Shape Analysis, Visual Art and the Axis of Symmetry

Conversations between John G Harries and Harry Blum (postponed by 35 years)

These dialogues may be fictional. The characters represent real people and events as closely as possible, and any resemblance to persons living or dead is entirely intentional.

First conversation

JGH I was hoping to propose that you participate with me in an art-science collaboration project initiated by Jennifer Galanis, but it turns out that you took permanent leave some 20 years ago.

HB It's true, I don't get around much these days.

JGH Well, I don't know whether your genes are still replicating themselves, but I notice that your memes are still getting about, cropping up in various papers and books dedicated to you. I should like to discuss this idea of a collaboration, undeterred by the trivial setback we have just referred to.

HB We would probably not be able to communicate by letter or telephone.

JGH No, and not even by email (which has developed as an ubiquitous tool of communication since the 1970s). But the imagination can be a much better channel than any of these – faster, more flexible, and costs nothing; mine was fired up by your article of 1973.

HB OK. So what's your idea?

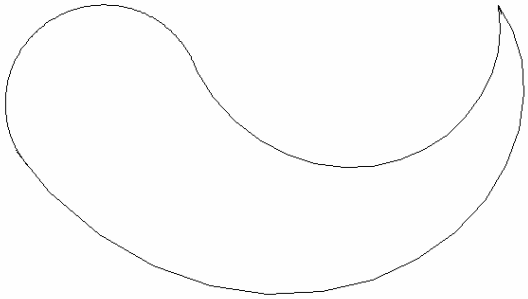
JGH In my work in visual art I have been chiefly occupied with the synthesis of shape rather than the treatment of existing visual material. My revival of interest in the problem of analysis arose from work on the video *Babel*, which is a series of variations on two figures designed by Noa Eshkol many years ago for a shadow puppet show. For the purpose of adopting them as the basis for a composition, I reproduced the shapes by a tedious process of trial and error; however, I recalled your article, which intrigued me at the time, but which I did not find a way of fully integrating in the EWMN approach to movement that I employ.

HB What is the EWMN approach?

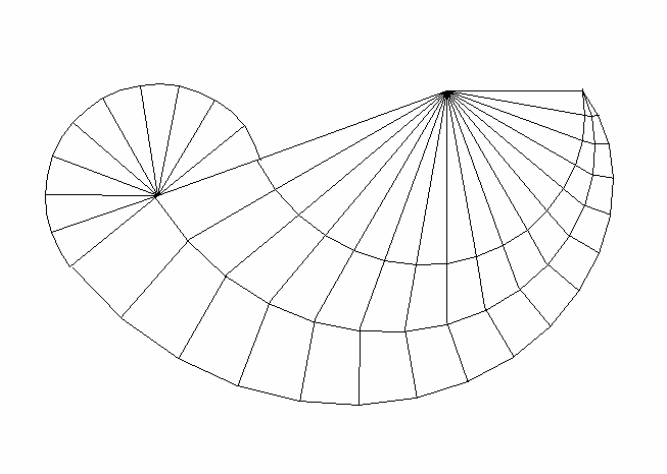
JGH Eshkol Wachman Movement Notation (EWMN) is a method of recording in symbols the movements of any object or organism that can be conceived as a linkage. Originally it was intended for the composition of dance / human movement. In the late 1960s I began to apply it to visual art. In the early 1970s you and I nearly met at Tel Aviv University, at the instigation of Ilan Golani, who used EWMN in the context of animal behaviour. Unfortunately that meeting didn't quite happen.

HB Yeah, I seem to remember something like that. But tell me some more about this system.

JGH Well, take this shape for example *(draws a horn-like image):*



It could have been traced by the movement of a linkage of three rectilinear components, like this:



HB Uhuh, and you could make a record of the movements?

JGH Yes – a movement score defining the sense, angular amount, and any change of length:

(9)↑ 1=10°

	0	(27)	↓18 +12	↑20
E	0	(27)	+12	
	15	(27)	↑16 +7	

…and to this can be added colour and type of trace (swept, line, hatching, or even a movement leaving no trace).

HB Why would you want a movement that leaves no trace?

JGH It is like a painter lifting her brush so as to make a stroke somewhere else on the canvas. Also, a proximal link can carry a more distal link, without itself being visible. Just the brush stroke, without your arm leaving any smudges and mess.

HB Modifying the path of the movement of the more distal link…

JGH Exactly, and even if the distal link is only carried passively, it can leave a trace.

HB Well, you seem to have got a pretty good system working there; why do you want my collaboration?

JGH Because, although I can generate shapes quite easily, if I want to take a given form and use it as the basis for variations using the EWMN approach, I have no way of analyzing the given shape so as to reproduce it, other than trial and error.

HB So what makes you think my work could help?

JGH Mainly the fact that your method seems to be intuitively right but at the same time based on definite measurement, and reasonably easy for a non-mathematician like myself to grasp – provided you can help me to understand one or two issues.

HB And that's it?

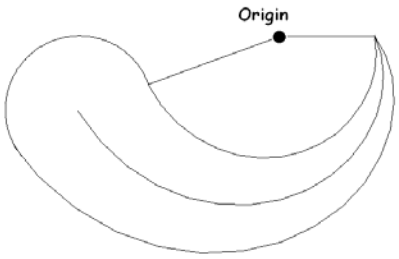
JGH No: if we prove able to integrate your analytical method with my synthetic one, the fact that you employ a succession of discs (growth from a point) as the wave front, suggests that a new option will enrich my toolbox – a trace with a less severe wave front than my usual rectilinear one. Resembling something closer to a brush stroke than broad nibbed calligraphy.

HB Sounds likely.

JGH Shall I explain briefly where I've got to so far?

HB Mm.

JGH *(Draws again.)* I establish the origin for my linkage, as the intersection of the normals to the tangents of the more concave boundary of the shape.



Does that make sense to you?

HB *(Muffled)* Bzz mmf grr shmzzz huh phrm.

JGH Sorry, I didn't quite catch that.

HB Shrrrr shmzzz hup phrm glk.

JGH I'm afraid I'm a bit hard of hearing… or are we losing contact? Perhaps I'll take that as a provisional OK, anyway.

HB *(Fading)* Zzzzp.

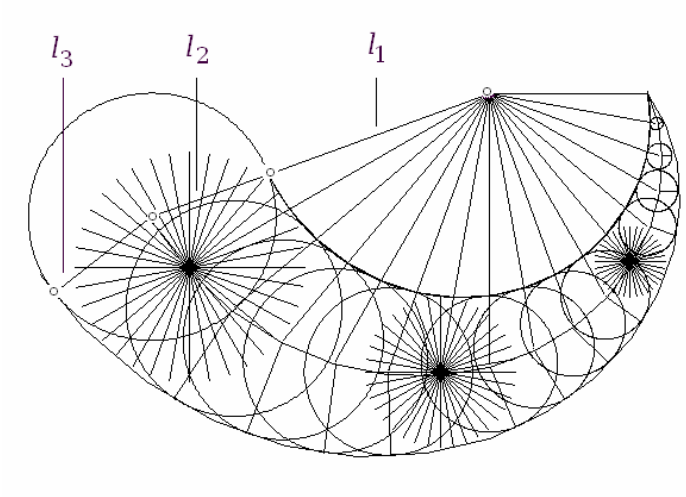
JGH You're not going are you?

HB I went long ago, but I'm still here.

JGH Thank goodness. Thought we'd lost contact.

HB Only temporally. Reception's not too good here. Now, if you are reading me **LOUD AND CLEAR,** what's your next step?

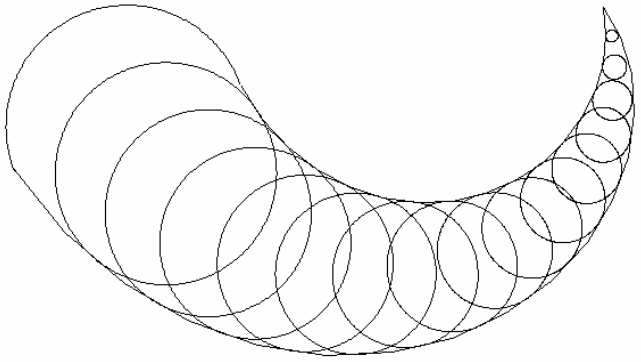
JGH From the origin we extend the first link – let's call it l_1 – to meet the nearest boundary of the object-shape, which we can do at equal angular intervals, like this. (*Begins sketching another diagram.)*



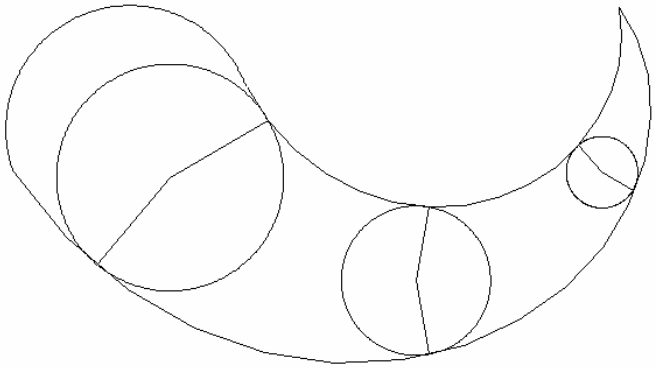
The two links l_2 and l_3 are of the same length, and are extended from the first. They are potentially radii of a circle; and that is where EWMN and your maximal disc approach coincide.

HB But how do you arrive at the size of disc that fits the shape?

JGH Using the disc as a measuring instrument, we get the distance to the far side of the boundary by increasing the length of the radii, grown from a point until we get a fit. Essentially, it's what you do yourself: finding a maximal disc at every point – and of course an infinite number of discs would generate everywhere a perfect fit with the boundary of the object. Look. (*Draws.)*



HB It's important that you recognize that the radii relevant for you are not necessarily those that are diametrically opposite one another. *(Appears to be sketching too.)*



JGH Aha, that's a really important point, which I hadn't properly addressed. It means that the two radii only form a diameter when the boundaries are parallel, but otherwise are at some angle – perhaps changing as l_1 carries them along?

HB They are the nearest (equal) distance from the centre of the disc to the boundary. Now, if you join up the centres of all the successive discs, you get a

symmetrical axis for the object shape. It's symmetrical because it is equidistant from the boundaries at every point along it.

JGH You didn't answer my question, but what you describe is a bonus from my point of view: we get a kind of sculptor's armature for the shape. It could be the spine for any number of other object shapes, all variations on the basic symmetrical axis.

HB I guess so.

JGH As I said, another bonus will be that the wave front will always be curved (part of a disc). And of course the main point is that this is a way of analyzing any shape, reproducing and defining it in an EWMN score.

HB There you go. I think your next task will be to try out the whole procedure on more complex object shapes now, thinking from within the object outward rather than always the reverse.

JGH From an interior core, outward. Very organic.

HB Well, after all my idea was for a geometry of biology. Anyway, my guess is, this whole project of ours will provide you with quite a new outlook.

JGH If you'll pardon the expression, I think you are dead right.

Second conversation, much later

JGH Hello, Professor.

HB (*No reply)*

JGH Doctor Blum?

HB Mm?

JGH That you, Harry? – May I call you that?

HB You might as well; so happens it's my name.

JGH It's been a while since we talked, but I'd be glad if we could take up the idea again where we left off.

HB Ah, it's that Doctor Harries, isn't it?

JGH I'm not a doctor, just John Harries with no handle. I suppose I could be Mr, like a surgeon in the U.K.. After all, I am doing my best to *analyse* – and in Hebrew the same word means performing a surgical operation.

HB Well, putting medicine and linguistic analysis aside for a moment, how's the geometrical bit going?

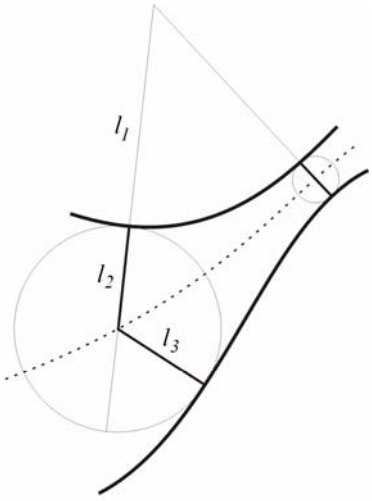
JGH I was hoping for your help with that, if you can spare the time.

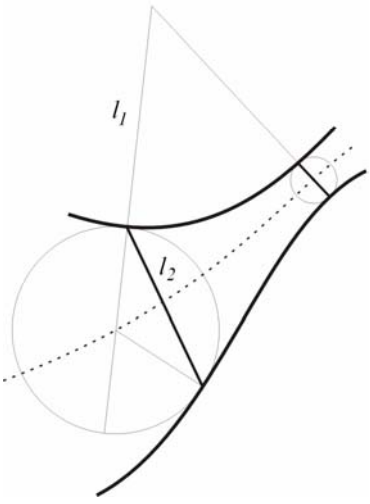
HB Me, I've got all the time in the world.

JGH Wish I had.

HB It comes with a price tag. Anyway, what seems to be your problem?

JGH First of all: last time we talked, you made that remark about the points of contact between a disc and the contours. Because they are not necessarily diametrically opposite one another, the radii *l2* and *l3* are likely to be at some angle to one another. This means that a rectilinear wave front would be formed by a line joining the distal ends of the two radii.





That's good news, because it provides a single light link l_2 that traces the shape at all points along the movement: economical and precise. Alternatively, the disc itself provides a curved wave front – a welcome addition to the available options, although in this case it looks a bit bulbous doesn't it? Is that right, do you think?

HB Yes, because the contours are continuing to diverge, so the discs will continue to increase in size, or as I like to describe it, the grassfire will continue to spread as it moves along.

JGH Right, so that's good news too. The bad news is, I have no idea how to calculate the (changing) length of the 'new' link, l_2, or for that matter the (equal) lengths of the initial l_2 and l_3, the radii of the circle.

HB Do you really need to at this stage? Wouldn't it be better to concentrate on the procedure and get that worked out by trying to apply it to an actual case?

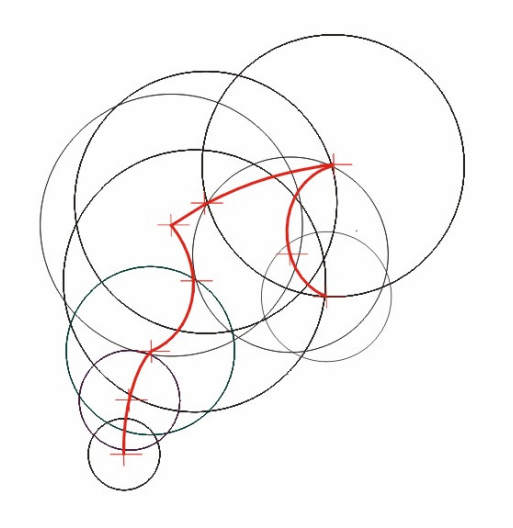
JGH Maybe you're right. Let's try it with this figure, which I happen to have here:

HB A curious figure, kind of simian.

JGH Should be all right for monkeying around with then, hahahaha. Actually it's one of those figures designed by Noa Eshkol for a shadow puppet show called The Tower of Babel that she and I dreamed up for an end-of-term party when we were dance students in London many years ago.

HB Well, why don't you just fill it with as many discs as give a good approximation of the shape. Or maybe take a small part of it for a trial run first.

JGH Yes, let's take the head. Here, these are discs that roughly fill it, and the symmetrical axis that results:



HB You've been a bit stingy with your discs, which makes the symmetrical axis (sym-ax) very ambiguous, but it will do for a start.

JGH Yes; I didn't want to get bogged down with an endless number of disc sizes. I think it might be worth selecting a set of equally graded circles, as a kind of measuring scale, to get the relative lengths of the radii at each selected point.

HB Yes, at least that will give you some numerical values to work with later on.

JGH Twelve disc sizes should provide for a fair approximation of the whole shape I think. I've coloured them to make them easier to identify. What do you think?

HB Dodecachromatic, you might say.

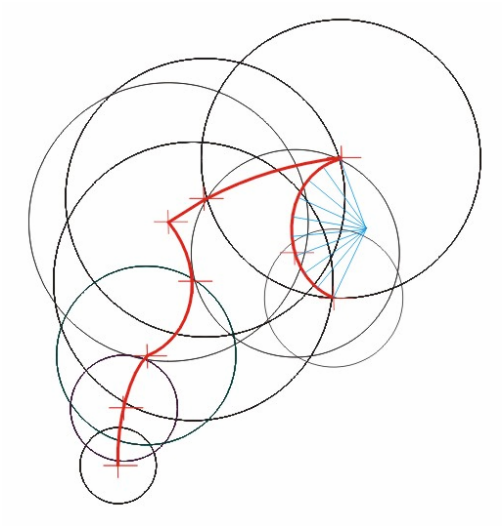
JGH I might, but I certainly won't. I'm serious but not serial. The irregular shape we've chosen probably wouldn't lend itself to any simple patterning anyway.

HB An irregular shape will be a good test of the procedure, so let's stay with it.

JGH By the way, I made the segments of the sym-ax as nearly parts of circles as possible (encouraged by your sanctioning of ambiguity). This should keep things reasonably simple.

HB Yes, I noticed that. Now, for your purposes you'll need to be able to *define* the path of the sym-ax.

JGH I can do that in the same way that we began the analysis of a shape when we had our previous conversation. By extending the normals at each end of a segment until they meet, I obtain the centre of the circular arc, which will be the origin for a link moving to describe the curve:



HB Nice bit of reverse engineering –

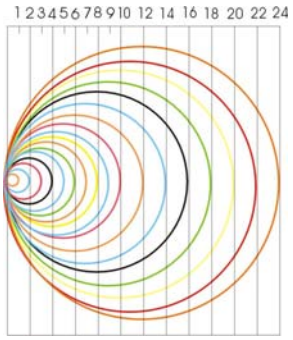
JGH – even if you do say so myself.

HB Let's see if you can get a reasonable number of fits to the whole shape with your twelve step scale.

JGH Okay. H'm – there are places where we could do with 'microtones' to get a continuous fit.

HB Never mind, you'll most likely find those gaps are filled by a uniform change of radius length as you move your linkage.

JGH I'll interpolate some smaller discs anyway, to get a better fit.



HB Twenty-four steps to your scale – that's still quite manageable.

JGH Yes; but look, there's another problem: there will be places where the sym-ax is a straight line segment, so we can't get an origin for the curve, even infinitely distant.

HB You seem to be forgetting a feature of your own system, that allows change of length of a link.

JGH How will that help here?

HB Well, from one end of the segment, establish the direction of growth of the sym-ax line, and just increase the length of an interpolated link, from zero to whatever, without any angular movement.

JGH Of course! I must have got obsessed by the apparent need for all these origins to be on the concave side of the sym-ax, not *on* it.

HB Now you've got some work to do, constructing the complete sym-ax, which is obviously going to have branches.

JGH *(Exits, and comes back several days later)* There, it's done. *(Shows the result:)*

HB Okay; now you will have to repeat the process of finding origins for each arc of the sym-ax, getting a whole lot of points of origin scattered over the entire field.

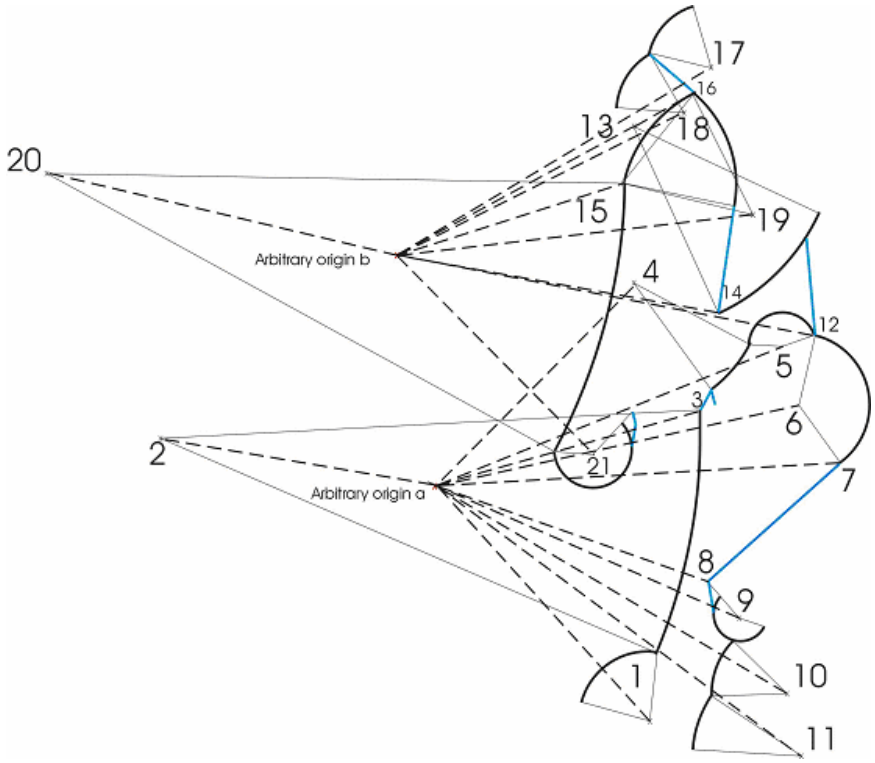
JGH Yes, it looks a bit daunting.

HB Aren't you getting into an infinite regress here: next thing, you'll be looking for some kind of sym-ax for all those points of origin.

JGH No, for this stage I propose to carefully choose a single arbitrary point as the origin of a single extra 'heavier' link. Moving from one position to the next and changing its length, this heaviest link will serve sequentially as coordinate for each of these scattered points. This will provide the closing step, with no further stages necessary.

HB A purely intuitive process, of course.

JGH Of course. Actually I think that for clarity and convenience we should use two positions of the 'heaviest' link in this case, even though a single one would be perfectly workable.



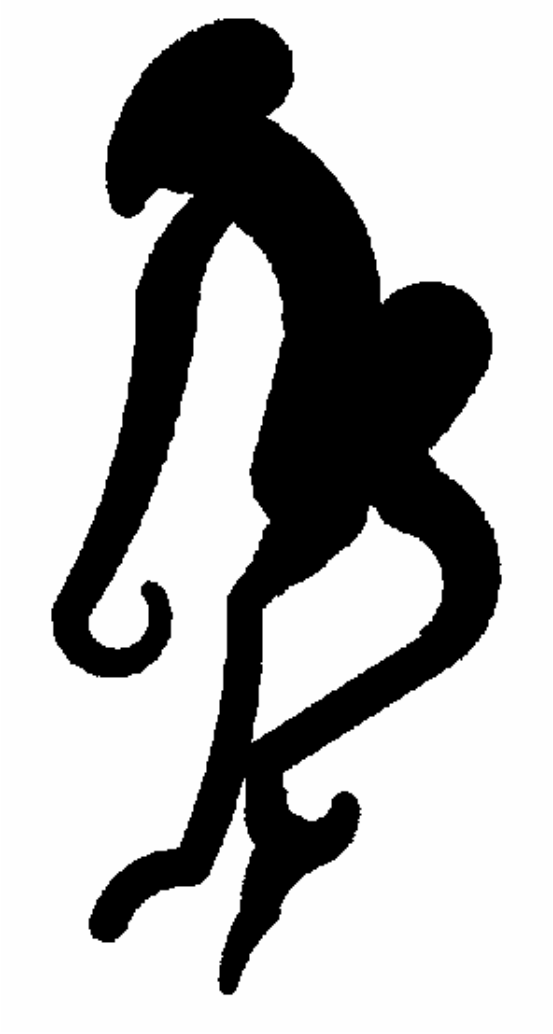
It would be nice if we could automate all of the processes we've discussed, but I think that will have to wait at least until we've completed this project.

HB I guess so.

JGH To give the idea a complete trial run, I intend making use of this figure as the theme for a video of variations in which the sym-ax provides the constant basis.

HB Yes, I see the preliminary drawing; it's remarkably like the original.

JGH The analytical phase works well, and the resulting sym-ax is fine (could be near perfect with closer sampling); but in the synthesizing stage I had some intractable anomalies in the disc measurements. Probably it will be essentially a matter of a more dense sampling of the disc size at the analytical stage. In the end I decided to forge ahead fairly intuitively with the reconstitution, but always relying on the basic armature to keep me on track. (For future use, it shouldn't be too hard to devise a way of monitoring the closeness of fit with the reconstituted disc-matched form.)



That council of despair turned out to have its reward: working rapidly, it was almost like using a brush and controlling the breadth of stroke by varying the pressure. But what is really important is that the very act of employing EWMN involves

quantification, which is basically what this is all about. Anyway, I'm now ready to start composing the video. I'll be back shortly.

JGH *(Again absents himself, this time for several months, during which various untoward events take place, including his computer suffering a mental breakdown.)* Hello again Harry – as you see, I'm late.

The late HB: Me too. How's your video project going?

JGH Because of technical setbacks, so far I've only got a rough cut of a small part of what I planned, but it's enough to show that the overall idea of integrating your concept of an axis of symmetry with my application of EWMN in visual art does work in practice.

HB Can we have a look at that video?

JGH Here it is *(runs a three-minute clip)* The first part is based on the identical axis of symmetry derived from the analysis of the 'Babel' figure, the images being the result of variation of the distances from the sym-ax to the hull (*sym-dist*). Finally, the original figure is reconstructed on the same sym-ax basis:

Some of the images emerge in 'grassfire' fashion, while others are generated by the movement of rectilinear axes.

HB Well, it certainly turns out to be an integration of propositional communication and existential communication –

JGH What?

HB Science and art, that's what I take this project to be about.

JGH Oh yes, absolutely; and I'm really grateful for your help with it.

HB It would have been a pleasure. I'm a bit weary now, so if you'll excuse me…

JGH Of course.

HB …I just need a bit of a rest.

JGH Thank you, Harry Blum. Rest in peace.

Notes

Dr Jennifer Galanis, formerly of the National Institutes of Health, Maryland U.S.A., and currently post doctoral fellow at the Fritz Haber Institute, Hebrew University, Jerusalem, Israel.

Professor Noa Eshkol (1924-2007) was the co-founder of Eshkol-Wachman Movement Notation (EWMN).

Professor Ilan Golani of the Department of Zoology at Tel Aviv University, initiated the use of EWMN in the study of animal behaviour.

Dr Harry Blum (deceased). When at the Division of Computer Research and Technology, National Institutes of Health, Bethesda, Maryland U.S.A., published **Biological Shape and Visual Science** in *J. theor. Biol.* (1973) **38,** 205-287.

John G. Harries, was a student and colleague of Noa Eshkol and member of her earliest experimental dance group. He first applied EWMN to visual art in the 1960s and continues to work with the notation in the composition of video art.