The shape of creativity

A discussion paper

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Abstract. In this discussion paper, several proposals are made for potential interconnections between notions of ‘shape’, ‘ontology’, ‘design’ and ‘creativity’. The purpose of the paper is to summarise the points made in the Shapes 3.0 presentation and to promote further discussion and consideration of some of the connections drawn. Shape is proposed as an essential embodied construct deeply anchored into our way of dealing with the world and capable of deployment for a broad range of comprehension and production processes, including creative design.

Keywords. shape, ontology, creativity, perception, embodiment, design

1. Introduction

In this discussion paper, the course of the argument will start from the notion of ‘shape’ and ontology, run through some of the current discussions of ‘creativity’ – particularly approaches to *computational creativity* (cf. Colton & Wiggins 2012) – and then return to ‘shape’ at the conclusion. To begin, however, we can ask the question as to why the title of the paper so blatantly commits a category mistake: how can ‘creativity’ have a ‘shape’?

Here we need to observe a continuum of more or less extended usages of the term ‘shape’. These begin with presumably unproblematic cases where material objects are talked of having shape, but quickly move on to discussions where shape takes on a more metaphorical flavour. Certainly aggregates of material objects can have some shape, even though the aggregates themselves are no longer entirely physical: ontologically more complex notions need here already to play a role (cf. Galton 2013). Detailed discussions already exist for such notions as ‘holes’ (Casati & Varzi 1994) and even the shape of ‘empty space’ (Bhatt & Schultz 2013). It is also equally common to talk of certain quite immaterial ‘objects’ as having shape however: for example, shapes of arguments or shapes of mathematical figures (e.g., the abstract notion of a triangle) appear just as well suited to descriptions in terms of shapes as their more material relatives. There is also the common practice of referring to temporal phenomena in terms of shapes: in particular, musical phrases or pieces may well have shapes in some sense (Wattenberg 2002). So there does not appear to be a clear ‘cut off’ that provides a boundary between what might have a shape and what might not – evidently some rather more abstract notion of what is occurring when we talk of, or use, notions of shape other than that inherent in material objects is going to be necessary. This leads to our particular focus for current purposes: just what is it about shape that lends itself to drawing connections of these kinds so freely?

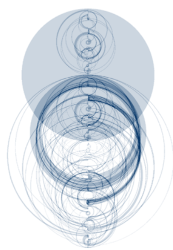


Figure 1.: Watternberg’s song shapes

2. Where might 'shape' belong ontologically?

Here we take up previous discussions, such as that of Galton (2013) in a previous Shapes meeting, to ask where in a formal foundational ontology might we best locate the notion of 'shape'. If we take the DOLCE ontology (Masolo et al. 2003, Borgo & Masolo 2010) as representative of an appropriately well articulated and ontology of this kind, then we would probably be led to suggest a placement of 'shape' alongside other physical qualities, such as spatial location. Physical qualities are necessarily linked with physical objects and take a value drawn from within corresponding physical regions.

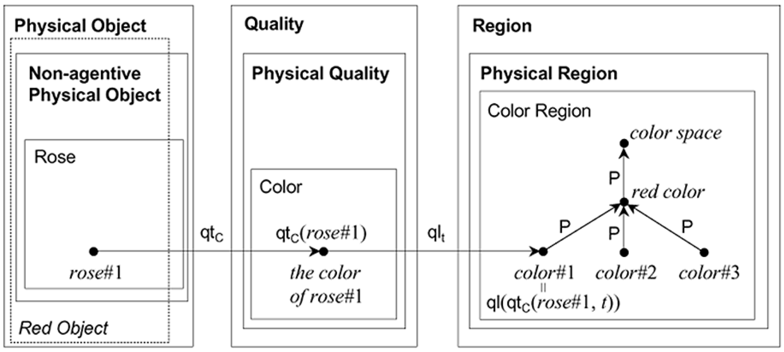


Figure 2. Quality and quality spaces (taken from Masolo *et al.,* 2003)

The usual diagrammatic representation of these interrelationships is as shown in Figure 2, drawn from Masolo et al. (2003). Here we see that some physical endurant, such as a rose, necessarily has a physical quality of 'colour': this is time independent and unchanging. The particular colour of that object then has a value drawn from a corresponding region, in this case the colour region shown on the righthand side of the figure. This region may have several qualitatively distinguished and named subregions, such as 'red'. Thus, when the colour of the object changes, a different subregion within the associated colour region is pointed to; in all cases the colour of the rose remains its own unique quality, however.

Now, this sounds promising for shape also. Each physical object definitely has its own unique shape that is its and no other's. It may then be the case that one way of locating shape ontologically is within a corresponding physical region capturing the nature of shape. Then, quite analogously to colour, if the shape of some object changes, then its particular shape simply takes on a new value (or set of values over time). Let us pursue this further.

3. Quality spaces and perception

For a 'cognitively'-motivated construction such as the foundational ontology DOLCE, one might expect that its quality spaces have something to do with perception. That is, it is not just 'colour' in the abstract that is characterised within the corresponding physical region but colour as it plays a particular role in our, i.e., human's, dealings with colour. This is necessary because it is well known that the relationship between physically measurable properties of lightwaves, such as frequency and intensity, and phenomenologically experienced 'colours' is quite complex.

Figure 3. Colour systems discussed by Gärdenfors (2000) and others

There are, moreover, various models of 'colour' as perceived, which can all be assessed empirically according to how well and in what respects they 'match' our experiences of colour. Two examples of such schemes discussed by Gärdenfors (2000) are shown in Figure 3; there are several more. Each such scheme might serve as a way of organising the internal details of a physical colour region: particular colours might then be distinguished by articulating subregions within the spaces so modelled.

Regardless of which scheme one takes, however, the complexity of the relationship between these qualitative representations and the physical properties of the generally assumed carrier of colour, light, becomes particularly clear when the behaviour of the human eye is considered. Although there is general awareness of the fact that the eye contains components – the so-called 'cones' – that are sensitive to red, green and blue frequencies, it is less generally realised that expressing the properties involved in this way already serves to confuse somewhat the distinct levels of description involved. The actual sensitivity of the three relevant components of the human eye according to light frequency is shown in Figure I4.

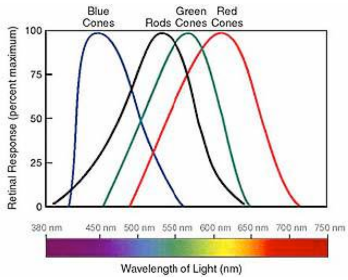


Figure 4. Colour sensitivity of cones in the human eye
(**URL:** *http://light-measurement.com/perception-of-color/*)

Here we can see that there are no 'pure' receptors and that there is considerable overlap in sensitivities. Cones with a peak receptivity to 'red' are also very active when receiving 'green'; cones with a peak receptivity to 'blue' also overlap with both 'green' and 'red' (cf. also: Gärdenfors 2000, 13). It then might be asked just how clear colour perceptions occur at all. The answer is that the actual colours perceived depend on further levels of neural calculation. The overall brightness, or luminescence, is calculated from the sum of the inputs of each of the cones; then one factor is derived from excitation from the ‘red’ and the ’blue’ and inhibition from the ‘green’, while a further factor is derived from excitation from the ‘red’ and the ’green’ and inhibition from the ‘blue’.

This differential procedure serves well to *distinguish* certain states of affairs rather than simply to respond to frequencies. Taken together this then begins to approximate our commonsense colour experience. There are many perceptual experiments that can be performed that produce highly non-intuitive results that rely on these differential processes of excitation and inhibition, demonstrating both their validity and their relevance for colour perception. This means that colours offer an elegant example of where the ‘physical universe’ and our perception of it lie a long way apart.

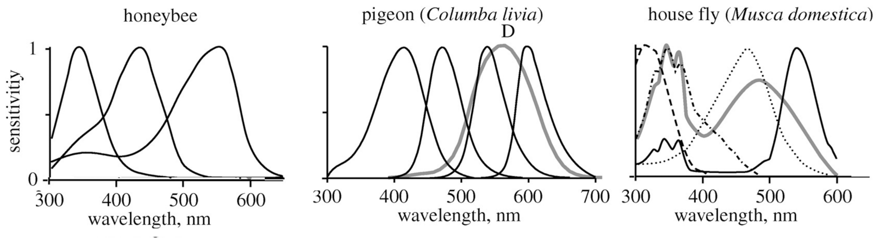


Figure 5. Colour sensitivity of cones in various species, adapted from Osorio & Vorobyev (2005)

This point is emphasised further when we examine the visual make-up of several other species. There is, in fact, a broad variety in ranges both of sensitivities and of how those sensitivities are combined during ‘colour processing’. Figure 5 shows sensitivity graphs for honeybees, pigeons and house flies similar to that shown above for humans. One consequence of this is that although the overall ontological organisation proposed by DOLCE may remain, the individual internal construction of quality spaces for colour may well need to be quite different for differing species – indeed, it may well need to be different even among humans, should we wish to characterise more adequately differences in colour perception, such as colour blindness of various types. Returning to the main line of argumentation for the current paper, however, we need to address just why such differences occur and what they tell us about the role of the perceptual system.

Figure 6.: Chillis against a green background

First and foremost, such biological results provide strong evidence that perception is *functional* in the sense of being rather precisely targeted at the capabilities that species require to survive. As Matthen (2005) sets out in considerable detail, the relative sensitivities of the cones in the human eye result in a system that is excellent for discriminating red and green and it is then no accident that red-green separation is an ideal capability for recognising, for example, berries against background vegetation. A perceptual system that evolves to make red stand out against green is then well suited for finding food of this particular kind; Figure 6 (when viewed in colour!) suggests this more visually.[1] This relation between behaviour and the perceptual systems that have evolved to support that behaviour can be found across species. Figure 7, for example, shows a simulation of a bee’s visual percep-

[1] Image of cheiro roxa bush taken from **URL:** *http://thehotpepper.com/topic/27468-pjs-2012-glog-with-a-kaleidoscope-of-colored-peppers/page-8*.

tion produced by Nicolas Chalwatzis of some flowers at different stages of development (cf. **URL:** *http://www.ultravioletphotography.com/content/index.php/topic/648-simulation-of-bee-colours-ii*). Whereas under daylight these flowers would appear the same colour for a human observer, the differential organisation of the colour receptors for bees show them (again only when the figure is viewed in colour) quite differently, thus allowing finer discrimination very much along the same lines as that just illustrated for humans with berries.

Figure 7.: Simulated bee vision (Chalwatzis, 2013)

Now, it has been suggested above and by Galton (2013) that shape may be similar ontologically to colour, appearing as a kind of physical quality. This then requires a corresponding kind of physical quality region. Given that, as we have now argued, the organisation of such a physical quality region for colour needs to pay appropriate attention to how the perceptual system has evolved to support particular kinds of behaviours, we should in all likelihood expect a similar kind of structuring to take place for 'shape'. What might that look like?

4. Shape as a functional perceptive category

We have asked questions of colour concerning the behaviours that experienced colour differentiation affords for its perceivers. So, crucially, if shape is going to be seen as a quality region, there is very little reason to consider our perception and use of shape differently to the situation for colour. This means we will need to capture just what it is that shape does for us in various contexts of physical interaction with the environment. One source of relevant behaviour here is going to be found in very early interaction as we develop the skills necessary to support more complex abilities – that is, in interaction of the kind suggested in Figure 8.[2]

Figure 8.: Acquiring the perception of shape?

The quality region for shape may thus be similar to that suggested above for the physical region for colour, but we still have very little idea of just what dimensions of variation are going to be necessary for its classification. Indeed, it may turn out to be a quality space far more like a pigeon's or housefly's complex versions of colours than like simpler 3D Euclidean space or colour wheels. Considering perception as situated embodied action, as Matthen (2005) and many others now propose, would mean that we also need to consider the distinct kinds of physical interactions that some notion of 'shape perception' would afford. A starting point for such a construction is sketched in Figure 9, organised around bundles of 'behaviours'.

Here we see a range of dimensions of interaction with physical objects, each of which gives potentially useful information concerning the object in the world being encountered. It is likely that there are considerably more such dimensions, all encoding various parameters that might be found beneficial for low-level body motion and manipulation. Relevant bodies of research for taking such a consideration further would, therefore, include neuroimaging and related techniques exploring just how the brain is making sense of the world it interacts with physically and directly on a close personal scale.

Such categorisations may also play a role for grounding aspects of linguistic behaviour and descriptions of shapes. This is suggested in Figure 10, which overlays sev-

[2] Image taken from **URL:** *http://www.parentsareimportant.com/2010/05/benefits-of-blocks.html*.

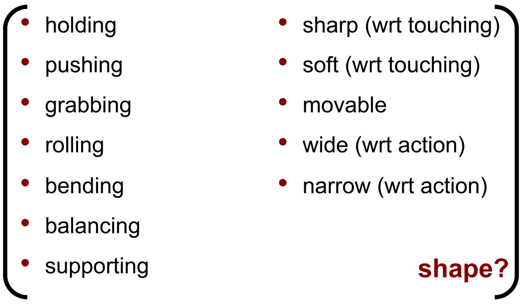


Figure 9. Suggestive dimensions for organising 'space' as an embodied, functional perceptive category

eral regions and corresponding labels over the dimensions suggested in the first figure. Note that the subregions as well as the naming here is purely suggestive of how such a procedure might unfold; the particular labels and regions identified are not intended as hypotheses in their own right. The analogy being drawn here is that with the use of colours in the original figure concerning DOLCE above (Figure 2), i.e., particular subregions of the space are picked out by a culture for specific labelling. It is to be assumed, here following Gärdenfors (2000), that such labels pick out connected subregions in some sense – this may then well serve as an additional source of information for the organisation of the space as a whole or in part. Interesting here is how languages typically have a very limited range of potential shape 'names' and that very often labels are drawn from the objects that possess particular shapes. This is occasionally described as a metaphorical usage, although the connection drawn appears rather more straightforward within an architecture of the kind being sketched here.

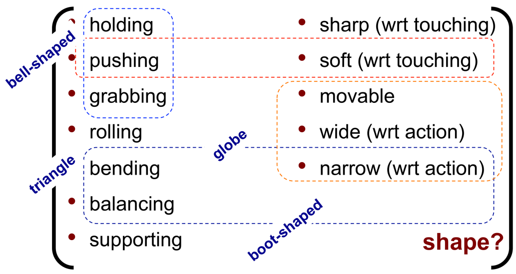


Figure 10. Shape subregions used for grounding shape terms

We also need to remark, if only in passing, that there are other kinds of shape-related interactions that will be relevant. For example, drawing further on Bhatt & Schultz's (2013) discussion of the nature of 'empty space' mentioned above, we can see that 'shape' is equally relevant for the spaces we *inhabit* or *move within*: i.e., shape is not only an external perceptive feature of objects but also of our environment. We return to this briefly below as well.

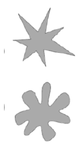
5. Shapes and image schemas and blending

If 'shape' ties into rich collections of affordances of these kinds, all physically embodied, then we can see some of the reasons why the notion of shape' is so productive. Assigning some entity a shape is a powerful way of characterising what can be done with that object in terms of manipulations of various kinds. Similarly, assigning some shape to our environment tells us much of our potential for action in that environment. There is potentially much to draw on from the nature of such perceptual spaces themselves. The idea that such spaces are anchored not only in perception but in embodied perception then opens a further significant line of contact with the growing body of research concerning image schemas as one foundation for explaining not only flexible action and interaction with the world but also our construction of complex conceptual understandings of that world (Fauconnier & Turner 2003, Turner 2014).

Accounts of image schemas providing links grounding conceptual organisation in embodied experience of the physical world are growing in popularity and power. An introduction and suggestive formalisation in terms of families of theories is discussed by Hedblom et al. (2015). This has been used to lead directly towards accounts of computational creativity. For our current purposes, we can consider any dimensions of description of the space of shape as being necessarily linked into image schema-like and, consequently, to 'bodily-formatted' representations (cf. Gallese & Sinigaglia 2011); the contribution of brain studies as pursued by Gallese and colleagues to the perception of shape is for example explicitly considered by Uithol et al. (2015) among others.

Assuming such a level of deep representation that may participate in image schemas and combinations of image schemas, as characterised in terms of *blending* (cf. Kutz et al. 2015), opens up the door to offering explanations of a variety of further phenomena.

For example, it becomes more straightforward to imagine the motivation for previously challenging effects such as shape's evident *cross-modality* as discussed, for example, by Deroy & Auvray (2013), also in a previous Shapes meeting. Certain apparently arbitrary associations with shape across different sensory modalities have long been known. Classic studies asking experimental participants to associate nonsense words and abstract shapes, such as those reported in Köhler (1947) or Ramachandran & Hubbard (2001), have shown that connections are systematic and reliable. A rounded shape, for example, would be correlated reliably with the nonsense word 'maluma', while a pointed or jagged shape would be correlated reliably with the nonsense word 'takete'; Deroy & Auvray (2013) offer further references to work of this kind discussing aspects of the general phenomenon of cross-modal association. Such connections show that a simple consideration of space only in terms of geometry is not yet sufficient. What is more likely is that there is a fairly deep connection being drawn in the brain across quite diverse domains and employing rather abstract features. Blending at level of affordances and image schemas may offer a useful way of characterising such connections.



We can also see the role of this embodied anchoring of 'shape' in higher level conceptual and linguistic behaviour. Consider, for example, a description offered of one of his own works by Paul Klee, an artist who was particularly concerned with 'cross-medial' effects and who proposed 'polyphonic painting' as exhibiting many properties of music, 'made spatial'. The work in question is shown in Figure 11; his description is as follows:

> "A wide span from pole to pole lends space to breathe in and out deeply, which can even turn into a wheezing struggle for air. A lesser span muffles the breath to

Figure 11.: Paul Klee. *Colour Table*, 1930, 83. Zentrum Paul Klee, Bern

> a sotto voce. Around about the grey area, it is only possible to whisper. Either you raise yourself above this position to the violins or sink below it to the violoncellos." (quoted in Düchting 1997, 60)

Regardless of how we might judge this piece of text, and its performance of the genre of 'aesthetic description', one thing is clear: Klee is invoking an extremely high degree of embodiment throughout. In his attempts to deal with his personal response to the various shapes and their textures, he is thrown into a deeply embodied style of description.

We can also draw attention to the potential role of this anchoring of shape in embodiment for even more abstract activities, such as mathematical reasoning. Morales & Saracho (2013), again from a previous Shapes meeting, discuss the role of shape for problem-solving in mathematics, arguing that much can be explained by appeal to rendering abstract problems as shapes that can be manipulated. This they quite correctly relate to notions of *iconic* representations as pursued in approaches to diagrammatic reasoning more generally. As they write:

> "Let us start by focusing on the idea of 'shape' in the sense of 'iconic representation'. Representations may be iconic, symbolic or indexical depending upon their role in reasoning with signs in specific contexts of work. According to the traditional view representations are iconic when they resemble the things they represent." (Morales & Saracho 2013, 118)

The notion of iconicity, and its contrast with 'indexes' and 'symbols' of course goes back to the semiotics of Peirce, and it is then useful to pick this up again with more of the Peircean background explicitly included.

The implications of Peirce's categorisations are often still less than fully appreciated and there is much to make use of. Particularly relevant here is the fact that Peirce's conception of 'resemblance', or likeness, that serves as the basis for iconic signs, is by no means to be limited to purely visual resemblance. Examples given in the literature readily focus on visual cases because these are far simpler to illustrate – but, in general, iconicity can range across any senses and combination of senses. This applies equally to the three subcases of iconic signs that Peirce distinguishes (cf., for an introduction: Jappy 2013): hypoicons (i.e., icons at their simplest, relying only on physical qualities), diagrams (where abstractions are drawn over the physical qualities so that only some dimensions are considered relevant for the sign and others not), and metaphors (where distinct domains are set into structural correspondence via 'abstract' resemblance). The latter also overlaps interestingly with the notions of blending currently being developed. Iconicity thus plays a central and foundational role for Peirce's view of reasoning and knowledge, precisely analogous to the role now being given to blending:

> "The first things I found out were that all mathematical reasoning is diagrammatic and that all necessary reasoning is mathematical reasoning, no matter how simple it may be. . . . This was a discovery of no little importance, showing, as it does, that all knowledge without exception comes from observation." (Peirce 1976 [1902], 47–48)

If, then, we focus more on 'resemblance of shape', rather than resemblance of appearance, as a basis for iconicity, and also combine this with the embodied perception view of shape as a multidimensional structuring of affordances of particular kinds, then this suggests even more strongly why shape is so foundational for many of our activities and why it is so readily applied to such diverse cases, both physical and abstract.

6. Shapes and design and creativity

Finally, let us readdress some of the notions of creativity touched upon above and design – particularly the role of aesthetics in design. Everaert-Desmedt (2006) develops a Peircean-inspired view of aesthetics and the creation of art works by recasting some of Peirce's accounts of logic and accounts of scientific creativity as artistic creativity. An overview of her account is shown in the graphic reproduced in Figure 12.

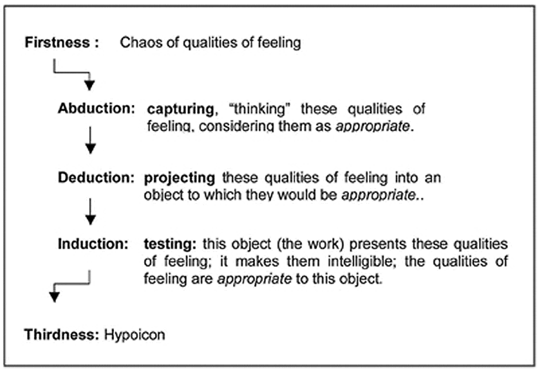


Figure 12. Everaert-Desmedt's (2006) characterisation of a Peircean-inflected view of artistic creation

It is useful and suggestive to run through Everaert-Desmedt's (2006) steps in artistic creation in slightly more detail and then to construe these simultaneously in relation to design and to shape. First, then:

> "At the outset, the artist is in an unsettled state, not due to a surprising fact, but to an unsettling feeling. [He or she] is plunged into firstness, into a chaos of 'qualities of feelings' (Peirce, 1931-1935, 1.43): a feeling arises that seems appropriate, but there is no object to which it is appropriate."

Subsequent to this, the process of semiosis steps in, as always for Peirce driven primarily by abduction:

> "The artist begins creating the work of art by using abduction. But while scientific abduction consists in hypothesizing a solution to a conceptual problem, artistic abduction or hypothesis consists in trying to express the problem, in letting qualities of feelings arise, in trying to capture them, in 'thinking' them, and considering them as appropriate."

Here we can consider the particular spin and flavour given to this account when 'thinking them' is seen in terms of *embodied action and shape*. The creation process then becomes one of 'thinking shape'.

This is a very different perspective to that pursued in the interest of scientific modelling, or even of constructing ontologies. One common position adopted when considering ontology is that of Varzi, quoted below, where it is emphasised that one needs to start from a deeper consideration and understanding of what is the case, rather than how it may or may not be described in language:

> "There is, in fact, no way of telling what sorts of things there are given the sorts of things we say. But neither is there a complete gap between our words and the world out there. It's just that that bridge must be built from below, as it were: ontology comes first, and depending on what we think there is, we must attach a meaning to what we say. Going the other way around is wishful thinking." (Varzi 2007, 35)

This is no doubt good advice for ontology construction, even though much more needs to be said concerning the precise relations and, potentially, mutual dependencies between language and ontology. When we are in the domain of design, however, where the aim is not to find out what is in the world but to add to that world, then we can draw more productively on the role of shape as guiding such processes. Perhaps then, to adapt Varzi's pronouncement:

> that bridge must be built from below … : ontology comes first, and depending on what we think there is, we must attach a meaning to what we say. Going the other way around is ~~wishful thinking~~.
> design!

Figure 13.: Interior view: Church of the Gesù, Palermo, Sicily.

This can involve creating 'purposively shaped' artefacts – not only for manipulations in personal space but also to 'inhabit'. The former naturally overlaps with the area of product design, the latter closely with issues in architectural design. Particularly in architectural design the role and effects of 'shape' have long been a central concern. In Figure 13, we see a particularly finely articulated 'shape' of empty space. Again, much of what makes this (and other cases) effective (or not) is the transferral of embodied experience across the diverse scales of experience. Further formalisations and experiments in this direction are then clearly of considerable importance for gaining more theoretical and practical control of the notion of 'shape'.

7. Conclusion

In this purely exploratory paper several lines of thought and literature have been brought together in order to suggest that shape may need anchoring in a more encompassing view of embodied perception and then, with the functionalities this affords, may go on to help characterise a variety of processes of creative thought and design.

This anchoring of shape would naturally support the extremely broad application of 'shape' in a variety of discourses that is readily observed, providing more technical detail to the commonsense notion that something 'shapelike' may be metaphorically extended to apply in domains ranging from mathematics to music to argument and so on. The nature of this metaphor can be connected directly both to Peirce's particular view of 'metaphor' as a form of iconicity and its foundational role in reasoning and knowledge on the one hand, and to currently developing notions and formalisations of blending and its centrality for creative thinking on the other.

From the perspective sketched here, it does not become too far a stretch to consider creative design as essentially a process of *shaping*, of forming shapes that have not been formed before, for new purposes and in new domains – an interrelationship and process summed up graphically as a final picture in Figure 14.

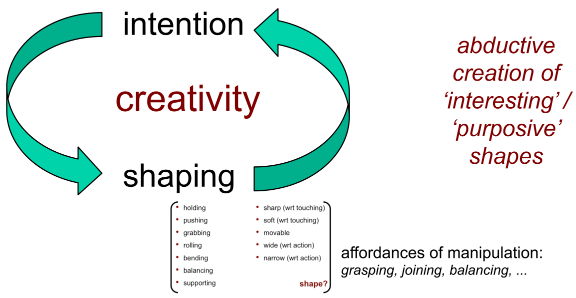


Figure 14. Design as shaping: the creative loop

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