor for Awareness in Motion's*" software. Since this software's algorithms are meant to be "danced with", in real-time by dancing bodies, they will facilitate a better understanding of how all these algorithms are capable of conveying choreographic knowledge.

5.1 - Diagramming Gesture

Regarding the encounter between dance and technology, Erin Manning notes that one recurrent problem has to do with the definition of gesture. In her words, "[e]xplorations of new technologies and dance, led by Mark Coniglio, Scott DeLahunta, Antonio Camurri, and others, have often focused on the difficulty of locating gesture-as-such" (2009, p. 61). Despite the fact that, here, the philosopher is specifically referring to the encounter between dancing bodies and digital computers and, precisely because of this, to the "embedding into the software program" (Ibid.) of gesture's definition, this difficulty is common to all practices of dance notation. In fact, in what regards the definition of gesture, between automated processes of gesture recognition and non-automated ones, the difference is hardly one of quality.[106] And this is not to say that the subjective experience of someone who translates dance into choreographic notation is not a qualitative one. Qualitative experience is necessarily implicated in the transductions of knowledge conveyed by subjects for whom indetermination (of the body) is a fundamental condition. It is rather to say that, insofar as in both cases the content-expression encounter of writing is conditioned by symbolic conventions, what can in fact come to be defined as gesture remains within the limits of what language can possibly express. This is a quantitative limit. Whereas in the case of computers these possibilities are necessarily located at the level of binary code, in the case of notational systems they are located at the level of the symbols used to express choreography. And of course that, if the former is used to express the latter what one necessarily gets is a possibility space resulting from the concurrent set of binary code and choreographic notations. In sum, besides being conceptually determined, gesture is here defined by what is possible to be written.

From this standpoint, the written expressions of gesture can be said to coincide with its conceptual structure. By limiting the possibilities of expression both with discrete signs and with the articulatory nexuses of its significations, writing discontinues the dancing body and, in this way, defines gesture as such. Conversely,

106 To say that computers recognize and notate gesture automatically is just a matter of expression. For, as Simondon asserts, "there is no such thing as a robot" (1969 p.10). As such, computational machines must be considered from the perspective of the context from which they result and in which they evolve. In other words, as technical individuals, they must be considered together with the associated milieu of their technicity. After all, what a computer comes to recognize as gesture needs first to be defined by its inventors. Not only this, but the very definition of gesture embedded within a computer's software depends as well on what the computer can in fact recognize as gesture. In this sense, both computer and its definition of gesture individuate depending on one another.

such writing does not occur without the implicit determination of the concepts of the understanding. At once, the definition of gesture regards what gets to be determined when a body dances and the limits of writing itself. In regard to this relationship of the dancing body with writing, through the determination of concepts, Manning quotes dance and technology scholar Scott DeLahunta, for whom "the best way of coming to an understanding of gesturality is to work collaboratively with dancers such that 'the choreographic and computational processes are both informed by having arrived at this shared understanding of the constitution of movement. This means descriptions (what we think of as co-descriptions) of movement that can exist in both its own terms (as in physical) as well as in the symbolic abstractions that are necessary in order to use these techniques of gesture modeling, simulating, learning, following etc. with the computer." (Manning, 2009, p. 61; Delahunta, 2006). Though in the writing of gesture the determination of concepts does not go without expressive determinations, they differ and can therefore be distinguished from one another. First and foremost, this difference regards the fact that the dancing body moves on the basis of continuous and undetermined potentials. As mentioned before, the determination of concepts proceeds from this bodily excess and cannot be understood without it, at least from a processual perspective. Though writing occurs as well in relation to a degree of indetermination, which ultimately is of the body itself, its limits are different and depend on the domain of expression. Nonetheless, and regardless of this latter dependence, a written gesture can only only come about with the discontinuous expression of determinate possibilities. If the dancing body is the plane where undetermined potentials and determinate concepts are related, the gestural body is the plane where the determination of concepts gets to be related with determinate expressions. The one is unbounded and the other limited, for example, by convention.

The *DS/DM*'s software of gesture recognition—*Gesture Follower* (GF)[107]—is a good example of how conceptual conventions of gesture can be embedded into digital code. This software is used both in the DVD and Interactive Installation versions of the *DS/DM* to recognize certain movement patterns of the system's user. Such patterns correspond to the workshop's movement qualities. But here, instead of being known by

107 The *GF* started to be developed by Frédéric Bevilacqua, in the end of 2009, in the frame of his research in gesture analysis and interactive music systems, at the IRCAM (Institute for Music/Acoustic Research and Coordination in Paris), as included in the Real Time Musical Interactions team (Bevilacqua, 2007, p. 27). The *GF* "is implemented as a collection of modules in the Max environment [...], taking advantage of the data structures of the FTM library such as matrices and dictionaries. Recently, the core algorithm was developed as an independent C++ library and can therefore be implemented in other environments." (Bevilacqua et al., 2010, p. 9).

the system's user, they are known by the computer itself. Specific definitions of gesture have been embedded into the software so that this can recognize which user's movements conform with them. As computer scientist Frédéric Bevilacqua writes, “[t]he general idea behind the *Gesture Follower* is to compare a performance with prerecorded ones. Basically, the first step corresponds to choosing one or several phrases that will be recorded and stored in the computer memory. The choice of these phrases is a crucial step; they should be representative of a gesture vocabulary or contain meaningful qualities for the artist. The second step occurs during the performance: the computer program assesses in real-time whether similar vocabulary/qualities are present. The results can be output as ‘likelihood scores’ expressing the similarities of a given performance to the stored ones in the database.” (2007, p. 28). As such, this software follows gestures on the basis of what it already knows. The definitions of gesture embedded into it are digital memories that can be recalled for the sake of recognition, memories that consist not only of registered events but also of their indexation. “Finding similarity between the performance and stored ones in a database can be one mechanism to characterize motion qualities, if each phrase of the database has been labeled.” (Ibid., p. 30). Moreover, what allows for the software to compare the two datasets is an algorithmic procedure of calculation that takes each definition of gesture to be quantitatively determined. The *GF* converts the *DS/DM*'s movement qualities into determinate quantities of binary code and defines each gesture as a digital patch against which to compare the real-time displacements of the user's body. Such comparison serves to inform the system's user if the movements performed conform or not with the given definitions and to instigate him or her to move accordingly.

There is, notwithstanding, a determinant difference between the DVD and the Interactive Installation versions of the *DS/DM,* which regards the sensors used by each system to create motion data from the user's activity. Whereas in the Interactive Installation the dancing body is captured with video cameras, in the DVD it is captured with the computer's mouse. Such difference necessarily results in different types of dataset, for their structure depends upon the input device. Whereas the computer mouse is capable of capturing motion with regard to one moving point, the motion capture made with video cameras can create arrays of data regarding the many moving points of one pixelated plane of expression. If infrared cameras are instead considered, it is possible that the datasets from them derived are structured in accordance with a three-dimensional grid of variable points. These differences necessarily imply that the datasets in comparison must be structured similarly. The *GF*'s gestural definitions must be structured as to be compared with the datasets derived from the input devices in use. Which is to say that the very possibilities of motion capture play a part in structuring the definitions of gesture embedded into the software. They act as a frame of reference that limits and determines the quantities that the *GF* must calculate out of the examples to it provided. In this sense, given gestures can only be recognized if the memory of what has been previously registered is mappable onto the novel data. Of course that on both sides this occurs on the basis of algorithmic calculations, which structure data in determinate ways. The datasets reciprocal mappability depends on how raw data is structured by the softwares in use, i.e. belonging both to the *GF* and to the motion capture devices.[108] It is also here that the conventional agreement of what gesture is comes in. The structuration of data occurs both in accordance with what is possible to be computed and in accordance with what gesture is known to be. This mixed procedure is explained by Bevilacqua to be "based on the recognition that both our abstract gesture representation and actual gesture data generally share common time properties, and the links between them can be expressed as time relationships. For example, features occurring simultaneously in both representations can be made explicit. This can correspond to adding markers and profiles to a timeline [...]. The gesture follower

108 To say that the captured data is raw stands for saying that there is a structure to it. If such structure is to be computed with determinate functions of expression (i.e. the algorithms themselves), it needs to be transformed. That the data provided by motion capture systems does not correspond to an intuitive image of the dancing body and that, for this reason, if it is to be rendered into the expression of a recognizable figure, it needs to be processed and restructured, is noted by Frédéric Bevilacqua in the following way: "Making links between our abstract gesture representation and the gesture data is problematic. I always find it difficult to explain this to people who have little experience with motion capture systems: they often do not realize this frustrating gap between how they think about gesture and how actual capture systems behave. As a matter of fact, data often corresponds to a sparse and non-intuitive representation of what body motion is. This leads to practical difficulties when working with gesture capture technology, which sometimes gives the impression that the problem is with the technology itself, while it is more often with the methods of tool use." (2007, p. 30). As such, to say that datasets' structures are raw stands for saying that they need to be restructured, for the purpose of recognition. Likewise, it stands for saying that they are already structured in ways that are determined by the algorithms of motion capture themselves, notwithstanding the fact that such structures do not comply with the purposes of recognition. For example, the infrared camera of a Kinect sensor has been used in the *DS/DM*'s Interactive Installation for capturing the movements of the system's user (Alaoui, 2012, p. 72). This sensor infers the position of the dancing body in two steps. It first computes a depth map (using structured light) and then infers body position (using machine learning) (Freedman et al., 2012; Khoshelham & Elberink, 2012). It is not worth here to describe these computations in detail. It is enough to note that the image of the dancing body generated by such sensor is the result of a set of algorithmic procedures belonging to the motion capture system itself. As computer scientist Sarah Fdili Alaoui notes, "these data need to be subjected to a supplementary treatment in order to be possible to extract from them, for example, the positions of certain parts of the body". In other words, these data need to be restructured in order to be used for determinate purposes. "In the frame of the *DS/DM*", says Alaoui, "we have developed a patch in Max/MSP/Jitter, which makes use of the cv.jit library (for image processing), in order to subtract the background of the captured image and, with this, generate a silhouette of the dancing body defined by certain geometrical characteristics." (2012, pp. 79–80).

embodies such an approach, as it considers phrases as temporal objects we can observe – we can 'look inside the phrase' to find salient moments or try to predict what is going to happen. These temporal objects can also interact with other objects, sounds for example. This represents a different view on the usual interaction paradigm considering frame/posture as basic elements. Typically, the relationship between gesture data and sound or visuals is referred to as 'mapping', a clear reference to the consideration of primarily spatial relationships". (Bevilacqua, 2007, pp. 30–31). Such mapping onto sound files is used by the *GF* to inform the system's user of the coincidence between the movements performed and the salient moments of a temporal digital object. In this way, all three datasets are mapped onto one another so that the software is capable of following the movements performed by stretching or shortening both the reproduction of sound and the reproduction of the registered examples.

The conventional representations of gesture used in the DVD for the workings of the *GF* exemplify how the problem of their expression had to comply with the fact that motion data is here retrieved from the computer's mouse. Instead of being defined with video registers of the dancing body, each of the *DS/DM*'s movement qualities is represented by an ideogram (see Illustration 4, below) which allows it to be defined as a determinate succession of points across one or several lines. Though such ideograms have been specifically created for this software, they derive from a system of choreographic notation used in Japanese Butoh-Fu, called Butoh-Kaden[109]. The reason for this choice is explained by Bertha Bermúdez in the following way: "The issues treated in the Notation Research Project that EG|PC initiated in 2004, deal with dance documentation, notation and their relation with movement intentionality – the inner motivation for the movement. It is around the very problematic question of how to notate intentionality that the Butoh-Fu system shares some principles and tools with this research project." (2007, p. 59). It follows that the *GF*'s ideograms are meant to convey the movements of thought implicated in each of the *DS/DM*'s movement qualities. Though expressed symbolically, they implicate the metaphorical, imagetic, and diagrammatic character of the choreographic ideas intended to be transduced.[110] They

109 In Bertha Bermúdez's words, "Butoh-Kaden is based on the idea that 'physicality exists through acquired knowledge. The images refer to form and the words refer to symbols. Words are important in the Butoh-Kaden system because they express matters that cannot be symbolized and they are the medium to expand physicality through the use of imagination. [Yukio Waguri, Butoh-Kaden's creator] has structured eighty-eight Butoh-Fu (i.e. scores) that are connected to seven different worlds. These seven worlds have different qualities that are described through images, words, sounds, workshop experiences and performance demonstrations." (2007, p. 59)

110 It should be noted that, in order to facilitate the transduction of choreographic ideas, both the DVD and the Interactive Installation allow for the *GF* to be used in different ways. In both cases, one can "watch" examples of how to move, one can "learn" how to move by following the registered cases of

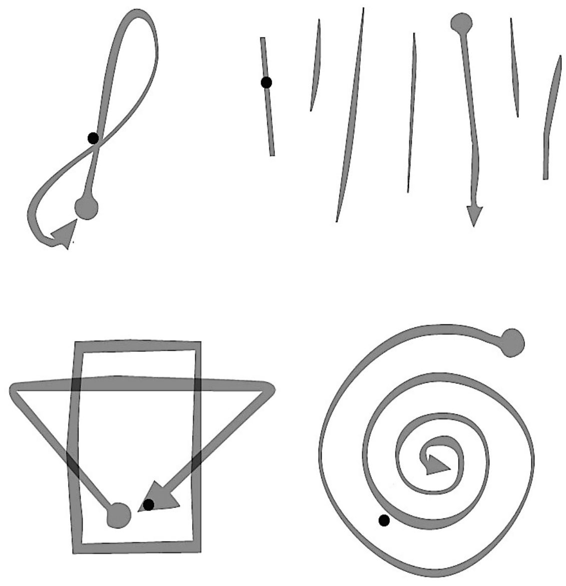

Illustration 4: The symbolic notations of each of the DS/DM's movement qualities, as seen on the GF's interface of the DVD. Here, the black dots represent the mouse's cursor. (Delahunta, 2007a).

are specific cases of solution with regard to these ideas. Also, it is worth noting that determinate patterns of displacement along the lines of these ideograms were registered in order to be compared with the displacements of the computer's mouse. These are the referential definitions of gesture given to the software to be compared with what this may capture from the user's activity. What here gets to be recognized as gesture is but the synthetic resolution of a point's expressive displacements along the lines of symbolic notations.

In this respect, the Interactive Installation's *GF* is different, for its definitions of gesture must comply with the data structures derivable from the input sensors in use. Bevilacqua mentions two different methods used here to create the digital definitions of gesture. On the one hand, in "a particular section of the Double Skin/Double Mind workshop […] the breathing phases – inhale/exhale – [were] defined as contours/ shapes (but not measured by sensors). After recording this gesture, an 'ideal' breathing contour was drawn manually on the timeline representing the phrase. […] The follower makes possible a precise synchronization [between the] drawn curve, generating a breathing

solution, and one can "play" freely with the different movement qualities in order to be signalled by the software about which one is being performed. All these modalities of use complement one another with regard to the transduction of the different choreographic ideas being expressed. By watching, learning and playing with the *GF,* the user experiences the workshop's movement qualities in different ways and can therefore more consistently learn how to move accordingly.

sound, with the body movements. The dancer is then 'followed' by a breathing sound, either stretched or shortened, depending on how slow or fast the phrase is performed." On the other hand, "[s]everal phrases from the workshop Double Skin/Double Mind were recorded with a mixed capture system using both sensors attached to the body and video analysis (EyesWeb). In particular [they] focused on two choreographed phrases danced by Bertha Bermúdez and Emio Greco (around 30 seconds long) that [were] recorded several times. This choice was driven by the need for having phrases with precisely specified movements, which greatly facilitates the comparison mechanism of the gesture follower. Different tests were tried. First, [they] segmented one of the recorded phrases into subsections [..]. When performing the phrase again, the gesture follower was set to recognize these subsections and output a sonic signal (a 'click'). According to both the dancer (Bertha Bermúdez) and the viewers, the sound was heard at the right time, indicating that the system was able to segment the phrase correctly". (2007, pp. 29–30). One of the differences between these two notation methods thus regards the moment in technical transduction when cases of solution for the structuration of movement qualities are determined. In the first case, gesture is determined with notation itself. Drawing the contour of a dance form on video is a qualitative determination that depends both on the chosen registers and on the specific way in which the contours themselves are drawn. Here, the determination of gesture occurs after the dance event and in concomitance with the conventional agreement that gesture can be defined as it is drawn. In the second case, gesture is determined with the structuration of a dance phrase by the dancing body, constraining already here the undetermined potentials of each movement quality with a given form. In this case, the digital definition of gesture then just simply remarks a structure defined from the outset, in the very moment of the dance event. Such definition corresponds to the conversion of the dance's remarkable points into definite quantities of data. It is the conversion of this choreography's conceptual structure into determinate quantities of data retrieved from the dance's video registers. In both methods, the definition of gesture by means of video attests that, for the *GF* to recognize and follow the movements performed by the system's user, it must take as reference gestures depicted from the same kind of data generated with the input sensors in use, that is, video data. The positional character of these models cannot be emphasized enough. Gesture is defined by an array of points, each with a determinate value. Regardless of the fact that these values can vary in accordance with given probabilities, the models at stake discontinue movement into a series of numbers. They not only discontinue movement into measurable quantities but do this by codifying them with determinate arrays of binary states. At the level of computation, this is gesture's conceptual structure. If granted that gesture's matters of content belong to the computational system's electronic circuits (including the interfacial and qualitative expressions of sounds and visuals), then its functions of expression must be granted to belong to the mathematical abstractions of computational algorithms. From which it follows that, computationally, choreographic objects are mathematical abstractions. In other words, they are the algorithmic models that bring electronic circuits into qualitative expressions capable of conveying choreographic ideas.

Both in regard to the data structured from the referential examples of dance and in regard to the data structured via input sensors, the *GF*'s algorithms act as functions of expression. They restructure the datasets by computing them in accordance with determinate parametric constraints. "The system outputs continuously parameters relative to the gesture time progression and its likelihood. These parameters are computed by comparing the performed gesture with stored reference gestures. The method relies on a detailed modeling of multidimensional temporal curves." (Bevilacqua *et al.*, 2010, p. 1). What is compared are the quantities calculated from treating the datasets with these constraining parameters. Such computation not only allows for predicting gesture's progression according to a statistical distribution of probabilities (associated with each calculated value), as it also allows for the datasets to be compared precisely on this basis. The *GF*'s algorithms sample points from the temporal profile of the video registers, translating them into values that define gesture in each specific location of its development. It can therefore be said that the interest here is both "in computing the time progression of the performance, or in other words answering the question 'where are we within the gesture?'" and "in computing likelihood values between a performed gesture and pre-recorded gestures stored in a database. This can be used to perform a recognition task, but also to characterize gestures. [...] Moreover, the estimation of both the time progression and likelihood values enable another important feature of such a system: the possibility to predict the evolution of the current gesture." (Ibid., pp. 1-2). The parameters computed by the *GF*'s algorithms rely on the calculation of temporal and spatial descriptors of the dancing body. This is described by computer scientist Sarah Fdili Alaoui in her doctoral thesis, dedicated to the problems of gesture's analysis in the context of the *DS/DM*'s research projects, in regard to the use of infrared cameras.[111] "The spatial descriptors define the

111 It is worth noting that Frédéric Bevilacqua was Alaoui's thesis co-supervisor.

geometries of the dancing body, in relation to its surrounding space. The temporal descriptors define the gesture's temporal evolution." (Alaoui, 2012, p. 81, *my translation*). The spatial descriptors are: 1) body's verticality (calculated as the ratio between the silhouette's height and width); 2) shoulder's angle (calculated as the angle held between one arm and the silhouette's vertical axis); 3) body's extension (calculated as the maximum distance between the silhouette's centre of mass and the sum of its extremities); 4) legs' width (calculated as the distance held between the two feet); 5) weight transference (calculated as the distance between the mass centre's abscissa and the centre of the segment connecting the two feet). The temporal descriptors are: 1) periodicity and frequency (calculated as the average of the coefficient of statistical correlation between the four extremities of the silhouette); 2) increment and decrement (calculated as the temporal evolution of any of the previous spatial descriptors); 3) quantity of movement (calculated as the frame-by-frame variation of the silhouette's number of pixels, when translated into a digital display). (Ibid., pp. 81–82). From the calculation of such descriptors, the *GF* can then express the gestural body as a series of solutions with regard to the problem of how to represent the movement qualities in case with digital possibilities. According to Alaoui, "[t]he reason for this choice has to do with the fact that the descriptors […] allow for the *GF* to account for the very fine nuances of movement that are characteristic of the *DS/DM*'s dancing body. The algorithms are in this way capable of recognizing movement qualities that more general approaches, such as Labanian ones, aren't." (Ibid., pp. 80–81). Since such descriptors are calculated relatively to the dancing body's silhouette in order to output visual representations of gesture, i.e. quadrilateral shapes, which allow for the system's user to grasp how the computational system is processing such translation (see Illustration 5, below), it can in fact be said that this is a Labanian method of analysis. Expressively, this is a method which reduces the dancing body to a geometrical form that, despite being different from Labanotation, results from the same kind of movement analysis. The *GF*'s capacity of recognizing nuances in movement can instead be addressed to gesture's temporal progression, since the 30 frames per second that these sensors output allow for movement to be notated with a resolution much greater than the one usually attained by traditional methods of choreographic notation.

This notation method is somewhat different from the two previous ones, for the calculation of descriptive variables is from the outset a quantitative procedure. Of course all these methods rely on the conversion of conceptual structures into structured quantities of data. But in this latter method definitions of gesture are not given to the

Illustration 5: In this picture, it can be seen how the learning subject is placed in front of a screen, where two different figures are displayed. There is the figure of Emio Greco's dancing body, as recorded with video. And there is also the silhouette of the dancer's body, as processed by the software after motion capture. As it can also be seen, the software not only extracts the silhouette of the dancer's body from motion capture data, but also draws its geometries with moveable boxes. Such boxes describe gestures parametrically. Retrieved 04/06/13, from http://sarah.alaoui.free.fr (Alaoui's Ph.D Webpage).

software on the condition of being relative to a set of examples, but rather on the condition of being primarily unrelated to actual matters of content. In this sense, the algorithms that structure the sensors' raw data can be understood as definitions of gesture in themselves. And though these algorithms are specifically designed to act as functions of expression, what will come to be defined as gesture depends solely on the descriptive values computed by them. As such, they are perfect examples of what a choreographic object can be like in the digital domain. They express the *DS/DM*'s conceptual structure independently from the matters of content generated with the input sensors.[112] Conversely, the definitions of gesture necessary for the workings of the *GF*

112 It should be noted that, in her doctoral thesis, Alaoui develops still another method where gesture is defined with the computation of determinate parametric structures (2012, pp. 66–78). This is a method said to follow from the intuition that the *DS/DM*'s movement qualities correspond to the dynamic behaviours of spring-mass systems (Ibid., p. 64). A spring-mass system is defined on the one hand by an object composed with a mass attached to a spring and on the other hand by the fact that this object's displacements, in one dimension only, are conditioned by forces of elasticity and viscosity. With this method, gesture is first coordinated in regard to the relative position of body parts to be analysed (i.e. the extremities of the dancing body) and then calculated according to differential equations in regard to variables such as speed and acceleration. Since these differential equations are capable by themselves of modeling gesture, this is a model that neither requires that the software is provided with a set of referential gestures (and therefore with a learning phase) nor that it is programmed to work according to a set of gestural descriptors (Ibid, pp. 65–66). Even without such

can only be determined after the calculation of cases of solution for the problems implicit in the software's algorithmic functions of expression. From which it follows that, because such choreographic objects are constrained by the possibilities of the digital domain, instead of being just models of potential transition, they can also be thought as models of possible transition. For as much as the *GF* acts as an insert of possibilities amidst the potentials of a milieu of technical individuation, it limits the latter with what the software can in fact calculate. The abstract character of choreographic objects is in this way reduced to the possibilities of the digital domain. A constraining of potentials with the possibilities of digital code. Nonetheless, such choreographic objects should be seen as being embedded in a milieu of technical individuation, full with undetermined potentials. After all, not only are these algorithms technical individuals, as they are also the necessary condition for a choreographic transduction to occur into dancing body's domains.

5.2 - Gestural Bodies, Extended

The capacities of algorithmic calculation have been used for writing dance in ways that extend the image of the body in space and time. This is not new to choreographic notation. Writing dance with symbols not only gives form to the problems in translation, as it brings past experiences into spatial juxtaposition. What in the dancing body unfolds in succession, in traditional notation stands side-by-side. Accordingly, one of the problems that is possibly solved with choreographic notation regards the sense-making of what in experience is both immediate and diachronical. The individuation of thought is mirrored by the individuation of writing and resolved into expressions that convey both their own logic and a sense proper to the ideas in regard to which they stand as solution. What is mirrored between individuations is the idea's diagrammatic structure, i.e. the same problems that relate the different modes of expression. In regard to memory, the expressive variations of choreography can result in different instances of retention, each with its proper character. Whereas dance is experienced empirically only to be, sooner or later, forgotten, writing retains such experience by representing its diagrams. Without writing, memory remains abstract.

requirements, it was concluded that "spring-mass models are good candidates for the visual presentation of dynamic renderings of the *DS/DM* movement qualities" (Ibid, p. 64, *my translation*). For more developments on the expression of spring-mass models in the context of the *DS/DM*'s Interactive Installation, see Chapters 5 and 7 of Alaoui's doctoral thesis (Ibid., pp. 87–115, 131-149).

Writing overwrites the actual conditions of its own individuation by compressing memory into the actuality of the present.

In contrast to traditional methods of choreographic notation, what algorithmic procedures of digital computation allow for, in a truly novel manner, is the automation of writing. For if it is true that such algorithms require being invented and concretized, it is also true that the solutions that they may compute can result without human intervention. Once digital automatisms are put to work, they can be seen as operating independently from external determinations. This also stands for the case that, insofar as in such computation all is written, all occurs in actuality. From which it is possible to argue that there is no durational dimension to digital computation and that this necessarily occurs on the basis of articulations between discrete symbolic elements. Only by articulating arrays of data can computation proceed and generate solutions for the problems in case, a standpoint from which it is also possible to assert the difference between traditional methods of notation and digitally automated ones. Whereas the automatic computation of solutions depends solely upon sets of possibilities, the durational and subjective notation of dance cannot generate solutions but with regard to problems in an affective-perceptive field. In this latter case, memory is empirically formed, but soon forgotten only to be recalled, from a transcendental point of view, into the subjective experience of duration, which does not cease to be related with the actuality of an empirical experience. The subjective and durational notation of choreographic ideas results from technical individuations that can not only create what cannot be predicted, but also remember what has already been forgotten.

In contrast to this, the digital notation of choreography can be understood from an exclusively objective perspective. This not only regards a conception of algorithms defining them as "specific sets of instructions for carrying out procedures or solving problems, usually with the requirement that the procedures terminate at some point" (Weisstein, 2002), as it also regards the possibilities of digital coding. When a finite set of instructions is digitally programmed, what one gets is an automated object, that is, a system capable of iterating its own programmatic determinations. Of course digital algorithms are not disembedded from technical milieus, with all that is subjective in them. But insofar digital computation can proceed without further regulated, automated algorithms can be seen independently from the subjects of technical invention and control. Which is also the reason why, when computing vast spaces of possibilities, digital algorithms might express what can hardly be anticipated by their inventors (i.e. computers count much faster).

The possibilities of algorithmic computation are many. As many as the ones comprised by the possibility space of the content-expression encounter calculated between two datasets. Even in the case where both functions of expression and matters of content remain the same, relatively to one another, differences in expression can occur. The same set of actual expressions can vary in space and time, contracting or expanding the perception of a first calculated order of magnitude. In regard to choreographic notation, this stands for the fact that the gestural body can be contracted or expanded and, with each of these procedures, express otherwise imperceptible data. In fact, these are not two distinct procedures but only different perspectives upon one same operation. Insofar as this operation is characteristic of choreographic notation, any of its expressions serves to understand the duality in case. It suffices to say that, because writing compresses time into one same plane of expression, it also expands space. This duality is, for example, expressed when the graphic symbols of choreographic notation are used to inscribe the memory of a succession of states onto one same surface, accreting in this way matters of content to the plane of their own expression. The more time is compressed onto the surface of graphic inscription, the more space is created. The compression of time into one same plane of expression can in this way densify or disperse the number of occurrences within one same referential metric. In either case, the objective space is extended.

Several examples of gesture's extendability by means of digital computation can be found in the "*Motion Bank"* (MB), "a four-year project of The Forsythe Company, [developed between 2010 and 2013], providing a broad context for research into choreographic practice."[113] In fact, this project can be said to have been initiated before. The "*Synchronous Objects for One Flat Thing Reproduced"* (SOfOFTr) website,[114] which is presented as one of *MB*'s choreographic scores, resulted from a project that ended just before the initiation of the *MB*. One of the reasons for this contributive development regards the fact that the *SOfOFTr'*s website is dedicated to the quantitative analysis and notation of William Forsythe's choreography "*One Flat Thing, reproduced"* (OFTr). The *MB* developed this type of choreographic endeavour into the artistic work of other choreographers, such as Deborah Hay, Jonathan Burrows and Matteo Fargion, Bebe Miller and Thomas Hauert, and generated for each of them an online score.[115]

113 Retrieved from the *MB's* website (http://motionbank.org). All references from online sources quoted in this section were retrieved during August, 2014.
114 http://synchronousobjects.osu.edu
115 http://scores.motionbank.org

In the case of William Forsythe's choreographic work, the website *SOfOFTr* represents a series of efforts for “visualizing choreographic structure from dance to data to objects”[116]. Such efforts were coordinated by Forsythe himself, together with artist and scholar Norah Zuniga Shaw, from the Ohio State University’s Department of Dance, and Maria Palazzi, the director of Ohio State University’s Advanced Computing Centre for the Arts and Design. Together with a group of designers and scientific researchers, they “worked with the Forsythe Company to unearth the choreographic building blocks of *OFTr*, quantify them, and repurpose this information visually and qualitatively” (Forsythe *et al*. 2009, pp. 2–3). The result was a series of digital objects that, because they are all mapped onto the same spatiotemporal grid (i.e. the choreographic metric depicted from the dance performance), are synchronous in regard to one another. Because their temporality is organized with the same metric, they can be seen not only as different expressions of one same topological object, but also as the overall expression of the *OFTr*'s multidimensionality. To visualize the different objects synchronously is to relate in perception the many nexuses that the *OFTr* not only expresses, but also holds in potential. Also, such objects can be synchronized with one another because all of them have taken the video registers of the *OFTr'*s performance as the referential data from which to depict this choreography's diagrammatic (i.e. temporal and spatial) character.[117] Many of the *SOfOFTr* are but choreographic notations of the *OFTr'*s performance, made on its video registers. Such notations resulted from two specific types of data. They resulted from the spatial data generated “by tracking a single point on each dancer in both the top and front views of the source video of *OFTr*. By combining the coordinates from both views, [the animators] were able to generate a three-dimensional data point for each dancer’s location at every moment of the dance”. And they resulted as well from the attribute data “built from the dancers’ firsthand accounts. […] The attribute data catalogs the three systems of the dance: movement material, cues, and alignments”. (Forsythe *et al*. 2009, pp. 2–3). Whereas attribute data served the dance's qualitative notation, spatial data served its algorithmic notation. Both modes of notation are expressed digitally in the *SOfOFTr*'s website, together with the video recordings, on top of which they are drawn. But whereas the notation derived from attribute data has been subjectively drawn, the notation derived from spatial data has been objectively drawn, that is, it has been drawn by means of digital algorithms

116 Retrieved from http://synchronousobjects.osu.edu.

117 Though the public performance of “One Flat Thing, reproduced” was premiered at the Bockenheimer Depot, Frankfurt, in 2000, the video recordings used for creating the *SOfOFTr* website were recorded from a performance presented in 2005, at the same site of its première. (Forsythe *et al*., 2009, p. 1). These recordings can be viewed at: http://synchronousobjects.osu.edu/content.html#/TheDance.

programmed to compute the quantities of data retrieved from analyzing the dance's video recordings.

It is therefore with the spatial data used to create the *SOfOFTr* that the issues of spatial compression before mentioned can be best understood. Not only has this to do with the fact that, "[a]s in many forms of inquiry, quantification requires a reductive process that necessarily obscures certain aspects of knowledge (the dancers' intentions, performance quality, and kinaesthetic awareness) in order to reveal others (in this case, choreographic structure)" (Ibid.), as it has to do with the fact that the *SOfOFTr* created with spatial data resulted precisely from the accretion of data on data. The objects created with the "*Video Abstraction Tool*" (VAT)[118] (see Illustration 6, below) are examples of this. This tool was invented "to demonstrate novel ways of visualizing the dance itself. [With it] patterns that are hidden due to the overall complexity of the entire scene can be brought out by visually emphasizing movement so that both the short- and long-term patterns of the dance, temporal relationships between movements, and spatial information regarding how the performance area is being utilized, are revealed" (Andereck, 2009). This is done by applying a number of possible algorithms, i.e. filters,

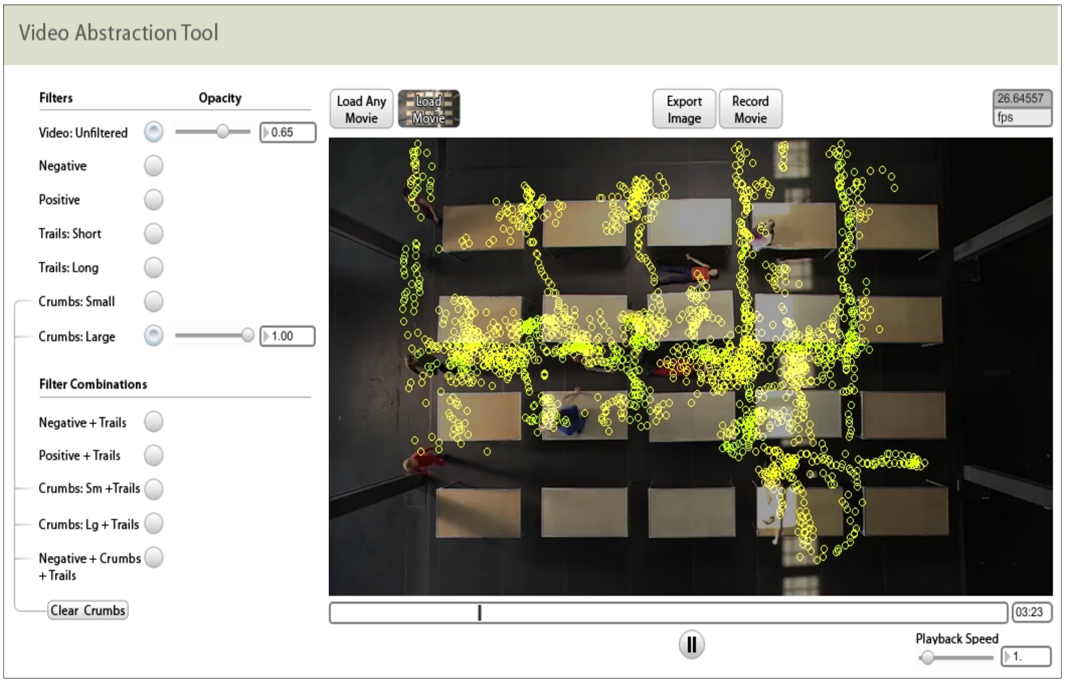

Illustration 6: Video Abstraction Tool's GUI. The yellow circles, here designated as "crumbs", trace each dancer's displacements within the video frame according to a determinate temporal metric. The filter "crumbs" has been used to create the "Difference Marks" object.

118 This tool is available for download at the *SOfOFTr*'s website (http://synchronousobjects.osu.edu/content.html#/VideoAbstractionTool). Notably, it is a piece of software programmed with the MAX/JITTER environment.

to the choreography's video recordings. When a filter or a combination of filters is used as a function of expression for processing video, this is brought into results that, rather than expressing the transformation of what is given, i.e. the video itself, express the accretion of novel data onto it. In this way, new datasets can be mapped from and onto the very video from which they result. Space is mapped onto space. Not just any space, but the space formed with choreographic resolution. Each of the *VAT*'s filters compress spatio-temporal data in order to double the video's movement-images with other images of movement. These latter images can be described as deformations of the spatio-temporal patterns belonging to the referential movement-images. Space is extended in order to be perceived as an extension of time. When time (i.e. a spatial time) is extended, what wasn't perceived by reason of being either too fast or too small, or even either too large or too slow, becomes information. It informs subjects with novel perceptions regarding the *OFTr*.

All the objects created with the *VAT* express differentials belonging to the performance of the *OFTr*. This is so not only because the performance itself expresses the *OFTr*'s choreographic system, i.e. the differential topology to which it belongs, but also because this tool's algorithms are programmed to compute the frame-by-frame variation of its video registers. As Norah Zuniga Shaw (2009) notices, the *VAT* was created "in order to share aspects of the software filters used in making the '*Difference Forms'*, '*Difference Marks'* and '*Noise Void'* animations.[119] Each small adjustment in the filters [used] for these animations creates interesting aesthetic results and analytical discoveries". Further, these objects' names indicate the algorithmic computation of differences in the video's frame-by-frame progression that they express. Perhaps the most clear expression of this is the "*Difference Marks*" object. As shown in Illustration 6 (above) the expression of this object notates, with a series of small circles, the displacements of each dancing body. As the dance develops, the graphemes accumulate, expressing in simultaneity what is given with the frame-by-frame videographic succession. As it can be read in the *SOfOFTr*'s website: "This object visualizes the accumulation of the dancers' motion over time. Here the duration of the dance is compressed from 15 mins. 30 secs. to 1 min. 30 secs., and any instance of motion (what we call localized difference) is noted with a small mark. The colours of these marks change over time from red to blue, revealing distinct layers and patterns of motion as

119 These animated objects can be seen, respectively, at: http://synchronousobjects.osu.edu/content.html#/DifferenceMarks; http://synchronousobjects.osu.edu/content.html#/DifferenceForms; and http://synchronousobjects.osu.edu/content.html#/NoiseVoid.

the piece progresses. One of the goals for this object, which looks down at the dance from above, was to see how much the dancers both reinforce the grid of tables and subvert it. As the animation progresses, outlines of the tables grow distinct as the dancers interact with them."[120]

In contrast to the *VAT*'s algorithms, the synchronous notation of the *OFTr*'s attribute data regards, first and foremost, the qualitative expression of technical transductions. Most of the objects created with such attributes are but notative expressions of the marks allowing for this choreography's remembrance. The first object created with such remembrance is a graphic score (Illustration 7, below) where movement materials are disposed across the performance's time frame, and cues and sync-ups notated relatively to them. This score expresses how the *OFTr* is focused on examining and reconfiguring classical choreographic principles of counterpoint. Here, counterpoint is defined as "a field of action in which the intermittent and irregular coincidence of attributes between organizational elements produces an ordered interplay" (Forsythe et al., 2009, p. 1). The interaction between the *OFTr*'s different attributes creates the choreography's counterpoint. Additionally, a series of different

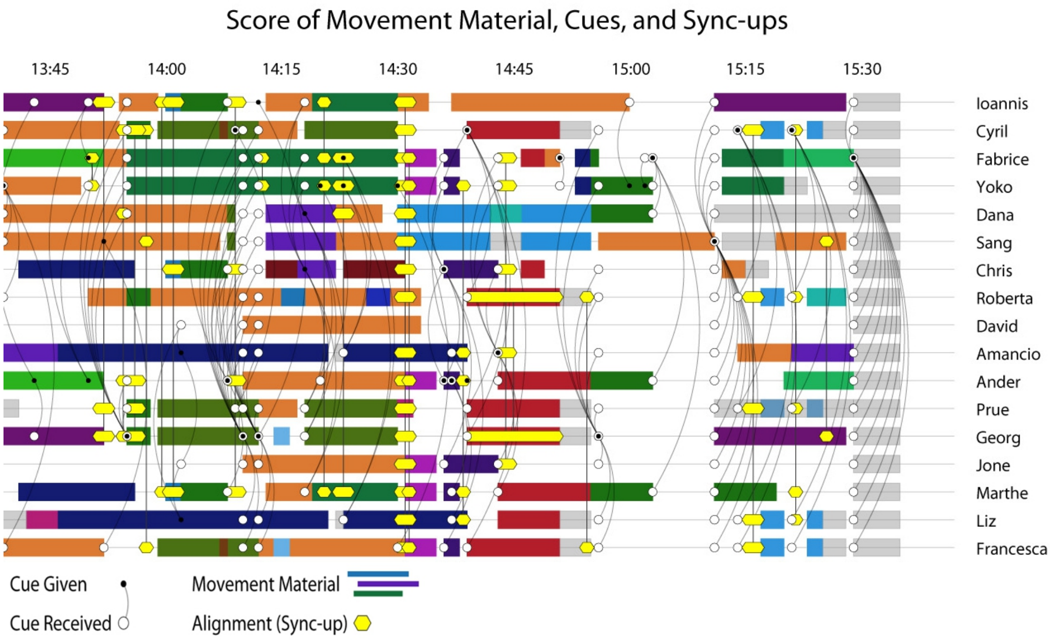

Illustration 7: "Cues and Themes - Graphic score of movement material, cueing and sync-ups generated from the data gathered from One Flat Thing, reproduced. Credit: Synchronous Objects Project, The Ohio State University and The Forsythe Company." Retrieved from http://synchronousobjects.osu.edu.

120 Retrieved from http://synchronousobjects.osu.edu/content.html#/DifferenceMarks. Moreover, the algorithms used for creating the "*Difference Marks*" object were also used to create the "*Center Sketch*" (http://synchronousobjects.osu.edu/content.html#/CenterSketch) object and the "*Movement Density*" object (http://synchronousobjects.osu.edu/content.html#/MovementDensity).

objects have been created after such notation. There are the objects where these notations are overlaid on the *OFTr*'s video registers and visually synchronized with the dancers' performance (as seen, for example, in Illustration 8, below), and there are the objects that translate the *OFTr*'s attributes into parametric structures, which can be operated by altering the parameters' values (for example, the "*Cue Visualizer Tool*", as seen in Illustration 9, below). The latter are generative tools, similar to the *VAT*, which allow for visualizing the different possibilities of expression that the rearticulation of the *OFTr*'s attributes allows for.

These procedures of data quantification and qualification have been iterated in different ways in the remaining scores of the *MB* project. For example, in the case of the score "*No Time to Fly"* (NTTF)[121], a choreographic work for a solo performer by Deborah Hay, data was quantified with a computer vision procedure similar to the one used in obtaining the *SOfOFTr*'s spatial data.[122] But whereas the *OFTr's* video registers were taken to render unproblematically the choreography's structure, i.e. representing its invariant functions adequately, each of the *NTTF*'s video registers was taken to record only one possible case of solution for the problems posed by this choreography's ideas. Which is to say that this choreography's principles are to a great extent undetermined,

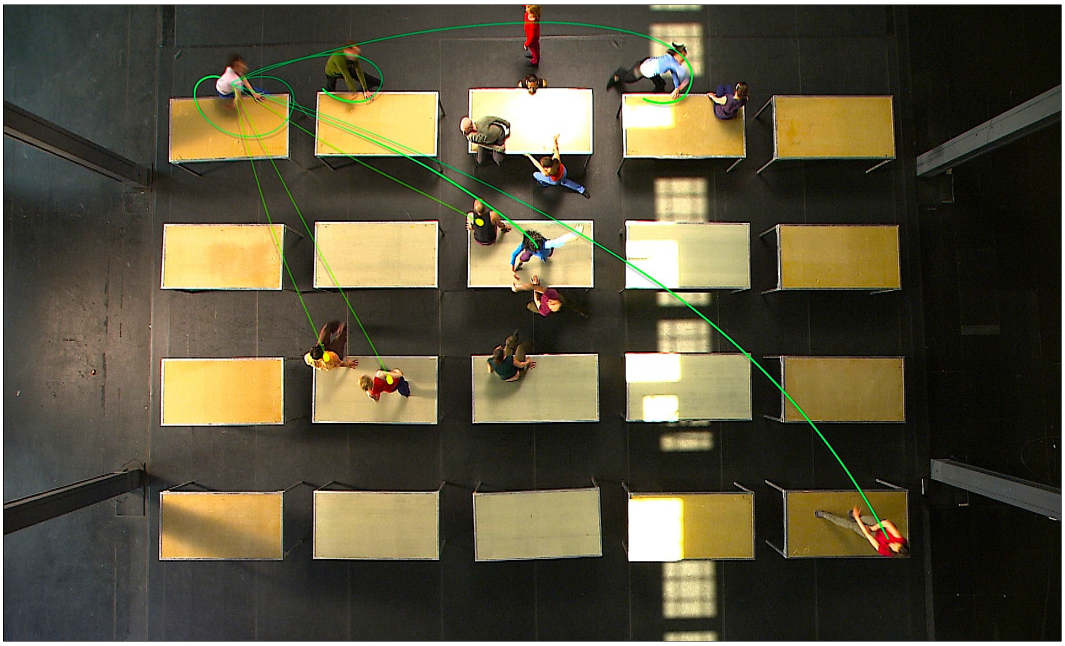

Illustration 8: "Cueing System - Still from annotated video illustrating the complex system of cueing in One Flat Thing, reproduced Credit: Synchronous Objects Project, The Ohio State University and The Forsythe Company." Retrieved from http://synchronousobjects.osu.edu.

121 The full *MB's* score of *No Time to Fly* can be accessed at http://scores.motionbank.org/dh/.

122 The full explanation of this procedure can be accessed at http://motionbank.org/en/event/deborah-hay-score-project-solo-filming.

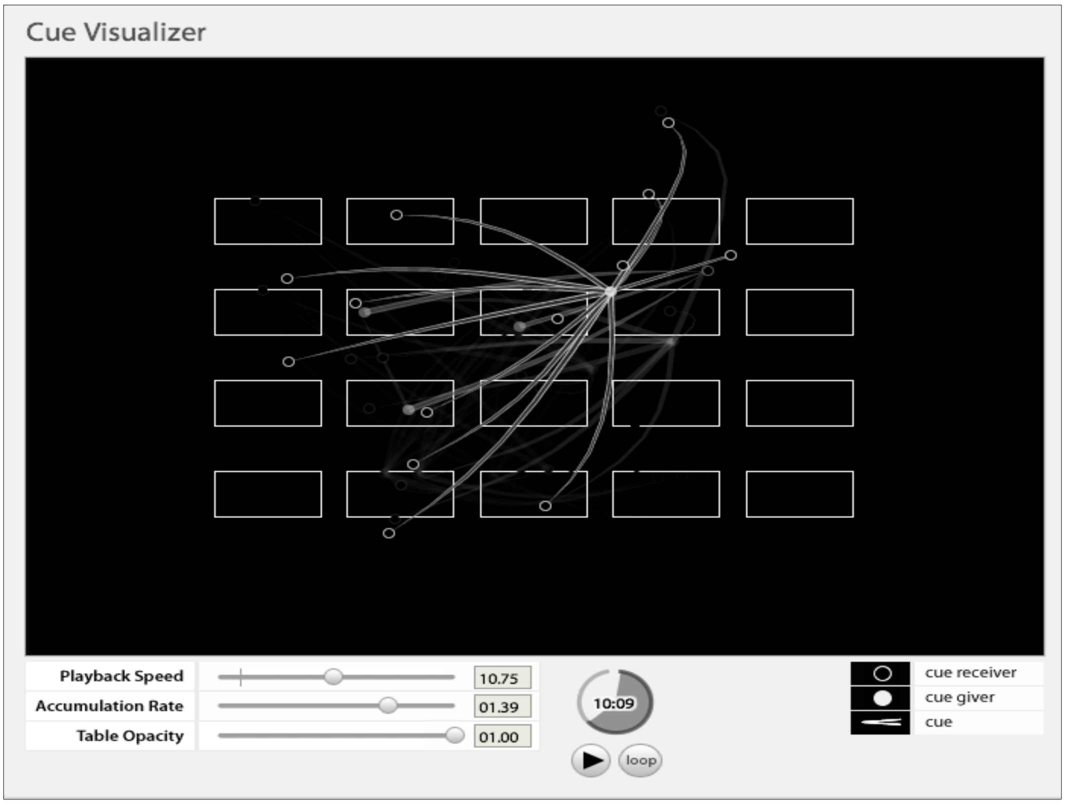

Illustration 9: Cue Visualizer Tool's GUI. Retrieved from http://synchronousobjects.osu.edu/tools/cueVisualizer.html.

leaving space for highly variable expressions. Whereas the *OFTr* is a choreography with a great degree of formal structuration, one which assures its invariance across different instances of performance, the *NTTF* is a choreography with large margins of indetermination, i.e. its expressions in performance are highly variable (given that it is nonetheless determined by constraints such as being a stage performance for one dancer only). In order to deal with this problem, the *MB* project video recorded a series of performances by three different dancers—Ros Warby, Juliette Mapp and Jeanine Durning—so that their differences could be juxtaposed and, in this way, facilitate the perception of this choreography's nexus. One of the expressions rendered after the motion capture of this choreography's different interpretations is the overlay of all the pathways performed across the stage (see Illustration 10, below), a sort of visualization that does not differ much from the ones created with the quantitative analysis of the *SOfOFTr*'s spatial data.

The transduction of the *NTTF*'s movement qualities into the digital domain has instead rendered a sort of algorithmic expression that is nowhere to be found on the *SOfOFTr*'s website. This is a 3D digital animation of algorithmic parameters, designed by programmer Amin Weber (see Illustration 11, below), after the experience that the

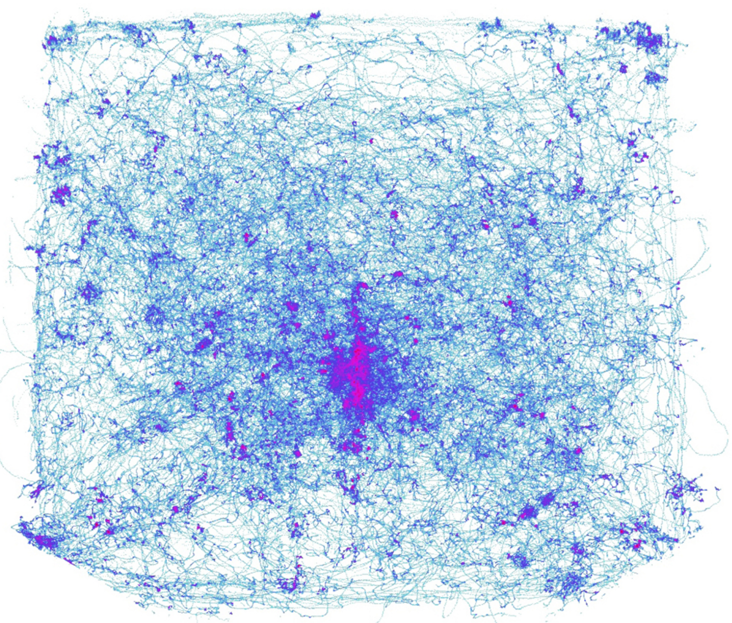

Illustration 10: “21 solos overlaid. 7 x 3 performers.” (seen from above). Retrieved from http://motionbank.org/sites/motionbank.org/files/glossary.pdf.

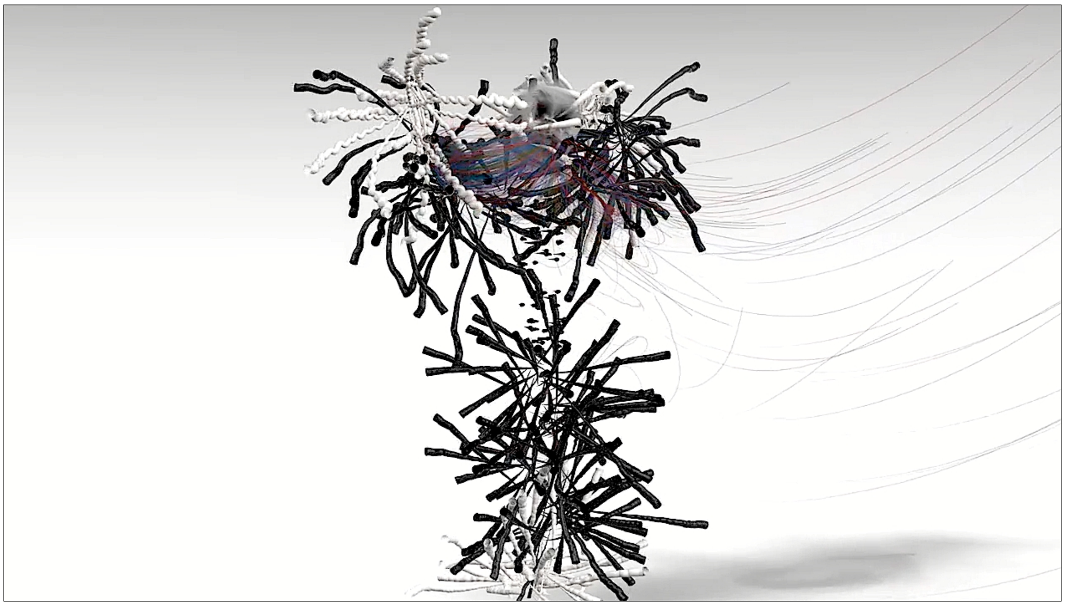

Illustration 11: Still from the final version of the digital adaptation of the solo “No Time to Fly” by Deborah Hay, as programmed by Amin Weber. Retrieved from http://scores.motionbank.org/dh/#/set/digital-adaptation-of-no-time-to-fly.

dancers, the choreographer and the programmer had of the different performances.[123] In contrast to quantitative analyses of motion data, what is here expressed by digital means is the programmer's own conception of this choreography. Which is why this digital animation is referred to as an "algorithmic metaphor". It expresses the resolution of problems located at the many levels of a transduction, which goes from the dance to the viewer and from the viewer turned programmer into the digital domain. This is really not a matter of translation. It is a process that unfolds on the basis of thoughts, which move towards resolutions of the problems at stake. Such problems necessarily pertain both to the content-expression encounter of thought and to the content-expression encounter of writing. And if the problems of the former can be located at the level of the affective-perceptive order of subjective experience, the problems of the latter necessarily pertain to the relationship between the excessive potentials of thought and the limited possibilities of digital coding. If what is transferred between domains are not only forms but also forces, what in the end attests the transductiveness of such process is the metaphorical character of its digital expressions. What is expressed is less what was seen to be danced, but more what was experienced as a whole, that is, the very openness of the dancer to its excessive reality. What is expressed are the principles of individuation felt by the viewer when acting upon the dancer. It can even be said that the kinds of image schemata underlying the many metaphorical projections taking place in this whole process are the ones that mirror in the viewer the forces active in the dancer. Empathy in kinaesthesia. And from the internal resonance of such senses in the body follows the challenge of expressing within the limits of writing the forces in transduction.

The gestural bodies created by the *MB* from the joint work of choreographer Jonathan Burrows and composer Matteo Fargion are also algorithmic metaphors. The "*SEVEN DUETS"*, dedicated to "[f]ragments, movements and insights from the interplay between"[124] the two artists, comprises collections of what have been designated as "*Generators*" and "*Performers*".[125] "*Generators*" are pulse patterns used

123 For insights on the programmer's own experience see: http://scores.motionbank.org/dh/#/set/digital-adaptation-of-no-time-to-fly.

124 The "*SEVEN DUETS"* scores, as created for the *MB* platform, can be accessed at http://scores.motionbank.org/jbmf/. "Fragments, movements and insights from the interplay between Jonathan Burrows and Matteo Fargion" is the subtitle of this *MB*'s section.

125 This section, "*SEVEN DUETS*", is titled after the fact that, for it to be created, seven different choreographic works of Burrows and Fargion were video recorded. The "*Generator/Performer*" pairs were composed not only from these registers, but also from a series of recorded insights where the choreographer and the composer discuss their artistic work. For the artists insights see the set titled "*Patterns and Pulse*" at http://scores.motionbank.org/jbmf/#/set/patterns-and-pulse. For the fragments of the video registers used to trigger the digital "*Perfomers*" see the set titled "*Fragments and*

to animate the digital "*Performers*". These pulse patterns were created by adding markers to the video recordings of different works with the "*Piecemaker*", a video annotation software developed by David Kern for The Forsythe Company to "support the organization and recall of materials created in the rehearsal studio"[126]. With this software, time markers output pulse patterns, which are then used for animating the digital "*Performers*". At the "*Meanwhile in parallel worlds...*"[127] set (where the collection of "*Generators/ Performers*" is presented), one can watch how animated "*Performers"* respond to the video registers of dance events. Illustration 12 (below), shows a montage of the "*Piecemaker*'s" GUI with the digital "*Performers"*. The latter are simple algorithms, programmed with Javascript, which animate the figures with each pulse received. In this illustration it can also be seen how the software's GUI comprises a video frame and the video's annotated timeline. Each of the timeline's coloured bands (in grey) corresponds to an annotation, which is also part of a list disposed below the timeline. Whenever the annotated video is read, the software outputs corresponding values. Such triggers can also be visualized while the annotations are highlighted on the list.[128]

The representation of Burrows and Fargion's dancing bodies by these animated "*Performers"* cannot be understood without acknowledging that the latter graphically express discrete quantities of data. They express the marks with which the videos have been annotated. What has been articulated by being cut can be rearticulated in as many ways as allowed by the possibility space of the encounter between two datasets. What perhaps distinguishes these graphic animations from other gestural bodies is the fact

Movements" at "http://scores.motionbank.org/jbmf/#/set/2012-recordings. For each video register of the seven choreographies see the set titled "*The 7+1 Duets"* at http://scores.motionbank.org/jbmf/# /set/all-duets.

126 Retrieved from http://motionbank.org/en/content/education-piecemaker. Furthermore, at http://motionbank.org/de/node/394 it can be read that "[i]n the context of the *MB* research project, "*Piecemaker*" has been reprogrammed for use in the development of the on-line digital scores and as a standalone tool for use in the studio by those working in dance creation and education. Now titled *PM2GO* (Piecemaker2GO) a free beta version can be downloaded along with instructions here [motionbank.org/en/event/pm2go-easy-use-video-annotation-tool]".

127 http://scores.motionbank.org/jbmf/#/set/a-parallel-world.

128 The explanation of how the "*Generator/Performer"* pairs were composed and how the relation between the two was programmed, notably by means of the workings of the one "*Piecemaker"* software version used for this task, can be accessed at the following address: http://vimeo.com/93275260. It is here worth noting that, just before the "*Piecemaker"* was developed in the frame of the *MB* project, another video annotation software with a focus on choreographic creation had already been developed. This is the already mentioned "*Creation Tool"* (CT) software, developed in Lisbon by the "*Transmedia Knowledge-Base for Performing Arts"* (TKB) project (see page 18). With it, it is possible to annotate video both while this is being recorded and in editing mode. Alongside with having been conceived to be specifically used with tablet computers (since it allows for writing with a pen directly on the video), the *CT* allows for a variety of other modes of annotation (annotations with voice, with hyperlinks, with predefined graphemes, such as the marks of the "*Piecemaker*", with the writings of the tablet's pen, with local files, and typewritten text).

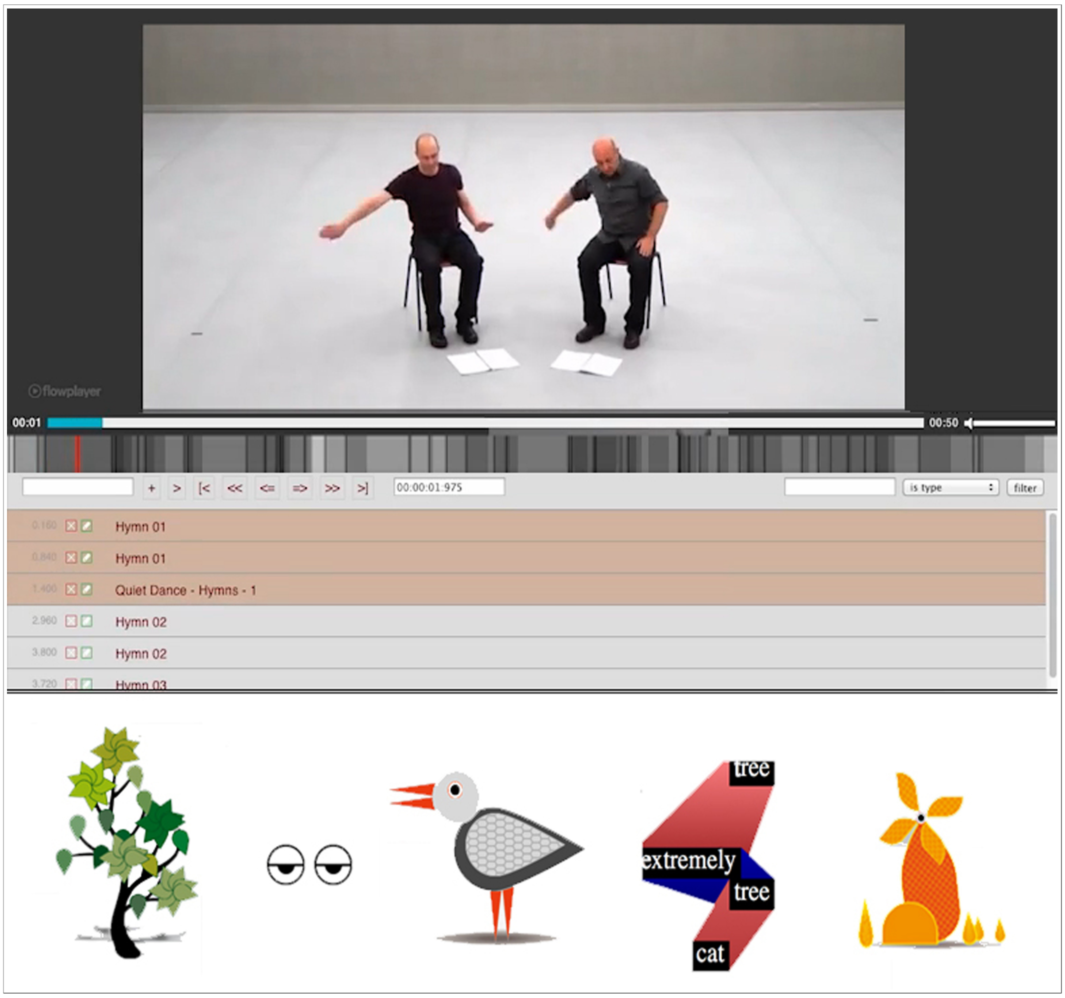

Illustration 12: Montage with the GUI of the Piecemaker software and the figures of the animated "Performers", which have been programmed to react to the software's cues. Images retrieved from the "Meanwhile in parallel worlds ..." set (http://scores.motionbank.org/jbmf/#/set/aparallel-world) and from the video explanation of the workings of the Generator/Performer's pairs (http://vimeo.com/93275260).

that these "*Performers"* have reduced degrees of freedom. For example, the "*Performer Watcha Looking At?*"[129], figured as two round eyes (see Illustration 12, above), and its paired "*Generator",* drawn only from video registers where Jonathan Burrows performs a series of arms' movements, has only eight degrees of freedom—closing the eyes, moving the eye balls to the right, and so on. These degrees of freedom are this "*Performer*'s" expressive range. The data computed from the video recordings eventuates only the possibilities programmed into their digital determinations. Moreover, this figure's animation iterates its expressive possibilities in different combinations of succession according to the distribution of annotations in the temporal profile of the video registers used to create its "*Generator"*. Which is to say that, because the "*Performers"* are spatial objects, possessing no determination with regard

129 http://scores.motionbank.org/jbmf/#/set/watcha-looking-at.

to the temporal disposition of events, their animated expressions depend on temporally determined objects, i.e. the "*Generators"*. Though such temporal objects can have no correspondence with Burrows and Fargion's dancing,[130] if the "*Performers"* are to be animated in accordance with the patterning structures of these choreographic works, they must be fed with the digital expression of representative conceptual structures, i.e. the discrete data of the video annotations. In regard to the formal differences expressed between these digital objects and the dancing bodies to which they refer, it seems most adequate to define the former as algorithmic metaphors. After all they express one thing in terms of another.

The notion of "algorithmic metaphor" seems to have been key for developing some choreographic objects of the "*TWO*" score.[131] This score "begins and ends with two choreographers, unrelated to each other. Bebe Miller (North America) and Thomas Hauert (Europe). […] two working strategies from each of the two choreographers [were selected], that together [deal] with the dancing mind and the thinking body". Or, in other words, this score "examines choreographic thinking in the construction of performance improvisation for small groups".[132] This score's algorithmic metaphors are designated as "*Attentive Agents*". They represent an improvisational practice, called "*Assisted Solos*", which is used by choreographer and dancer Thomas Hauert to generate movement material. The "*Assisted Solos*" practice consists in a series of exercises where "partners or assistants provide external impulses for a soloist in a series of different improvisation strategies from the introductory Light Touches to more complex forms involving several people and changing roles"[133]. For each improvisation strategy, an "*Attentive Agent*" was developed.[134] Each "*Attentive Agent*" is expressed by a GUI (as seen, for example, in Illustration 13, below) where gestural forms representing the dancing bodies are animated both according to the parametric structure of determinate algorithms and according to the "tactile" inputs that the system's user might provide to them (by clicking with the mouse's cursor on one of the GUI's remarkable points). If the latter case occurs, the gestural form reacts, simulating in this way the touches that might occur in dancing the "*Assisted Solos*". But this is not to say that these algorithmic metaphors simulate the dancing body as such. Rather, they

130 Which is the case of the object named *"Count for Nothing"*. This object's generator is a Youtube video with no apparent relation with Burrows and Fargion's choreographic work. This object can be accessed at http://scores.motionbank.org/jbmf/#/set/count-for-nothing.

131 http://scores.motionbank.org/two.

132 Retrieved from http://motionbank.accad.ohio-state.edu/about.

133 Retrieved from the same address where the "*Assisted Solos*" data can be accessed: http://scores.motionbank.org/two/#/set/impulse.

134 The different "*Attentive Agents*" can be viewed at http://scores.motionbank.org/two/#/set/impulse.

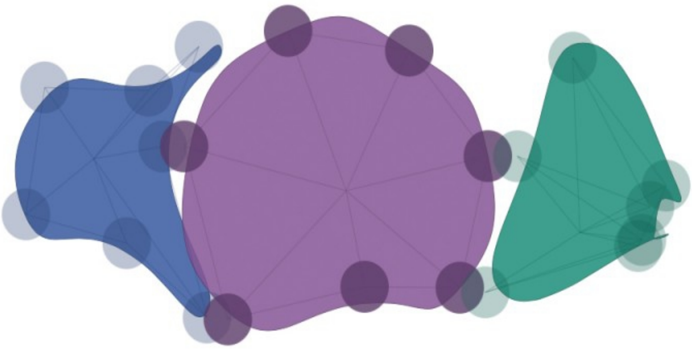

Illustration 13: "Interactive Attentive Agent, an algorithmic metaphor for the Pressure Assisted Solo strategy devised by Thomas Hauert." Retrieved from http://motionbank.accad.ohio-state.edu.

simulate the parameters derived from knowing how to improvise in such a manner. They are digital objects primarily defined by parametric structures that express determinate conceptions of choreography.

To say that an algorithm is metaphorical is to posit the hypothesis that, as a computational procedure, it is capable of thinking in its own terms. In other words, rather than being only the expression of a concept, the metaphorical character of digital algorithms can be thought as pertaining to digital computation itself, but beyond its limited possibilities and the towards the resolution of problems in potential. This is the hypothesis that digital computation is a mode of thought in its own right, one that like any other mode of thought opens processes' actuality to an infinity of potentials. If this is the case, these digital objects can be said to be not only algorithmic metaphors but also metaphorical algorithms. But this of course bears the contradiction of a digital potential, that is, the contradiction that the digital domain is defined both in terms of possibilities and in terms of potentials. Or, better yet, instead of a contradiction, this hypothesis posits the problem of how to relate discrete quantities of data with the continuous character of qualitative potentials. For it to hold, such relation must be thought in relation to potentials existing at the very heart of the digital domain's binary code.[135] The next chapter will be dedicated to such problem.

135 In her book "Moving Without a Body", Stamatia Portanova asks: "Can objects be processes?", which is the title of one of the book's chapters (2013, pp. 85–96). In this chapter, the author engages herself in a discussion about choreographic objects, from the perspective of Alfred N. Whitehead's process

In contrast to these algorithmic metaphors, the *TWO*'s 3D animations simply represent dancing bodies, after they have been motion captured.[136] Though these animations reproduce determinate expressions of dance, they do not necessarily express the choreographic thoughts that moved with the dancers' performance. They correspond more to the result of a translation than to the result of a transduction. Of course motion capture itself follows from technical transductions, which determine the kinds of gestural bodies that in the end will be expressed. But such gestural bodies only serve the presentation of what, after the dances have been registered, is possible to reproduce. The animation of these gestural bodies is no more than the reproduction of the motion capture registers. There is no parametric structure by them expressed that derives from transducing choreography's conceptual structure, that is, from resolving with a process of transduction the implicit problems of choreographic ideas. When motion data is used only to replay what has been registered, these procedures of digitalization cannot be said to be choreographic. If, in any case, the dance's choreographic structure is expressed with these animations, it is not because novel choreographic solutions were attained with digitalization, but only because what has already been determined (in dancing) has also been retained (digitally). The algorithms involved in capturing the dance and animating derivative gestural bodies are therefore functions of reanimation. They render the motion data in terms of what is necessary—a gestural figure recognizable as the dancing body—and sufficient—no deformations beyond the expression of these recognisable forms—to express the memory of past experiences.[137]

The possibilities that these 3D spaces of digital animation allow for, both in relation to the dancing body and in relation to the gestural body, have been far more explored by the "*Reactor for Awareness in Motion*" (RAM) project. Developed since

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philosophy, taking as a case study the work of choreographer William Forsythe and the digitalizations performed on it with the "*Synchronous Objects for One Flat Thing Reproduced*" platform. Here, it matters to emphasize that Portanova looks at the algorithmic character of choreographic objects and discusses the possibility of considering both their parametric structure and their generative capacities from the standpoint of a potentiality that exists not only with dancing bodies but also with numbers. In this regard, Whitehead's philosophy allows for thinking algorithms, even digital ones, not only as finite sets of instructions, but rather as processes that are open to and by undetermined potentials (from which results the possibility of radical novelty in whatever case of algorithmic computation).

136 These animations can be view in each of the *TWO* score's sets (http://scores.motionbank.org/two/#/set/sets).

137 It should nonetheless be noted that the "*TWO*" score's 3D animations allow both for zooming in and out the scene and for changing the viewpoint in all cardinal directions. The fact that one can roam freely throughout the three-dimensional space allows for visualizing the motion capture registers in ways that video registers don't. If programmed into the animation space, different modes of interaction are possible as well. For example, in the animation "*Redux Interactive*" the user can generate a random series of objects which become actual constraints for the animated gestural bodies, by clicking with the mouse's cursor on the animation space (see http://scores.motionbank.org/two/#/set/memory).

2011, by the Yamaguchi Centre for Arts and Media (YCAM), together with Yoko Ando (a dancer from The Forsythe Company), the *RAM* comprises a kit of digital tools for dance research, creation and education. The "*RAM Dance Toolkit"* is an open-source software application, written in C++, which contains a "graphical user interface and functions to access, recognize, and process motion data to support creation of various environmental conditions"[138]. This toolkit can be fed by motion capture systems such as the MOTIONER[139] or the "*Kinect"* sensor[140]. With these data, its algorithms can represent the gestural body in various ways, from more common expressions of choreographic writing, such as Labanotation, to all sorts of geometrical abstractions. The gestural bodies generated with the *RAM* algorithms can then be fed-back to the dancers through audio-visual displays (as seen in Illustration 14, below). With the creation of such responsive environments, the dancers are said to "decide their next movement" on the basis of what is calculated and expressed by the software's algorithms. In this way, together with the *RAM,* they create the "rules" by which they move. Dancing with the *RAM* "is a means to create and clarify problems, and to address deeper issues". For such reasons, the *RAM* is said to be "a technological inquiry into the nature of dance", driven by questions such as: "how do contemporary dancers themselves decide on their next movement?" and "what pattern of thought underlies their movement?".[141]

Since the "*RAM Dance Toolkit"* is also an open-source platform for programming environments that can respond to the dancers' movements, it allows for yet determined ideas to be expressed. Beyond what has been already programmed, the software is open for the inclusion of not yet programmed objects. Anyone with programming skills and choreographic ideas can use this platform to express the latter

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138 Retrieved from http://interlab.ycam.jp/en/projects/ram/. For all the information on the *RAM* project, see the same address.

139 "MOTIONER is the inertial motion capture system developed for *RAM*. The computer captures the dancer's movements via 18 sensors attached to the dancer's body. […] Using MOTIONER, you can capture, record and playback body movements, and send the data via OSC messages over a network. MOTIONER is designed to work with RAM Dance Toolkit using openFrameworks, and will work with creative coding environments that provide OSC. […] In general, motion capture systems are very expensive and very accurate, or very cheap and very inaccurate. To address this problem [the *RAM* team] designed one which is relatively low in cost and fairly accurate. MOTIONER has been developed with feedback from Yoko Ando and other dancers that resulted in a light weight, low-stress, and low latency system. Because it's an inertial system, users can attach the sensors inside or outside their clothing. [...] Special straps for the sensors were developed. The straps allow the sensors to be installed properly and flexibly, regardless of the dancer's body shape. This makes effective measurement possible." Retrieved from http://interlab.ycam.jp/en/projects/ram/motioner and from https://github.com/YCAMInterlab/MOTIONER/wiki/Overview. For a complete and detailed description of the whole system (including hardware and software) see https://github.com/YCAMInterlab/MOTIONER/wiki.

140 See footnote number 108 on page 157 for a short description of the workings of the "*Kinect*" sensor.

141 Retrieved from http://interlab.ycam.jp/en/projects/ram/.

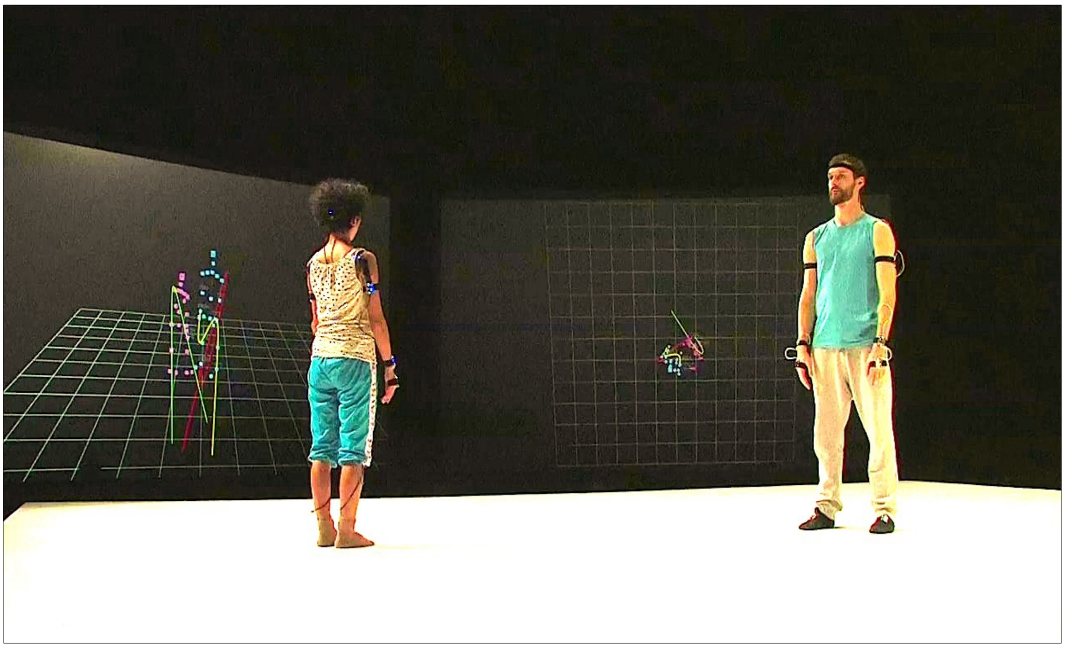

Illustration 14: Still from a movie where it is shown how "dancers react to the information from 'Line', which is one of the 'scenes' programmed into the environmental conditions of the 'RAM Dance Toolkit'". Retrieved from https://vimeo.com/64772291.

in relation to motion data. In the same way, the digital algorithms already programmed into the software express the choreographic ideas developed in the context of the *RAM* project. These can be divided into two categories. Those regarding possibilities of visualization and those regarding expressive derivations from motion data. In regard to the former there is here too the possibility of roaming freely across the 3D space while the animation is rendered, i.e. visualizing it from different perspectives. But beyond this, there is also the possibility of addressing functions to the viewpoint's perspective (here designated as camera). For example, there is the possibility of constraining the camera with one of the gestural figure's nodes (i.e. articulations). It is both possible to direct it towards the figure's nodes and to make it coincide with them (in which case the animation is viewed from the gestural body's perspective). Moreover, it should be noticed that the *RAM*'s scenes also allow for different motion registers to be reproduced simultaneously. Since each dancing body is here represented with a dataset of its own, different gestural bodies can be animated independently from one another, while still being viewed together in one same animation space. In regard to the expressive derivations from motion data, is it notable that the *RAM* software is equipped with algorithms that allow both for creating extensions, which respond to the gestural body 's expressions, and for notating the latter's displacements. At once, these algorithms express choreographic ideas and allow for the expression of new ideas. In the *RAM* software, the expression of each choreographic idea is designated as "*scene*". There are nineteen scenes programmed into the available software,[142] each expressing a choreographic idea of how to extend the gestural body. The correspondence between each scene's algorithmic set and a determinate choreographic idea is confirmed by the project's team when affirming that, by "[t]aking advantage of the power of computer programming, *RAM* externalizes the scenes dancers have in their minds. With *RAM*, dancers can visually observe their ideas and gain a real-time feedback of their movement from the environment. It enables them to experiment more with their perception and movement"[143]. Each of these scenes is therefore a case of solution for determinate choreographic problems.

The *RAM* software also comes with a series of presets, which combine different scenes. For example, one of the presets combines the choreographic idea of dancing with a temporal delay and the choreographic idea of snap-shooting the gestural body (as seen in Illustration 15, below). The algorithm that here computes the temporal delay is called "*Hasty Chase*". This scene is rendered after the algorithmic compression of the gestural body into a buffer, which is then computed into a replicant expression, but in delay. This delay can be stretched or shortened and reproduced faster or slower, according to the user's determinations. Moreover, it is possible to visualize the two

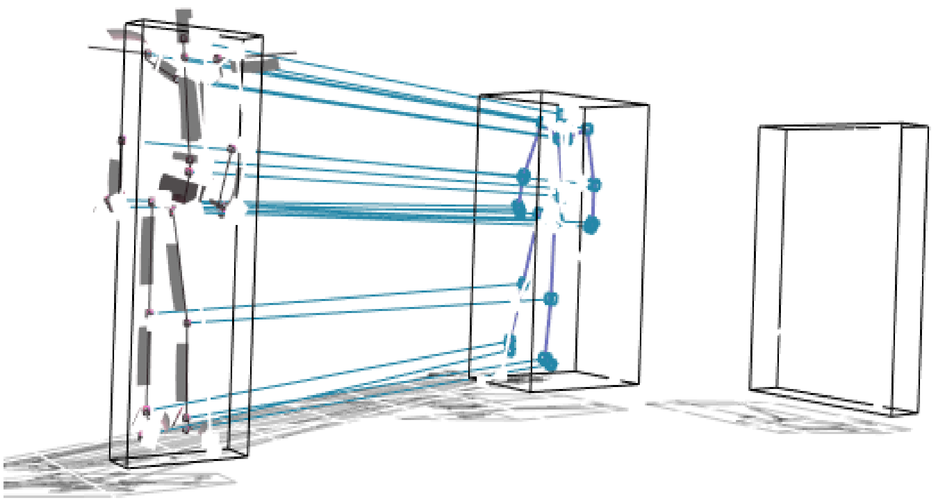

Illustration 15: Still from RAM's motion capture registers of one of Yoko Ando's dancing sessions. Processed with the algorithms "Hasty Chase" (the figure in blue), "Stamp" (the black boxes), and "Natto" (the lines in blue).

142 Which can be downloaded at: https://github.com/YCAMInterlab/RAMDanceToolkit/wiki/Overview.
143 Retrieved from http://interlab.ycam.jp/en/projects/ram/about_ram.

figures' connection with the elastic strings of the "*Natto*" scene. With it, it can be seen in a precise way how this choreographic idea is expressed digitally while being thought (i.e. moved) by the dancing body. Here, as in many other *RAM*'s scenes, the gestural body's extensions depend directly on the dancing body's responses. Finally, this preset combines these algorithms with the scene "*Stamp*". This scene allows for the user to define a temporal metric according to which the gestural body's position is marked with a box. While the dance develops, the animation space gets increasingly populated with these boxes, which can contain (or not) the gestural body's figure as captured by the snapshot. Both this one combination and the remaining presets are but a few examples of the variety of ways in which the *RAM* software is capable of extending the gestural body.

Importantly, the *RAM* is said to "provide the dancers with a way to recognize their subconscious movements by altering the dimensions of their everyday physical perception and creating a disparity from what they are used to". As such, this is a software that "inspires new ideas for dance".[144] This could not express more bluntly how much the *RAM* is a system of technical individuation. There is the choreographic individuation of this software's scenes and there is the individuation of ideas expressed by those who learn how to dance with the software. In this sense, the *RAM* is a whole system of choreographic individuation, one that co-individuates choreographic ideas in the digital domain and in the domain of the dancing body. In fact, as much as the algorithmic determinations of choreographic ideas in the digital domain consist of different possibilities, the learning subjects can think differently of their movements. In these conditions, it is possible for the dancing body to know itself on the basis of a difference regarding not what it can perceive immediately of itself, but rather what it can perceive of what is digitally computed. At the same time that the content-expression encounter of choreographic writing provides the conditions for a difference to be expressed, the content-expression encounter of choreographic thinking individuates the knowledge of an extended perception. In this guise, perception can be seen as a variety of differences that condition the individuation of knowledge. Differences that, in relation to one another, bring the overall system of individuation to novel states of resolution.

All these examples of digital choreography attest one thing: the diagrammatic topology of choreographic ideas is also algorithmic. As mentioned before, this shouldn't

144 Retrieved from http://interlab.ycam.jp/en/projects/ram/about_ram.

be understood as the choreographic object being algorithmic because it is digitally programmable, but precisely the opposite: it is programmable because it is algorithmic in itself. Such algorithmic character of choreographic objects regards the fact that they are resumable across domains. It regards the fact that they are known and, as such, conceptually structured. In relation to technical individuation, it is this intelligibility that allows for choreographic objects to be transduced across domains and, in this case, digitally programmed and expressed. All the algorithms discussed above are choreographic functions of expression. They not only express choreographic diagrams, but they also express how such functions are manifested when in relation with given quantities of data, i.e. matters of content. The fact that both parts in this content-expression encounter are sets of digital data attests their codification and programmability. It is this last feature that allows for digital data to express the dynamic character of choreographic objects. A program, instead of just expressing one possible solution for the problems in case, can iterate computations and express the many solutions existing in the content-expression encounter of each digital choreography.

From this standpoint, it should be asked: are these digital choreographies capable of novel ideas? Of course the case just mentioned, of the *RAM,* attests precisely this. But it does so with potentials belonging not only to the digital domain but to the overall technical system of individuation (including all that is analog). Instead, the question that remains to be asked is: are algorithmic computations capable of expressing novelty as such, when only the digital domain is considered? If so, it should be acknowledged that this can lead to non-programmed expressions, being themselves charged with the potentials of novel ideas. The next Chapter will follow this hypothesis.