The Meaning Potential of Motion Vectors in Cinema

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This essay examines the meaning potential of directed forces or vectors in cinema. The first part draws on the pioneering work of Rudolf Arnheim to highlight the prominent role of vectors in the visual structuring of meaning in paintings. In the second part, we move on to explore the semantic significance of motion vectors in cinema. To this aim we first define and diagram the filmic space in which vectors may articulate themselves visually. Having firmly grounded this spatial framework in film theory, we adopt the terminology of Herbert Zettl to further distinguish between three types of motion vectors: primary motion vectors (elicited by motion of visual objects), secondary motion vectors (elicited by camera movement) and tertiary motion vectors (elicited by editing). We conclude by applying the proposed conceptual tools of this essay to three filmic case-studies in which the relation between narrative meaning and motion vectors is further discussed and illustrated.

In memory of Stephen Prince

INTRODUCTION

   Research in cognitive science increasingly shows that meaning is not just a matter of a transcendent disembodied view of logic at the level of sentences (or propositions), nor is meaning a matter of truth-conditions or referential relations only. Rather, meaning is highly dependent upon our bodily disposition and the way we physically interact with the world.[1] One way in which scholars have tried to make sense of this theme of embodied cognition is by showing how the semantics of certain linguistic concepts are metaphorically grounded in gestalt patterns, so called 'image schemas', that arise in and through our sensory-motor experience.[2] This idea is central to the field of cognitive linguistics and the theory of Conceptual Metaphor Theory as it was first proposed by George Lakoff and Mark Johnson in 1980.[3] One pattern in particular that has been argued to play a pivotal role in the structuring of meaning in language is the 'force' image schema.[4] This schema arises in and through our physical interaction with objects and persons in our environment and functions as an important source domain for metaphorically structuring the abstract target domain of (emotional)

causality ('The home run *threw* the crowd into a frenzy', 'He *drove* her crazy', or 'She *pulled* me out of my depression').[5]

It might not come as a surprise that both Lakoff and Johnson took inspiration from the work of the famous theorist of visual art Rudolf Arnheim in order to develop the image schema of force and its structuring role in language.[6] Even long before the embodied view gained foothold in the cognitive sciences, Arnheim believed that sensory perception structures and informs thinking. His notion of 'visual thinking' served as the key concept to signify this non-dualist interplay.[7] Informed by the principles of Gestalt psychology, he considered visual percepts to be prominently dynamic and therefore as intrinsically meaningful and expressive. [8] Consequently, he extended this view to the realm of art by showing, through various inspiring case studies, how non-temporal media such as paintings and sculptures are able to portray the (abstract) dynamics of human life 'as a closed system in which all relevant forces are shown together in configuration, each in its characteristic direction and appropriate strength'.[9]

One concept in particular that plays a highly significant role in Arnheim's work on dynamics in the visual arts is the concept of a 'vector'. Vectors are the 'forces generated by the shapes and configurations of visual objects'.[10] As such, they are the 'carriers of dynamics', that is, 'the directed tension perceived in visual objects'.[11] It is through the configuration of vectors in the composition of a work that Arnheim believed that artists are able to communicate themes and narrative meaning in a purely visual way. More recently, the semantic role of a vector has also become a crucial component in Kress and van Leeuwen's account of the grammar of visual representation in which the authors merge concepts from Arnheim's theory of visual dynamics in art with concepts from Halliday's functional-semantic theory of language.[12] In both the works of Arnheim and Kress and van Leeuwen, however, the meaning potential of vectors has been predominantly analysed with respect to fixed images such as photographs, sculptures and paintings. Only limited attention has been paid to moving images. It is the goal of this essay then to demonstrate the semantic potential of vectors in narrative cinema. To this aim the essay follows a threefold structure. In the first part we provide a brief case study from Arnheim to show how the link between vectors and meaning can be established visually in painting. In the second part, we move on to explore the semantic significance of motion vectors, a concept which we adopt from Herbert Zettl.[13] To assess its use in cinema we first define the filmic space in which vectors may articulate themselves visually. Having firmly grounded this spatial framework in film theory, we extend Zettl's terminology to further distinguish between three types of motion vectors: primary motion vectors (elicited by motion of visual objects), secondary motion vectors (elicited by camera movement) and tertiary motion vectors (elicited by editing). We conclude by applying the proposed conceptual tools of this essay to three filmic case-studies in which the relation between narrative meaning and motion vectors is further discussed and illustrated.

THE MEANING POTENTIAL OF VECTORS

When people talk about force they usually refer to a physical or gravitational manifestation of it. It is the literal sort that we all experience when our bodies causally interact with objects and persons in our environment.[14] Forces, however, do not only manifest themselves in physical experience. We may also observe them, as Arnheim pointed out, as 'directed tensions' in our acts of perception.[15] They constitute the 'perceptual forces' that are inherent in the shapes, configurations, colors and locomotion that inhabit the visual world. As Arnheim writes: 'These dynamic properties, inherent in everything our eyes perceive, are so fundamental', Arnheim argues, 'that we can say: *Visual perception consists in the experiencing of visual forces*'.[16] This applies to both natural objects (e.g., the highly dynamic curve that we perceive in an ocean wave) as well as works of art (e.g., a painting), but with this fundamental difference that the former were never intended to be seen as embodying an abstract pattern or configuration of forces. As Arnheim remarks: 'They carry visual form only impurely and approximately'.[17] By contrast, works of visual art are made for the exclusive purpose of being perceived, and therefore 'the artist endeavours to create the strongest, purest, most precise embodiment of the meaning, that consciously or unconsciously, he intends to convey'.[18] That is, in works of art forces or visual dynamic fulfil an important semiotic function as *carriers* of the meaning or theme of a work. The theme is the formal pattern that indicates what the work is about. It turns the visual pattern into a semantic statement on the human condition. This is also the original sense of the term vector. Combining the Latin verb, *vehere* (to carry) with the agentive suffix -tor, a vector literally means 'carrier'. Vectors thus are the carriers of dynamics. And since dynamics are the 'very basis of expression', and expression is the manifestation of life, vectors become also the 'carriers of meaning'.[19]

To illustrate how the meaning of a work may be conveyed through a dynamic configuration of vectors or directed forces, let us consider an excerpt from Arnheim's brilliant analysis of Giotto's depiction of the *Lamentation*.[20] This fresco, as shown in fig. 1, depicts the subject matter of the story (death and resurrection) through a formal interplay between the horizontal and the vertical. As Arnheim writes: 'The horizontal of death is indicated but left behind by the body of Christ, which has been lifted and thus endowed with the dynamic quality of oblique position'.[21] Obliqueness thus fulfils a fundamental role in the creation of directional tension (and hence meaning), something which Arnheim explicitly states: 'Oblique orientation is probably the most elementary and effective means of obtaining directed tension'.[22] Returning to the fresco, Arnheim draws the viewer's attention to the arms which 'are made to deviate obliquely from the body'. The author sees in this deviation 'a motif of revival' which then finds its continuation in the vector of the diagonal ridge of the hill: 'Just broad enough for a man to walk upward, it leads through the entire picture, from the horizontal of death to the verticals of the two upright men, the vertical edge of the picture

frame, and the three. The tree takes over where the diagonal of the hill is about to tend and turns the oblique climbing into straight rising'.[23] It is only a brief excerpt, but it vividly illustrates how graphical vectors play a significant role in the shaping of visual meaning.

Throughout his career Arnheim analyzed many other examples, albeit almost exclusively with an emphasis on the meaning potential of vectors in fixed images such as photographs, sculptures and painting.[24] There is, however, no reason to assume that the vectors involved in motion do not play an equally important role in the structuring of visual meaning. One merely has to look at the experiments on so called 'functional relations', wherein one perceives such high-level properties as animacy and causality in simple animated movies.[25] Evidence can also be found in an increasing number of publications on the subject of expression and cinematic movement.[26] Moreover, Arnheim himself includes the notion of 'locomotion' in his definition of directed tension.[27] The fundamental difference is that when actual motion is used, as in the dance, the theater, and the film, 'direction is already indicated by movement'.[28] This is also how Herbert Zettl defines a motion vector as 'a vector created by an object that is actually moving or seen as moving-on screen'.[29] He considers motion vectors generally to have a higher magnitude than index vectors, which in turn have a higher magnitude than graphic vectors. The latter 'is created by a stationary element that guides our eyes in a certain albeit undefined direction' (e.g., horizontal and vertical lines) whereas an index vector is created 'by something that points undeniable in a specific direction' (e.g., an arrow, or people point or looking in a particular direction). Not all vectors are explicitly

supported by visual objects that are represented in the visual field (e.g., shape, color, movement), what Arnheim, dubs 'retinal presence'.[30] For instance, the index vector created by a figure's glance, what Kress and van Leeuwen call an 'eyeline vector', is not.[31] The magnitude of a vector then can be defined as 'a product of its relative strength, that is, its directional certainty and perceived directional force'.[32] It expresses what the scholar labels the 'aesthetic energy', the energy that we perceive from aesthetic phenomena such as color, sound and motion. A high-vector magnitude is strong, a low vector magnitude is weak. Hence, because motion vectors always have a precise screen direction (contrary to graphic vectors) and because they have a perceived object speed, motion vectors are generally assumed to have a higher magnitude.

Zettl's definition of a motion vector, however, remains formal in the sense that it provides no indication of the meaning potential of motion vectors.[33] For instance, he does not demonstrate, as Arnheim does with respect to graphical and index vectors, how motion vectors can convey story content. In other words, Zettl provides no semiotic definition. Moreover, his definition is strictly limited to primary motion (motion of objects) and does not take into account the structural importance of secondary motion (camera movement) and tertiary motion (editing). In the next section of this paper we address this issue by providing a tentative conceptual framework for analyzing motion vectors in cinema. Having provided a toolkit for doing so, we are conceptually equipped to lay bare its relation to the story content of three filmic cases.

MOTION VECTORS IN CINEMA

Before examining the question of motion vectors in cinema, we first have to define the space through and in which they may manifest themselves. A distinction made by film theorist Noël Burch seems to be a good point to start. In his classical book *Theory of Film Practice*, the author identifies two kinds of space in a film: the space included in the frame, the on-screen space, and the space included outside the frame, the off-screen space, which he further divides into six segments.[34] The first four of these areas are the most obvious ones, and are determined by the four borders of the frame: the space left of the frame, the space right of the frame, the space below the frame, and the space above the frame. The fifth segment is a rather peculiar one as it cannot be defined with the same degree of geometric accuracy. It refers to the off-screen space 'behind the camera'. Characters commonly reach this area by passing just to the right or left of the camera. Finally, there is the sixth zone of space behind the set which a character may reach by, for example, going out a door or going around a street corner, or by 'disappearing behind a pillar or behind another person […]. The outer limit of this sixth segment of space is just beyond the horizon'.[35]

We may continue to further define the on-screen space, as Zettl does, by adapting the spatial coordinate system of the French philosopher René Descartes which consists of three axes: the horizontal x-axis (screen width),

the vertical y-axis (screen height) and the illusionary depth line or z-axis with 'stretches from the screen (camera lens) to the horizon'.[36] Whereas the former two axes have definite spatial limits, imposed by the boundary of the frame, screen depth is 'virtually infinite'.[37] Zettl considers the z-axis aesthetically the most flexible screen dimension for it allows for a staging or blocking in depth; a technique which was famously applauded by the French film critic André Bazin. However, as Wittusen has pointed out, Bazin's interest lies not only in the z-axis as the single possible articulation of depth.[38] While making reference to the films of Jean Renoir, he also attributes significance to another depth dimension, which he coins 'the lateral depth'. 'In *The Rules of the Game*', he writes, 'Renoir actually uses simultaneous action on the same plane more than depth of field. This functions like a kind of lateral depth of field'.[39] In other words, the screen may suggest the presence of a field of depth which continues in the off-screen space beyond the spatial limits of the x-axis and the y-axis. As Bazin writes, 'The rest of the scene, while effectively hidden, should not cease to exist. The action is not bounded by the screen, but merely passes through it'.[40] More recently, Julian Hanich has adopted Bazin's concept of lateral depth for his own phenomenological analysis of complex mirror shots. Interestingly, he brings in two additional concepts to the discussion of depth in film: the 'anterior depth' which he uses in a similar sense as Zettl's z-axis dimension, and the 'posterior depth', which he uses to signify the 'depth' of Burch's sixth zone of off-screen space, that is, the depth 'behind and next to the camera'.[41] Whereas the anterior depth channels the viewer to look *into* the screen, the lateral and posterior depth dimensions make us look *beyond* the image.

Taken together, these theoretical terms constitute a spatial framework, which we may diagram as in fig. 2, and which allows us to further explore any number of vectors and dynamic forces within the frame space including not only graphical and index vectors, but also motion vectors which we will look
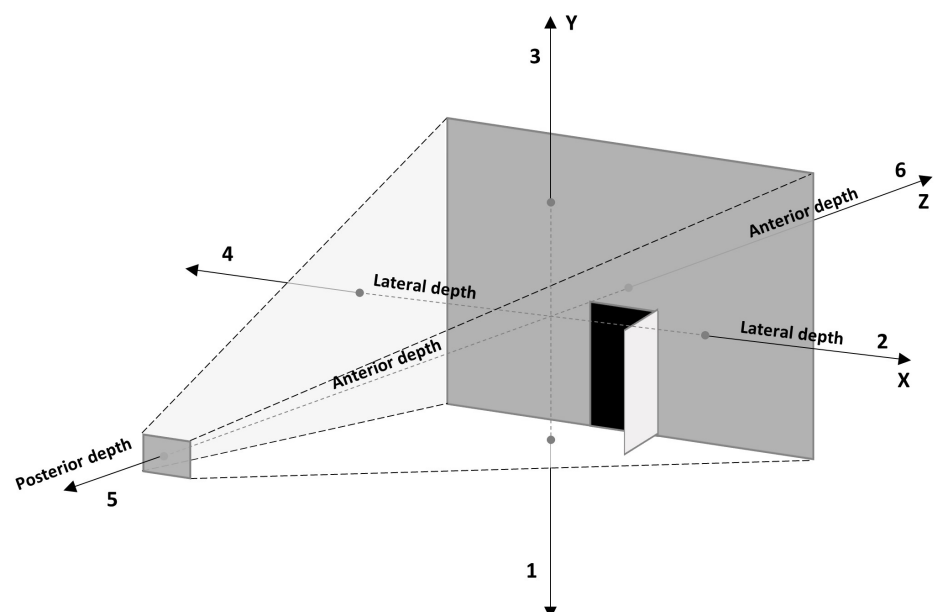

Fig. 2:
Diagramming the filmic space on the basis of film theory

into now. As stated above, Zettl originally used the term only to refer to the movement of visual objects, what he elsewhere describes as 'primary motion'.[42] In this paper, however, we will expand the notion of motion vector to also include Zettl's two other categories of motion, namely 'secondary motion' (or camera movement) and 'tertiary motion' (or editing). The latter further selects the primary and secondary motion vectors of the individual shots to shape what Karen Pearlman recently coined a 'trajectory phrase'.[43] In doing so, however, we should be aware of the phenomenological differences that still exist between the three types. As will become clear below, secondary and tertiary motion vectors seem more elusive and less definable than primary motion vectors.

Primary Motion

By primary motion we mean movement of visual objects (e.g., characters) in the on-screen space. Since the movement trajectory in this space is always relative to the 'container' of the frame in which the movement takes place, we may further distinguish between four dynamic patterns of fixed-frame movement: 'entry', 'exit', 'approaching', and 'distancing'.[44] Entry is created by an object that enters the on-screen space. The starting point from which the movement begins, is always located in one of the six zones of off-screen space as defined by Burch. When that same object leaves the screen space again, we speak of 'exit'. In this case one of the off-screen zones serves as the ending point of the moving object or trajectory. An object may also exit the frame along the z-axis. In such a case the pattern of exit is accompanied by a pattern of 'approaching'. The visual object increases in graphic mass as it comes closer towards the camera. By contrast, when an object 'distances' itself from the camera, the graphic mass will gradually decrease. As Burch has argued, these patterns of 'enters into' and 'exits from' a frame are crucial for delineating or 'defining' the spatial segments of off-screen space. By this Burch means that 'one or another of the spatial segments in question takes shape in the viewer's imagination every time an entrance or exit occurs into or out of that segment'.[45] This 'shaping' becomes especially vivid when a single primary motion vector starts to interact with another primary motion vector. Zettl goes further to delineate three such types of relationships that primary motion vectors can have within a single shot (and as we shall see later, also across a series of shots): 'continuing' (when two or more vectors point in the same direction), 'converging' (when they point to each other) and diverging (when they point away from each other).[46] The converging type can be nicely illustrated with a brief example that Burch describes in his book and that occurs towards the beginning of Jean Renoir's *Nana* (1926). It involves a static shot (see fig. 3) in which the paths of two men cross each other for a very brief moment. Young Georges has just left Nana's dressing room. Enchanted by her beauty he enters the frame left, along the horizontal x-axis. At the same time, the other guy, Muffat, rushes toward Nana's dressing room by entering the frame from the right. Their motion vectors cross like two arrows, without their even glancing at each other, and they exit on

Fig. 3:
Entries into and exits from the frame of Jean Renoir's *Nana* (1926)

opposite sides of the screen. As Burch observes: 'The essential part of the action in this shot (the trajectories of the two men) takes place *off screen*, although in such a brief span of time — the moment preceding and following each entrance and each exit — that it borders on the instantaneous; this action *simultaneously* defines the left and right segments of off-screen space'.[47] In other words, primary motion vectors play a significant role in further establishing Bazin's concept of 'lateral depth of field', as elucidated above.

Primary motion vectors, however, should not be limited to the actual movement of a visual object from one location to another. A primary motion vector may also originate from a fixed position by a character that moves his eyes away from one spatial zone to another (comparable to the tilting or panning of a camera). In such a case the direction of the eyeline vector (as an instance of an index vector) changes: the primary motion vector is not supported by the retinal presence of a movement trajectory along one of the axes, but by the retinal presence of a change of gaze. In a much cited example from Alfred Hithcock's *Notorious* (1946) there is a significant medium close-up in which Alicia (Ingrid Bergman) changes the direction of her glance from one zone (containing the reflection of Sebastian's shadow on the bathroom door) to another (containing the keys on the desk) (see fig. 4). Through this primary motion vector which makes us look beyond the image into its lateral depth, the film already foretells the movement trajectories that will unfold in the subsequent next shots, first of the camera getting closer, then of the character itself.[48]

Fig. 4:
Primary motion change of eyeline vector in Alfred Hitchcock's *Notorious* (1946)

Secondary motion

In cinema, however, we are not only dealing with motion vectors that have their origins in the actual on-screen movement of objects. In addition, we may also distinguish between motion vectors that emanate from the movement of the camera (e.g. dolly, zoom, tracking shots, pan shots). Naturally we do not see secondary motion vectors in the same way as we observe primary motion vectors. We do not literally see the camera moving from the right to the left as we see a character moving from the right to the left. What we do see is the on-screen effect of the mobile camera, that is, the component changes in what the camera records when its moves. For instance, it is well known that a camera pan to the left makes it seem as if a static object onscreen moves to the right.[49]

In contrast to primary motion vectors, secondary motion vectors usually do not interact with other secondary motion vectors in one and the same screen space unless the frame is a composite of multiple screens (e.g., split-screen). What the viewer perceives is the dynamic effect of the mobile frame as elicited by a single camera's movement. But secondary motion vectors may engage with primary motion vectors in various aesthetic ways. For instance, we speak of motivated camera movements as when the secondary motion vector is in tune or continuing with a primary motion vector. This occurs, for example, when the camera follows a character from behind. In such a case, both camera and character share the same direction. By contrast, when the secondary motion vector detaches itself from the character, such as is often the case in modernist cinema (e.g., the cinema of Antonioni), it becomes a 'wandering camera'.[50] It reveals the presence of a filmic narrator distinct from any of the characters. In this case, the independent movement of the camera (independent of any character's point of view) generates the spectators' awareness of an 'independent presence', that of an omniscient narrator.[51]

Tertiary motion

Once the primary and secondary vectors are created they can be further shaped into a temporal sequence by means of sequence motion or what Zettl terms 'tertiary motion'. Through a change of shots (i.e., single runs of the camera), we perceive 'a progression, a visual development'.[52] As Zettl points out, 'the important aspect of tertiary motion is not so much the vector field of the individual shot but the moment of change — the relationship of vector fields from shot to shot'.[53] In her own research Karen Pearlman, who is an editor herself, has termed this assemblage of movements appropriately 'trajectory phrasing'.[54] Together with timing and pacing it is one of the tools at an editor's disposal for shaping time, energy and movement for the purpose of creating cycles of tension and release. More specifically, trajectory phrasing 'describes the manipulation of energy in the creation of rhythm'.[55] The word 'trajectory' means 'the path described by a body moving under the action of given forces'.[56]

Trajectory phrasing then is joining together movement trajectories in different shots to shape the flow of energy (movements) between and through them. This is done by choices of takes and positioning of cuts. Using the vector terminology of this paper, we might well speak of 'vector phrasing' with the primary motion vectors and secondary motion vectors constituting a significant part of the raw material from which the editor produces affective rhythms, that is, patterned movement over time. This makes vectors at the level of tertiary motion to function more like an overflow effect, a higher-order accumulation or interplay of other vectors — comparable to what Eisenstein would label 'tonal' and 'over-tonal' effects in montage. They become a good deal more indistinct and diffuse as a result of it. Depending on the intentions of the filmmaker, we may nevertheless distinguish between several styles of editing for putting these vectors together. In most cases of narrative cinema, the editor will keep the audience spatially oriented. For this purpose, the editor will adhere to a prescribed syntax of continuity editing.[57] If for instance, a filmmaker shows a long shot of two people talking to each other (i.e., converging index vectors) and maintains these converging vectors in the subsequent separate close-ups of these people, there is still continuity across the converging vectors. Other filmmakers, however, will not strive for these subtle linkages, but for harsh collisions under Sergei Eisenstein's dictum that 'A smooth transition is an opportunity lost'. As Pearlman further writes, 'a collision might be a cut that juxtaposes light and dark, close-up and wide shot, but also movement left to right with right to left, [...] and so on'.[58]

There is more to be said about vectors in cinema and of their possible relationships with each other and with other types of vectors (e.g., color vectors, sound vectors, musical vectors), but for now let us put some of the conceptual tools that we currently have into practice by exploring, as Arnheim and Kress and van Leeuwen did with respect to fixed images, the expressive and metaphorical potential of motion vectors in cinema.

THREE CASE-STUDIES

In the last section of this paper we briefly discuss three filmic cases for the purpose of showing how motion vectors contribute significantly to the conveyance of meaning in cinema. In doing so, we will first stress the importance of vectors in two existing film analyses from the literature. We conclude this section by providing a more elaborated case study of our own.

Case study 1: Sanshiro Sugata (Akira Kurosawa, 1943)

In his brilliant treatment of Akira Kurosawa's cinema, Stephen Prince is keen to point out the importance of movement patterns in the conveyance of themes in the oeuvre of the Japanese director.[59] He states among others that the director frequently organizes movement to produce dialectical relationships often

in combination with the use of the telephoto lens. For instance, he describes one brief moment of converging (primary) motion vectors from *Yojimbo* (1961) in which the planes of movement are perpendicular to each other: the hero (Toshiro Mifune) crosses the frame along the horizontal x axis, from left to right in the foreground, while the villain advances from behind the setting (i.e., Burch's sixth zone) towards the camera from the background (the z-axis), as the telephoto lens produces the illusion that both primary motion vectors 'are about to crash into each other'.[60] In other occasions, however, motion vectors serve a more important narrative function by helping to situate characters according to 'important psychological and social relations prevailing along them', an interest that according the author runs throughout Kurosawa's oeuvre and reaches its climax in *Seven Samurai* (1954).[61] One vivid example that Prince analyses appears already very early in the director's career. It involves a scene near the beginning of *Sanshuro Sugata* (1943) in which the young pupil Sanshiro accompanies Momma and his mob to a late night ambush of the judo instructor Shogoro Yano (Denjiro Okochi). Kurosawa' formalizes Sanshiro's relation to Yano by introducing a lateral tracking shot and reduplicating its secondary motion vector three times. Each time Yano defeats one of Momma's men, the motion vector ends by including Yano into the frame, while the film intercuts between the two characters, 'each framed in isolation, in contrast to Momma's group'.[62] 'Here we can see clearly', as Prince argues, 'Kurosawa's injunction to use form in a meaningful manner: Yano is to be Sanshiro's teacher and spiritual guide, and the bonds between them are set out in visual terms during this early sequence, in which Sanshiro functions as an observer, learning a first lesson by watching a master'.

Case study 2: Blade Runner (Ridley Scott, 1982)

For our second example, let us consider a juxtaposition of images from Ridley Scott's *Blade Runner* (1982) that recently gave rise to an interesting discussion among two cognitive film scholars: Tim J. Smith and Karen Pearlman whose work we already cited above.[63] The first shot, as shown in fig. 5, involves a similar change of eyeline vectors that we already illustrated above with the example of *Notorious*. It shows how the character of Deckard (Harrison Ford) shifts his gaze from a horizontal x-axis index vector (pointing towards the second off screen space where the character of Rachel is located) to a z-axis index vector (pointing towards the sixth zone where an artificial owl is located). In the next shot the actual owl is shown as it gestures an opposite movement: the owl's gaze shifts from right (a z-axis index vector) to left (horizontal x-axis index vector). The film then cuts back to Deckard in a trajectory that exactly copies the owl's movement. Deckard now turns his head again from the owl in the direction of Rachel in the fourth off-screen zone (left of the frame). Smith considers this last cut to be 'slightly off', by which he means 'that the owl's gaze shift will cue viewer attention in the opposite direction to the saccade

Fig.5:
A trajectory phrase of eyeline motion vectors in Ridley Scott's *Blade Runner* (1982)

required to shift back to Deckard's face'.[64] The owl looks over Deckard's head and guides your eyes to slip over Deckard's head and then you slip them back. 'Such a mismatch', he argues, 'may result in a violation of a priori continuity'.[65] In her own analysis of the same scene, however, Karen Pearlman, argues that this mismatch is not a mistake. As she argues, 'it offers a different kind of editing, one that adds a visual rhythm, an embodied sense of alignment with character' and an element of what she reveals as 'a significant subtext'.[66] 'Its first creative purpose is to create a movement phrase. Like a dance phrase, a movement phrase created by the juxtaposition of two gestures is a statement of a rhythmic idea'.[67] But more importantly, she also adds a semiotic purpose to the movement phrase created by editing. As she writes: 'By comparing the owl's behaviour with Deckard's behaviour, the cut subtextually suggests that they are alike'.[68] She finds further evidence in the dialogue that immediately follows the comparison. Earlier Rachel has asked Deckard if he likes their owl. When Deckard moves his head away from the owl back to Rachel, he says 'it's artificial' upon which Rachel responds 'of course it is'. This is where the comparison takes on a semantic dimension. As Pearlman argues, it suggests that 'if they are similar, the possibility Deckard is also artificial, something that (spoiler alert) we learn only much later in the film may be true'.[69] From the terminology of this paper, we may further argue that this existential resemblance is pronounced visually by a formal similarity that is articulated at the level of primary motion eyeline vectors.[70]

Case study 3: The Untouchables (De Palma, 1987)

Our last example considers a case study that shows how vectors play an import role in the visual structuring of so called 'flow-of-emotion scenarios'.[71] A flow-of-emotion scenario conceives emotions to be embedded in a causal chain of three events: an emotion arousing event (the cause of event), an emotional state and a behavioural response (the effect of emotion). Such narratives of mental causation are not only ubiquitous in our ordinary lives, but also in films. To illustrate this, let us consider the first segment of the famous 'Odessa Steps' inspired staircase scene from Brian De Palma's *The Untouchables* (1987). During the Prohibition-era of the nineteen twenties, Chicagoan cop Elliott Ness (Kevin Costner) along with his sharp-shooting partner George Stone (Andy Garcia) have arrived at the city's Union Station in order to arrest bookkeeper Walter Payne (Jack Kehoe), the one man that could put Crime boss Al Capone in prison. As they wait for his arrival, a suspenseful chain of mental causation starts to unfold which we may analytically divide into a number of flow-of-emotion scenarios, the first of which may be described as follows: Ness, at the top of the stairs, sees a young mother appearing at the foot of the stairs, pushing a buggy while simultaneously carrying two large suitcases (the emotion arousing event). Perception in turn causes the first emotional state: Ness is nervously torn between helping the woman carry her buggy up the marble steps, and maintaining his watch for the accountant. The increase of emotional intensity results in a behavioural response: Ness gives into his good nature, and rushes down the steps to help the mother drag her buggy up the stairs (the effect of emotion).

The first part of this flow-of-emotion scenario is visualised, as shown in fig. 6, by extending the principle of index-vector target continuity: shots of Eliot Ness looking off-screen alternate between POV shots of the woman and the baby (located downstairs, Burch's second zone of off screen space) and shots of the station clock up the stairs. The emotional intensity increases as the clock almost reaches the pivotal moment of 12 am. To express this the film makes use of the

Fig. 6:
Visually structuring the flow-of-emotion scenario in Brian De Palma's *The Untouchables* (1987)

dynamic pattern of enclosure, here elicited by tertiary motion rather than by secondary motion: as the clock nears the arrival time and emotional intensity increases, the clock inside Nett's visual field increases in graphical substance. This visual progression in time can be seen as a cinematic manifestation of an embodied metaphor, which in the literature is known as the metaphor 'increase in emotional intensity is increase of substance in a container', a subtype of the more general metaphor 'emotions are forces'.[72] As the theory behind this metaphor goes, humans have a tendency to conceptualize the rising of a strong emotion (e.g., joy, anger, fear) inside a person's body in terms of the increase of a substance inside a container. When there is very little substance in the container, the pressure is low and thus emotion is at low intensity (there is enough breathing space).[73] By contrast, with an increase of the substance, the pressure becomes higher, and thus also the intensity of the emotion.[74] The increase of pressure, here visualized through the increase of the clock's graphical mass, further triggers a behavioral response. This is also what happens next. The eyeline vector, the directed force of Elliot's gaze, soon changes into a motion vector as our hero now hastens himself to go downstairs and help the woman. This further prompts the camera to move: as Ned lowers himself to approach the lady (and the location of the camera), the camera tracks backwards so as to *include* the woman and the baby inside the frame (i.e., Ness' 'container'). Another way of capturing this would have been to start with a fixed shot of the woman followed by a motion vector of fixed-frame movement as Ned enters the shot from above. But the effect of this would have been less dynamic and meaningful as it is Ness who 'brings' the woman and the baby safe into his 'personal container', not the other way around.

CONCLUSION

The goal of this article was to draw attention to the meaning potential of motion vectors in cinema. To this aim we first provided a preliminary discussion of the concept of a vector in the visual arts by reviewing the pioneering work on visual dynamics by Rudolf Arnheim. This theorist has convincingly demonstrated and illustrated through various cases how vectors play an important role in the visual structuring of narrative meaning in fixed images. Subsequently, we extended the question of vectors not only to the domain of fixed images, but also to the domain of moving images by addressing the meaning potential of motion vectors. For this purpose, we first had to define the filmic space in which motion vectors may unfold themselves. Having done so we distinguished between three types of motion vectors: primary motion vectors, secondary motion vectors and tertiary motion vectors. Since the proof of the pudding is in the eating, we concluded this paper by illustrating the concepts proposed using three filmic case-studies. The insights offered in this paper will hopefully provide an impetus to further explore, in an interdisciplinary way, the role of motion vectors in the structuring of meaning in cinema.

Notes

[1] Barbara Tversky, *Mind in Motion: How Action Shapes Thought* (New York: Basic Books, 2019); Varela, Francisco J., Evan Thompson and Eleanor Rosch, *The Embodied Mind: Cognitive Science and Human Experience* (Cambridge: The MIT Press, 1991); Raymond W. Gibbs Jr., *Embodiment and Cognitive Science* (Cambridge: Cambridge University Press, 2006); George Lakoff and Mark Johnson, *Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought* (New York: Basic Books, 1999).

[2] The concept of an 'image schema' is central in two classic 1987 monographs: Lakoff, *Women, Fire, and Dangerous Things: What Categories Reveal About the Mind* (Chicago: University of Chicago Press, 1987), and Johnson, *The Body in the Mind: The Bodily Basis of Meaning, Imagination and Reason* (Chicago: University of Chicago Press, 1987).

[3] Lakoff and Johnson, *Metaphors We Live By* (Chicago: University of Chicago Press, 1980).

[4] Johnson, 42–48; see also Leonard Talmy, 'Force Dynamics in Language and Cognition', *Cognitive Science*, 12.1 (1988), 49–100.

[5] Lakoff and Johnson, *Metaphors We Live By*, 184–185; María Sandra Peña Cervel, 'Subsidiarity Relationships Between Image-schemas: An Approach to the Force Schema', *Journal of English Studies*, 1 (1999), 187–208.

[6] For Johnson's discussion of the force schema, see Johnson, 76–79.

[7] Rudolf Arnheim, *Visual Thinking* (Berkeley and Los Angeles: University of California Press, 1969).

[8] Arnheim, *Art and Visual Perception: A Psychology of the Creative Eye* (Berkeley and Los Angeles: University of California Press, 1974); Rudolf Arnheim, 'Perceptual Dynamics', American Scientist, 76 (1988), 585–591; Arnheim, *The Power of the Center* (Berkeley and Los Angeles: The University of California Press, 1988).

[9] Arnheim, 'Perceptual Dynamics', 590.

[10] Arnheim, *The Power of the Center*, 229.

[11] Ibidem, 226.

[12] Gunther Kress and Theo Van Leeuwen, *Reading Images: The Grammar of Visual Design* (London: Routledge, 2021); Morten Boeriis and Theo van Leeuwen, 'Vectors', in *New Studies in Multimodality*, ed. by Ognian Seizov and Janina Wildfeuer (London: Bloomsbury, 2017), 15–36.

[13] Herbert Zettl, Sight, *Sound, Motion: Applied Media Aesthetics* (Boston: Cengage Learning, 2017), 127–131. As will become clear below, we will use the concept of a 'motion vector' in a wider sense than originally proposed by Zettl.

[14] Johnson, 43.

[15] Arnheim, *Art and Visual Perception*, 416.

[16] Ibidem, 412.

[17] Arnheim, *Visual Thinking*, 270.

[18] Ibidem, 270–271.

[19] Arnheim, 'Perceptual Dynamics', 585.

[20] Arnheim, *Art and Visual Perception*, 441–443.

[21] Ibidem, 441.

[22] Ibidem, 424.

[23] Ibidem, 441.

[24] It should be stressed, however, that Arnheim also wrote extensively about film, especially at the beginning of his career. Notable in this regard is his landmark book *Film as Art* (Berkeley and Los Angeles: University of California Press, 1957). However, since Arnheim never undertook any serious attempts to update or revise his position, and since his later work mostly focuses on static art media, the implications of vector dynamics for the study of meaning in film have been largely ignored in the literature.

[25] Notable in this regard are two classic works in the field of perceptual psychology: Albert Michotte's *The Perception of Causality* (New York: Basic Books, 1963), which is also cited and discussed by Arnheim, *Art and Visual Perception*, 388–395, and Fritz Heider and Marianne Simmel's influential article on perceptual animacy, entitled 'An Experimental Study of Apparent Behavior', *The American Journal of Psychology*, 57 (1944), 243–249.

[26] See, among others, Christina Schmitt, Sarah Greifenstein and Hermann Kappelhoff, 'Expressive

Movement and Metaphoric Meaning Making in Audio-Visual Media', *Body-Language-Communication*, vol. 2, ed. by Cornelia Müller, Alan Cienki, Ellen Fricke, Silva Ladewig, David McNeill and Jana Bressem (Berlin, München and Boston: De Gruyter Mouton, 2014), 2092–2112; Jordan Schonig, *The Shape of Motion: The Cinema and the Aesthetics of Movement* (Oxford: Oxford University Press, 2021); and Patrick Keating, *The Dynamic Frame: Camera Movement in Classical Hollywood* (New York: Columbia University Press, 2019).

[27] Arnheim, *Art and Visual Perception*, 416.

[28] Ibidem, 28.

[29] Zettl, 128. Notice that Zettl does not make reference to camera movement and editing in his definition of a motion vector.

[30] Arnheim, *The Power of the Center*, 228.

[31] Kress and van Leeuwen, 72.

[32] Zettl, 129.

[33] See also the criticism of Boeriis and van Leeuwen, 16.

[34] Noël Burch, *Theory of Film Practice*, trans. by Helen R. Lane (Princeton: Princeton University Press, 1981), 17.

[35] Ibidem, 17. For a discussion, see also David Bordwell and Kristin Thompson, *Film Art: An Introduction* (New York: McGraw-Hill, 2004), 258; Maarten Coëgnarts, *Film as Embodied Art: Bodily Meaning in the Cinema of Stanley Kubrick* (Boston: Academic Studies Press, 2019), 75.

[36] Zettl, 161–163; see also Michael Frierson, *Film and Video Editing Theory: How Editing Creates Meaning* (New York: Routledge, 2018), 5.

[37] Zettl, 162.

[38] Cato Wittusen, 'Varieties of Temporal Overlapping and Depth', *New Review of Film and Television Studies*, 12.2 (2014), 112–124 (118).

[39] André Bazin, *What is Cinema?*, trans. by Timothy Barnard (Montreal: Caboose, 2009), 69.

[40] Bazin, J*ean Renoir*, trans. by W. W. Halsey II and William H. Simon (New York: Da Capo Press, 1992), 89.

[41] Julian Hanich, 'Reflecting on Reflections: Cinema's Complex Mirror Shots', in *Indefinite Visions: Cinema and the Attractions of Uncertainty*, ed. by Martine Beugnet (Edinburgh: Edinburgh University Press, 2017), 131–156 (141).

[42] Zettl, 294.

[43] For a discussion of the concept of 'trajectory phrasing', see Karen Pearlman, *Cutting Rhythms: Intuitive Film Editing* (Amsterdam: Focal Press, 2016); Pearlman, 'Editing and Cognition Beyond Continuity', *Projections: The Journal for Movies and Mind*, 11.2 (2017), 67–86; Pearlman, 'On Rhythm in Film Editing', in *The Palgrave Handbook of the Philosophy of Film and Motion Pictures*, ed. by Noël Carroll, Laura T. Di Summa and Shawn Loht (Cham: Palgrave Macmillan, 2019), 143–163.

[44] Coëgnarts, *Film as Embodied Art*, 84–85.

[45] Burch, 18.

[46] Zettl, 129–130.

[47] Burch, 19.

[48] For a discussion of this scene, see also Pearlman, 'Editing and Cognition', 79; Vittorio Gallese and Michele Guerra, 'Embodying Movies: Embodied Simulation and Film Studies', *Cinema: Journal of Philosophy and the Moving Image*, 3 (2012), 183–210 (200–201); Coëgnarts, 'Cinema and the Embodied Mind: Metaphor and Simulation in Understanding Meaning in Films', *Palgrave Communications*, 3.1 (2017): 1–15; and Mircea Valeriu Deaca, 'The Control Cycle: Cognitive Model in Biology, Film and Culture', *Ekphrasis. Images, Cinema, Theory, Media*, 20.2 (2018), 63–97 (88–89).

[49] This apparently paradoxical phenomenon of the relativity of movement has been well described and illustrated by perceptual psychologists. See e.g., Julian Hochberg and Virginia Brooks, 'Perception of Motion Pictures', in *Cognitive Ecology*, ed. by Morton P. Friedman and Edward C. Carterette (San Diego: Academic Press, 1996), 205–292 (237–240).

[50] Seymour Chatman, *Antonioni or, The Surface of the World* (Berkeley: University of California Press, 1985). See also Kenneth Johnson, 'The Point of View of the Wandering Camera', *Cinema Journal*, 32.2 (1993), 46–56.

[51] Ibidem, 49.

[52] Zettl, 299.

[53] Ibidem, 299.

[54] Pearlman, *Cutting Rhythms*, 60.

[55] Pearlman, 'On Rhythm', 155.

[56] Ibidem, 155.

[57] For a discussion of continuity principles in relation to vectors, see Zettl, 369–393.

[58] Pearlman, *Cutting Rhythms*, 170.

[59] Stephen Prince, *The Warrior's Camera: The Cinema of Akira Kurosawa* (Princeton: Princeton University Press, 1999).

[60] Ibidem, 172–173.

[61] Ibidem, 42.

[62] Ibidem, 41.

[63] Tim J. Smith, 'The Attentional Theory of Cinematic Continuity', *Projections: The Journal for Movies and Mind*, 6.1 (2012), 1–27 (20); Pearlman, 'Editing and Cognition', 75.

[64] Smith, 20.

[65] Ibidem.

[66] Pearlman, 'Editing and Cognition', 75.

[67] Ibidem, 75.

[68] Ibidem, 76.

[69] Ibidem.

[70] A similar interpretation may be given to the cutting of the red men's bathroom in Stanley Kubrick's *The Shining* (1980). This is well addressed by Frierson, 22: 'Kubrick cuts across the 180° line to create a visual metaphor linking (Jack Nicholson) and Mr. Grady (Philip Stone) as socially isolated characters by flipping their position from shot to shot)'. Here, we may speak of a flipping of eyeline vectors through editing or rather the flipping of the participants from which these vectors emanate.

[71] For a discussion, see Coëgnarts, *Film as Embodied Art*, 28.

[72] Kövecses, 65–68; see also Coëgnarts, *Film as Embodied Art*, 63.

[73] For a discussion of the container image schema, see Lakoff and Johnson, *Philosophy in the Flesh*, 31–32.

[74] For a discussion of this metaphor in relation to the elevator scene from Francis Ford Coppola's *The Conversation* (1974), see Coëgnarts, 'Analyzing Metaphor in Film: Some Conceptual Challenges', in Current *Approaches to Metaphor Analysis in Discourse*, ed. by Ignasi Navarro i Ferrando (Berlin: De Gruyter Mouton, 2019), 295–320 (314–316).