Socio-Kinetics:
Visualizing Impressions of People Behavior through Motion

by Hyun-Yeul Lee

Master of Design, Interaction Design, Carnegie Mellon University, 2000
Bachelor of Industrial Design, Industrial Design, Rhode Island School of Design, 1996
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Submitted to the Program in Media Arts & Sciences, School of Architecture & Planning, In Partial Fulfillment of the Requirements of the Degree of Master of Science in Media Arts and Sciences at the Massachusetts Institute of Technology

September 2002

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Abstract

Online public discussion spaces such as Usenet newsgroups are rich social environments. The social dynamics within the community are not obvious upon looking at the strings of text-based content. Only a careful reading of the threads allows the viewer to discern complexities and nuances of social interactions. Expressive visualization, however, is an alternative medium for effectively conveying such information. In order to animate the dynamic social qualities found within the static data of a Usenet interface, I chose motion as the communicative agent for this visual translation. The goal of this thesis is to isolate those elements which comprise visual motion, such as position, direction, speed, and time, in order to develop a visual language through which the social complexities of online communities can be communicated. A series of studies exploring this problem were carried out using a theoretical framework inspired by cognitive and artistic precedents. These investigations resulted in an understanding of how motion can be successfully employed as a visual language for social expression.

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Acknowledgements

Thank you all for your support and community.

Mum and Pop.

Judith, John, and Brian.

Kevin and Julie.

Colleen and Kelly.

Fernanda, Raffi, Derek, Karrie, danah, and Andew.

Linda, Pat, and Meg.

Media Lab community.

And lastly but not least, I thank the Charles river and the weather gods.

Contents

1 Background

I have always been intrigued by visual beauty. In beholding a field of tulips swaying in the wind or Jonny Moseley twisting and turning in the air at the winter Olympics, my eyes are drawn to these visual forms that elicit from me an instinctual emotional response. This emotional response resulted in my questioning of what are the components of a visual stimulus that resonate within a viewer. Admittedly as the reader may observe, this response is subjective and idiosyncratic. Jonny Moseley and a field of tulips are two different visual expressions; however, there is a common language that underlies both examples which in turn intuitively evokes a response from us.

Figure 1 Jonny Moseley ski jumping

My eyes are drawn to how Moseley exhibits perfection in form – the arch of his back, the placement of his arms, and the angles at which his body turns during his aerial maneuvers. As for the field of tulips, I am drawn to the shape and form of the flowers, the density and concentration in the palette of colors seen in the field of tulips, and the manner in which they softly sway in the wind. We can articulate these descriptions at a more fundamental level where we can start to understand the constructs of the visual expressions in both examples. For instance, I can intuitively see physical perfection in Moseley's form because of the underlying basic elements – the placement, direction, and angle of his back arch and the speed at which he turns in the air. These elements all communicate to the viewer a cohesive visual whole that is capable of evoking cognitive responses.

Using these elements we are then able to create visualizations of data that will in turn guide the viewer to make sense of what is s/he is looking at. My past research includes the study of online social spaces such as Usenet newsgroups. It became evident at the beginning of my investigations of Usenet that there is a social life online. Despite the asynchronous nature of interactions in the space, there is a community presence in each newsgroup wherefrom their dynamic social qualities emerge through the threaded discussions. In order to animate these dynamic social qualities found within the static displays, I chose motion as the communicative agent for this translation. In the same way we were able distinguish the elements of Moseley's form, we need to analyze the fundamental properties of motion in order to employ the elements as a visual language for social visualization.

1.1 Motion

Why motion? In visualizing data, motion has the properties necessary to reveal the salient dynamic qualities otherwise obscured in text-based interactions. My first attempts at discovering what these properties are were primitive and perhaps incorrect. For instance, I defined it as; "something that moves"; "moves left, moves right, moves up, and moves down"; "walking, dancing, anything that moves"; "it is not still, perhaps dynamic"; "it is not color or shape but one of those elements used among or with them"; "moves from one position to another". In most of my early descriptions, I happened to use the word 'move' to relate it to motion. These early descriptions and concepts of what I thought to be accurate descriptions of motion were obscure. However, what is interesting is the concept of action that arises from these descriptions.

When I looked up the definition of action (Merriam-Webster 2002), the overall descriptions conveyed a sense of progression. This idea of progression conceptually differentiates motion from other elements in visual language. Progression is an inherent quality of motion and depends on no other visual cue. On the other hand, color, another visual quality, depends upon the incorporation of progression in order to show motion. Color alone does not evoke the dynamic quality that we find in motion. In chapters 3 and 4, I elaborate on the idea of progression as a fundamental attribute of motion.

Motion, as is elaborated upon in Chapter 4, is comprised of the following fundamental attributes: position, direction, speed, and time. Also, motion incorporates the notions of space, time, and energy. All of these combined comprise the language through which the social content of the Usenet communities is visually conveyed. These are the elements that I used to animate the data set. This data was called from specific Usenet memberships to calculate the behavioral characteristics and social atmosphere within the group. Seven significant qualities were quantified using an algorithmic filter derived in earlier research. Greater detail regarding Usenet and the algorithm are provided in Chapter 5.

1.2 Socio-Kinetics

In conceptualizing the interface I focused upon three big questions: How does motion communicate social information? How are the attributes of motion applied in the portrayal of data? Does motion effectively convey the social phenomena culled from data?

As humans we have the basic ability to recognize and construct visual phenomena which is an intricate process by which we understand the world around us (Hoffman 1998). The mind is able to make these recognitions and constructions through the intuitive perception of basic visual elements, such as color, speed, and shape. Socio-Kinetics creates a setting in which the basic elements of motion are used to generate a visualization. Acceleration, deceleration, direction, and magnitude are variables which can be manipulated through the interface. The resulting visualization can then be interpreted by the viewer.

Two applications were built for this research. The design of both toolkits was intended to specifically focus on understanding the nature of motion as a communication medium. I elaborate on the theory and context that influenced the overall design of the toolkit in Chapter 3, and in Chapter 4 I introduce a working framework of how we see motion as gestalts and not as a set of numerical properties.

The first toolkit, Motion Sandbox, allows you to explore motion in order to understand its nature. It also provides a means for qualitative studies of the types of emotional responses that are evoked through the visualization. The second toolkit, Socio-Kinetics, builds upon the first one by mapping the relationship between the social data culled from Usenet

newsgroups and the properties of motion employed in the visualization. The design of the toolkit is unconventional. Rather than generating a visualization of data from pre-assigned forms that have been determined by the designer, the toolkit allows you to dynamically change the forms. By selecting different attributes of motion in varying degrees and pairing them with any of the behavioral characteristics that can be derived in Usenet newsgroups you are able to explore the relationships between motion and data. In Chapter 6, I discuss how motion, when paired with data, conveys information.

1.3 Our Perceptions of the World

Sensuous impact, which might include color, texture, linear activity, etc., plays a new part once this bond of human sympathy is established. –J. C. Taylor

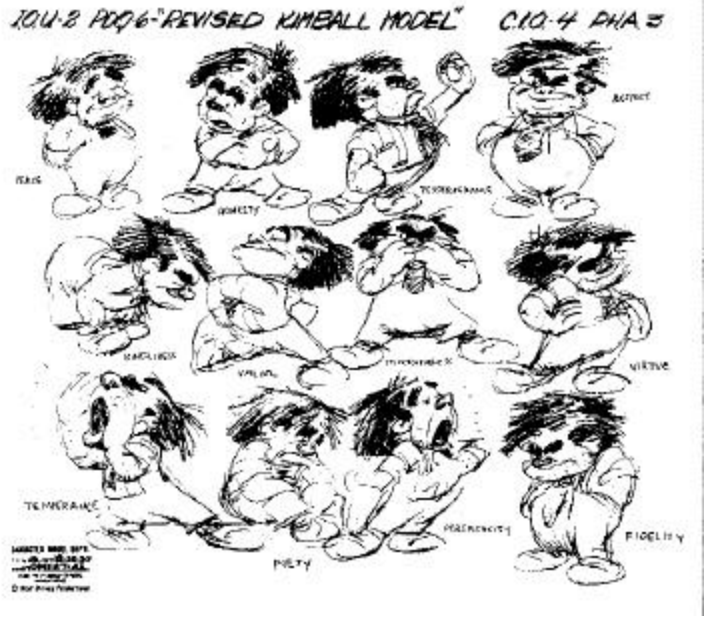


Figure 2 Gesture Illustrations (Thomas and Johnston 1981)

Our senses allow us to understand the physical world we live in. We are accustomed to seeing and reading facial expressions, such as a smile, frown, or wink to intuitively identify the emotion being conveyed. Our familiarity with reading gestures in the physical world also helps us to read various on-screen forms created in the fields of animation and graphic design, to name a few. In animation, caricature illustrations may depict an over joyous character through exaggerations in facial features such as the smile on the face. On the other hand, in graphic design, the color, typeface, and placement of these visual elements set a communicative mood of the presentation. In order to successfully convey information, understanding both the visual language as well as the dynamics in data is both important. This thesis seeks to understand how motion functions as a communicator of social expressions by revealing salient aspects present in online

communities, thereby leading us to an understanding of the social dynamics in Usenet. In Chapter 5, I discuss Usenet newsgroups in detail and how they are used in Socio-Kinetics.

1.4 End Remarks

Conveying a certain feeling is the essence of communication in any art form and that the response of the viewer is an emotional one. –The Illusion of Life, Disney Animation

In the course of my investigation, I have realized that this research is part of a bigger question than what I had conceived at the beginning. My methodology of discovering salient features of motion as a visual language in a qualitative and systematic manner is a first step in understanding its properties and its interrelationship with data. At the same time, I reveal the intricacies of the interrelationship between human perception, social information, and motion as a communication medium. I hope to show through contributions, of my explorations and assessments that reflect need and opportunity for visual motion to have a strong impact on expressive and legible visualizations of static data.

2 An Extended Example of Socio-Kinetics

Socio-Kinetics is a motion toolkit for exploring properties of motion so that we can understand which types of meaning may be derived from interrelationships between data sets and motion as a visual language. The thesis points me to two avenues for exploration:

- To understand underlying principles and the essence of what makes visual motion a communication medium.
- To understand how motion functions as a communicator of information.

Articulating the problem into two aspects is clearly reflected in the two applications that were built for this research: Motion Sandbox and Socio-Kinetics. The manner in which the interface is set up to explore the problem is a top-down approach. This application allows one to explore motion properties to understand its intrinsic qualities. This exploration also reveals how it affects visualizations – unlike data visualization methods there are no pre-assigned forms or specific relationships between data and motion properties. At the same time, the methodology of assessing motion visuals is of a qualitative approach. In the following chapter, I set forth theory from different domains (i.e. art, design, and cognitive science) that contextualize the questions I am asking here.

2.1 Motion Sandbox

The purpose for this application is to be able to explore basic properties of motion that will allow the viewer to sense its nature and relational qualities, in addition to assessing how motion acts as a communication medium. The application consists of two graphical interfaces: a visualization window and a motion control panel.

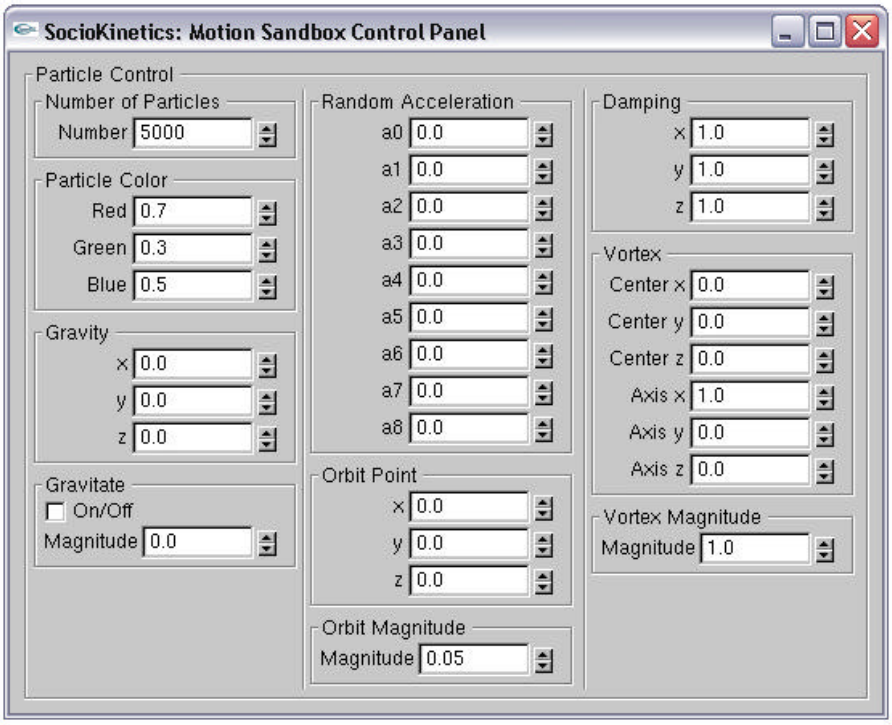


Figure 3 Motion Sandbox Control Panel

2.1.1 Functionality

The visualization window allows for the viewing of the visual translation of motion properties that is experimented with. In this window there are three ways of viewing the visibility of motion: lines, dots, and squares. Although the focus of this research is motion, I elaborate in Chapter 4 how other visual elements (i.e. shape) can aid in the visibility of motion effects.

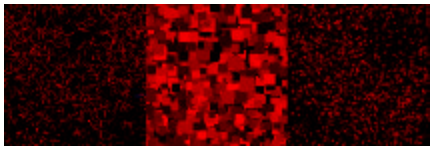


Figure 4 Visualizing using dots, squares, lines

The control panel allows the access to different types of motion properties (McAllister 1999). The rationale for these particular categories of effects in the control panel overviews two aspects:

- What physical properties are needed for motion?
- Which motion properties represent different relational effects?

These physical properties were specifically chosen to attribute the language of motion: the position of movements, the direction of movements, and the speed of movements. By design, the initial cloud of particles revolving around the center point (0, 0, 0) was to visually convey continuum and existence of form, as opposed to having particles bounce and explode which would result in the linearity of particles disappearing at the end. An orbiting cloud of particles is a starting point to visualize coherent forms. This design was inspired by the Glass pattern in Gestalt psychology (Glass 1969), whereby coherent patterns are seen when a set of random dots and a copy of those random dots are slightly rotated from the original.

Using the control panel is straightforward. Values can either be typed in or arrows can be used to control ascending and descending values. The values in the control panel are directly reflected onto the visualization window. In other words, the visualizations are processed in real-time.

2.1.2 Design Value

Motion Properties	**Meaning and Description**
Orbit Point	Move towards a specific point in space; acceleration determined by x, y, z coordinate value.
Orbit Magnitude	Exaggeration of movement in orbit point; strength of directional movement.
Vortex	Move about and around an axis; circular motion determined by starting point and axis.
Vortex Magnitude	Exaggeration of circular motion; strength of vortex.
Gravitate	Move towards each other elements; determined by strength.
Gravity	A pull; accelerate in a given direction of x, y, z-axes.
Random Acceleration	Move about randomly; acceleration towards random directions.
Damping	Overall speed to slow or fasten; amounts of density in x, y, z space.
Miscellaneous Attributes	**Meaning and Description**
Number of Particles	How many visual elements are seen with motion properties?
Particle Color	R, G, B colors to assign particles; value 1.0 is equivalent to 256^{th} value.

Table 1: Motion properties in Socio-Kinetics Motion Toolkit

Table 1 shows particular categories[4] that are based on basic properties of motion used in both Motion Sandbox and Socio-Kinetics. As mentioned before, the array of properties was carefully chosen to attribute motion qualities (i.e. position, direction, speed):

- Where is it going?
- What state is it in?
- How does it occupy space?
- How does it show form?

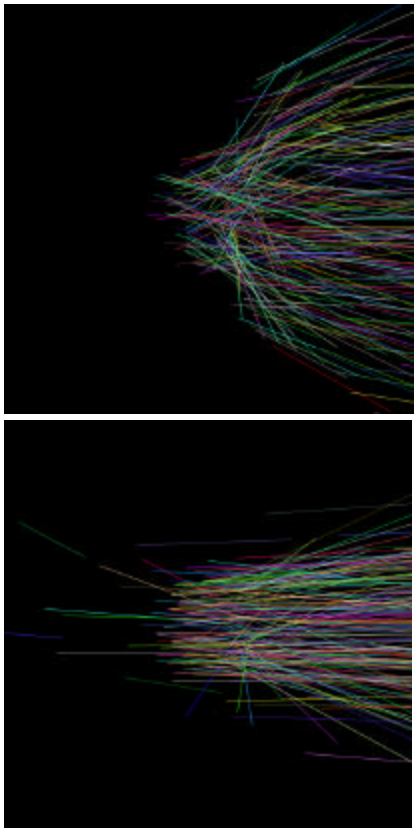


Figure 5a, 5b Altering speed of movement across time

All of the above descriptors can be explored through combinations of different property mappings. For example we can combine gravity, orbit magnitude, vortex, and vortex magnitude – observe Figure 5a. Here, we can immediately see that there is movement towards the right direction.

Motion is unique in the sense that it has a dimension of time. Time is an intrinsic quality of motion that is not present in other visual language elements such as color or shape. For example, if a dot moves back and forth between point A and point B, what is seen is the position changing and that holistically what is seen is a dot moving back and forth. The point is that, it is across time that we are able to see the dot moving back and forth. If we were to alter the speed of movement across time (i.e. use damping property) in Figure 5a, you would be seeing this effect depicted in Figure 5b**.** This again is an example of how time is unique to motion and is an independent variable along with other physical properties that can be used to show visual differences in motion. It is interesting that this example shows how we are able to make sense of what we are seeing and that we are able to distinguish qualities of motion encompassed with subtle differences.

2.2 Socio-Kinetics: Toolkit for Social Visualization

This application extends the functionality and design value of Motion Sandbox. The purpose for this application is to understand how motion properties interrelate with different data types to show spatial constructs rather than spatiotemporal constructs. In other words, I am interested in understanding how motion properties function to portray and characterize static sets of information, as opposed to using motion to depict changes of behavior in data sets. In this research, the data set I use is a collection of reputation scoring profiles of Usenet newsgroups (Golder 2001). The application consists of three graphical interfaces: two visualization windows and a motion-data control panel.

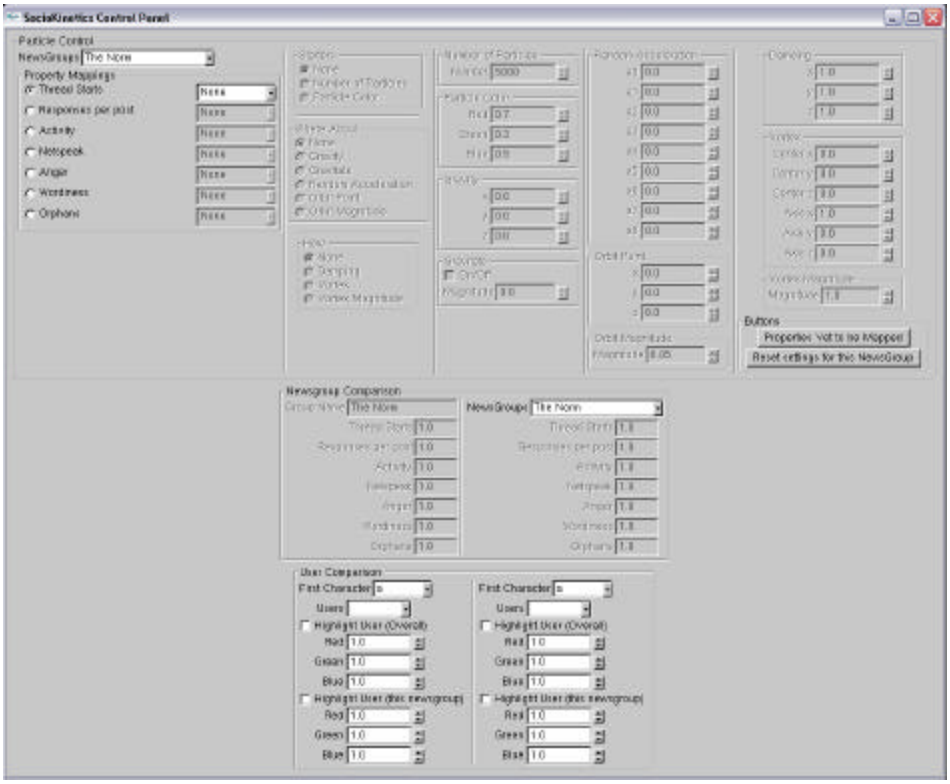


Figure 6 Socio-Kinetics Control Panel

2.2.1 Functionality

Two visualization windows allows for the simultaneous viewing of two newsgroups. The windows show visual translations of how motion properties interrelate with data sets. The way in which data sets are visualized relies on the model that is being created – recall that a top-down approach is used to manually model the visual motion-related form.

Modeling a visual form requires one to map a relationship between data sets and motion properties. By design, the application allows one to model norms of behavior in a newsgroup using motion. The data set to which it is being modeled to represents the norm (1.0000) – essentially certain relationships between the two are imposed. For example, we may decide to assign a relationship between the norms of wordiness (which is 1.0000) to the strength of a pull of 3.0. The data set we are using was designed to highlight unusual participants who stand out from the norm. Any value below or above 1.0000 signifies behaviors that are these unusual cases in a newsgroup. Then, what is seen in the visualization window is a reflection of an actual profile of a newsgroup that is modeled computationally in relation to the norm that you have modeled manually.

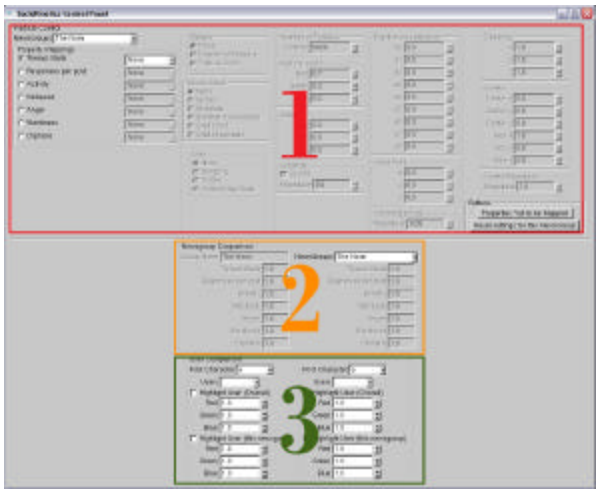


Figure 7 Functional areas in Socio-Kinetics GUI

The control panel consists of three main areas in functional concept:

1. Mapping group profiles with motion properties:
    - Drop down menu to choose newsgroups to visualize and see effects in parallel.
    - Ability to map a higher level function of motion constructs to a reputation scoring property:
    - *None*: this data set is not linked with any property.
    - *Starters*: mapping to visual elements (not motion properties) – number and color of elements drawn.
    - *Where about*: where do you want it to move?
    - *How*: how do you want it to move?

- Motion control panel that is interrelated with data sets. There can be an ascend and descend in value input to see motion property effects mapped to different types of data. This has the same functionality as Motion Sandbox except for in this application a specific motion property must be mapped to data in order to be active.

2. Information panel showing reputation scores across different properties:
   - Information panel on group profiles of the two current – viewed newsgroups.
   - Visual aid to both visualizations – to better understand its formal intricacies.

3. Individual profile superimposed onto a group profile:
   - Individual profiles can be superimposed onto group profile visualizations:
   - An individual's profile within the current newsgroup. What is this person like in this group?
   - An individual's profile across all newsgroups. What is this person like across newsgroups?
   - Individuals are identified by their email addresses and only appear on the list if they have contributed to the current viewing newsgroup.

In this application, a motion property is not active until mapped with a data set. However, the property values of motion can still be experimented with once it is linked to a data set. This specific model uses a one-to-one relationship model. For example, a mapping between wordiness level and gravity would be a one-to-one relationship. A data set cannot have more than one mapping property (i.e. not allowed: wordiness with gravity and vortex) – this would be a one-to-many relationship. On the other hand, many one-to-one mappings can be superimposed to create unexpected movements (i.e. wordiness to gravity, thread starts to orbit magnitude, and anger to vortex). For the purposes and focus of this thesis, I found a one-to-one mapping relationship to be most appropriate. The constrained interactions avoid unruly networks of mapping relations (Cutting 1986) and to see what dynamics rises from straightforward and uncomplicated relationships. The one-to-one mapping relation was an analogy from theoretical underpinnings (Cutting 1986) in perceptual theory (Figure 8a, 8b, 8c).

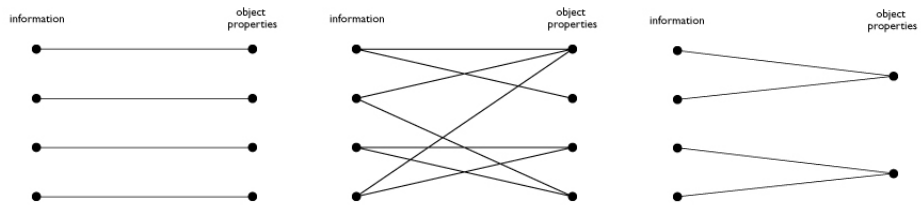


Figure 8a Direct perception; **Figure 8b** indirect perception; **Figure 8c** directed perception

Figure 8b and 8c show alternative methods of mapping relations. The implementation in this version of Socio-Kinetics is based on Figure 8a so that we can simplify interactions to clearly observe dynamics between motion and data based on a one-to-one relationship. An object map of the architecture of Socio-Kinetics application can be found in Appendix A.

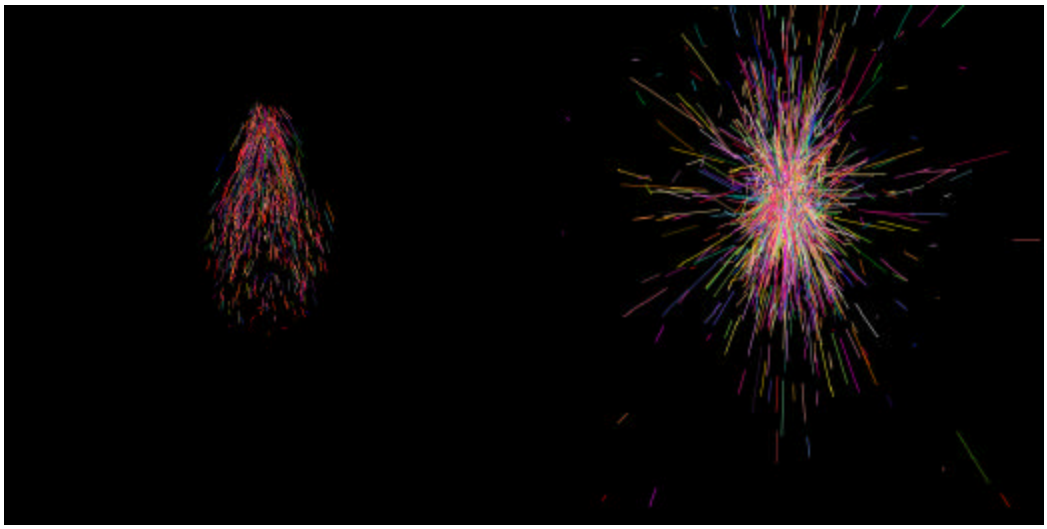
The basic usability of the control panel is straightforward – the current interface reflects the interactions and functionality of the application. The value input methods of motion properties is the same as in Motion Sandbox. Both windows show real-time calculations and visualizations of the mappings between motion and data sets.

2.2.2 Design Value

The focus of this application is to explore the following questions:

- What can we learn about the dynamics and interrelationships between motion and data?
- How do qualities of motion function to convey information in a legible manner?

A higher-level goal of this research is to find relationships that depict impressions of data. When some form of meaning is derived from data, we can classify it as information – we are acknowledging an understanding of data; it is communication or reception of knowledge (Merriam-Webster 2002). In this research, understanding data sets that are used in visualizations is important. This can even be to the extent of understanding the essence of what the data is telling you. Clearly, understanding the dynamics between motion (or any visual language elements used for that matter) and data, and how they may be mapped together requires a form of understanding about its information space.



This research succeeds in conveying to the viewer the magnitude of difference in behavior attributes between groups. It reveals straightforward comparisons that are not visible in current interfaces of Usenet. Alt.flame (see Figure 9a) and soc.singles (see Figure 9b) show strong differences in visual magnitude when the overall anger level in messages of a newsgroup was mapped to an orbit magnitude in space. We can start to ask some interesting questions about these two newsgroups as well as the relationship between motion and data:

- What types of algorithm can we use to convey behavioral expression?
- To what extent can we say that motion is expressive?
- What are ranges of a motion property and how are they visually translated?
- What are mapping structures between motion and data that seem to work?
- What types of motion provoke meaning and emotion?
- How much of these mappings are predictable?

The visualization shows difference in magnitude between the two groups. However, the connotations of spiky movements and the coherent form elicit an emotional response. We can also reverse the algorithm to match the form to the type of data. Future studies include these types of explorations in using appropriate algorithms to depict behavior attributes such as anger to spiky motions. There is a need to understand the nature of motion and its grammar in greater depth before strictly appropriating types of motion forms to behavioral attributes.

2.3 How Do We Learn from this?

The approach and advantage in the design of both toolkits is a top down approach and allows for better exploration and understanding of the nature of motion as a communication medium in real-time. The design and functionality in Motion Sandbox and Socio-Kinetics allows you to explore intrinsic qualities of motion as well as to reveal any structural patterns that may underlie relationships between motion and data. The juxtaposition of two visualization windows also allows you to better grasp how motion and data are visually translated and interrelated; a future version will allow for more visualization windows. In this research, qualitative assessments are made to discover salient aspects of motion as a visual language and how it functions as a communicator of information. In addition, the design of the toolkit allows for future investigations using quantitative methods.

3 Perception and Motion as Visual Communication

3.1 Motion and the Arts

In the arts, there are dancers, kinetic artists, painters, animators, and visual designers that use properties of motion to convey time, movement, and information. They show

sequence, progression, and narration using motion. In dance and animation both have similar qualities in the sense that motion is used on stage to show expressions, action, character, attitude, and storyline. Through their gestures and movements, we are able to quickly grasp and understand their expressions of character while we make mental constructions of a sequence.

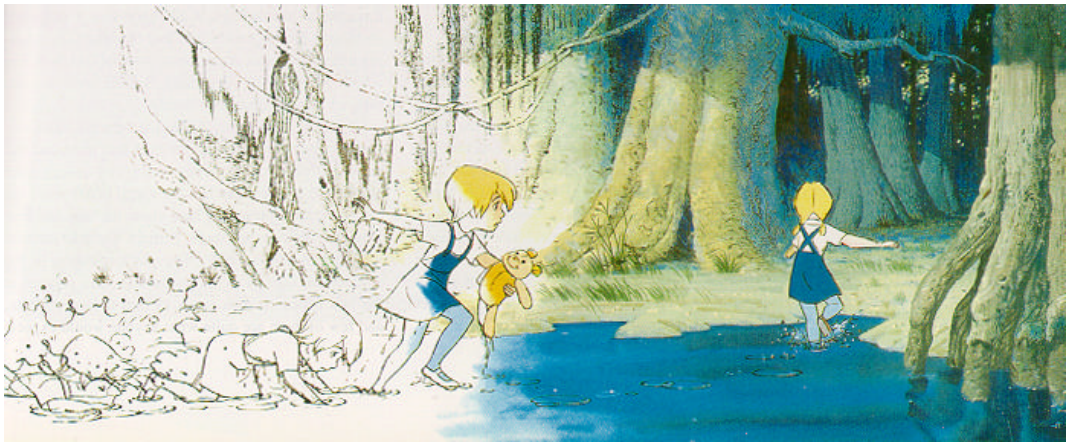


Figure 10a Dance; **Figure 10b** a sequence in animation

Visual designers who make motion graphics use time and motion to manipulate visual elements such as type and color to convey both information and mood. The opening title sequence for Seven previews and sets forth the mood and atmosphere of the movie so that it helps the audience to transition into the storyline. Not only does the composition and sequence heavily rely on aesthetics but also, motion is used as a vehicle for graphics

to maintain a sense of atmosphere and prepare the audience of what is to come in the storyline (i.e. in this case a psychological thriller).

Figure 11 Seven; opening frames in title sequence

Traditional graphic designers on the other hand, specifically those who design static layouts such as posters, magazines, and brochures can also use form and structure to convey a sense of motion. Principles in two-dimensional designs are an underpinning to how we can understand motion as a visual element.

Painters and other type of artists such as sculptor have suggested movement in static form long before film was introduced (Collopy 2000). In Malevich's painting he stresses the use of movement to 'dynamizing form' and 'non-objective sensations'.

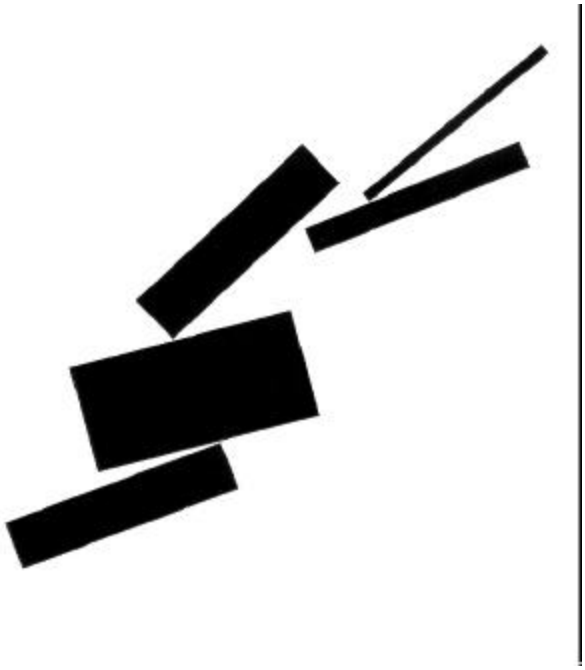


Figure 12 Casimir Malevich; Suprematism 1916-17

Painters Mondrian and Kandinsky used form to convey properties of motion and to engage the viewer's eyes. Their constructivist approach to creating a sense of character using abstract but formal relationships is relevant to what we are exploring in this thesis.

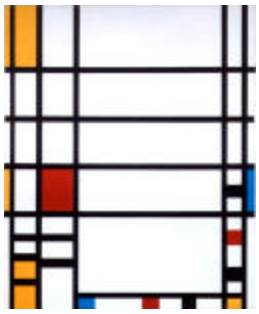


Figure 13 Piet Mondrian; Painting No.9 1939-42

In Mondrian's constructivist painting, "Painting No.9" (Figure 13), he uses lines that are rigid and bold to create a grid-like composition. He plays around the idea of how lines form tension by attributing each line as a force (Taylor 1981). What is interesting here is that because our eyes naturally prefer straight lines and uniformity (Hoffman 1998; Taylor 1981) (i.e. right angles and symmetry), he is able to disengage the viewer's eye from the actual form of the line and let the viewer feel the tension that is created in the overall composition. On the other hand, Kandinsky who is known for his use of vivid colors and bold lines uses a similar approach like Mondrian. He uses visual elements with his own aesthetic style to capture sensuous energy and explosion. The abstract relationships of color and lines create a composition that transcends the viewer into the experience as well (Hoffman 1998; Taylor 1981) (see Figure 14).

Figure 14 Wassily Kandinsky; Painting with White Form 1913

These practices exemplify how formal qualities interact with motion properties to represent and communicate abstract meanings. Our constructions of what we see and how we see strongly ties with principles from Gestalt psychology on the nature of visual perception – a theory that emphasizes that we see patterns and groupings rather than separate components and parts (Koffka 1935; Arnheim 1974) in visual images and also that we derive meaning from visual form. The relationship between what is being expressed and how it is being expressed is not obvious and complex.

3.2 Motion and the Sciences

There have been major advances in visual motion perception in Vision sciences. Through complementary research in psychophysical, neurophysical, and computation, crucial roles of visual motion have been discovered. This includes: the ability to way find which relates to our optical flow, the ability to perceive shapes from motion, the ability to separate depth, the ability to judge timing (i.e. stop pouring water into a cup because it is full), and the ability to perceive motion direction and speed. At the same time what they have discovered is that motion can compensate for what other visual forms lack to

convey in visual information (Sekuler et al, 2002). For example, the manner in which a person moves about a room can project the depth and space of the three dimensionality of the room. Experiments in vision research tend to focus on the discrimination and detection of motion perception. We are able to refer to these fields to ground our work in Socio-Kinetics. The questions we must ask are: What types of motion discrimination are they looking into – i.e. direction, speed, and coherence? To what degrees are the results relevant to visualizations using motion?

3.3 Inferences

I affirm, for example that I hear a man's voice. This would pass in common language, for a direct perception. All, however, which is really perception, is that I hear a sound. That the sound is a voice, and that voice the voice of that man, are not perceptions but inferences. –J. S. Mill

Perceptual processes are closely tied with inference. It is not only about looking at what is in front of you but what you make of it. Despite ongoing debates on perceptual theories in the sciences (Cutting 1986), there is a premise to which inference plays an important role to how we make sense of what we are looking at. In Mill's excerpt he describes how not only do we recognize sound but that we also base our acknowledgement of a man's voice through our mental constructions using cues and associations. These patterns of how we make sense of what we hear and look at are theoretically complex.

There are two ways in how we identify visual effects (Hoffman 1998):

- A relational sense
- A phenomenal sense

The difference between the two is that a relational sense is when you know what it looks like based on the fact that it physically exists, and a phenomenal sense is what you are experiencing and that you may be seeing beyond what really exists because of your mental constructions. An example of this would be that I see clouds in the sky (relational sense) while you see an elephant in the sky (phenomenal sense) because of how the clouds form a shape that reminds you of an elephant.

The question that we need to ask here is: how do we make inferences of what we are looking at? With the cloud example, you were able to see an elephant but this is your response and subjective – the way the clouds were shaped, your occupation as a

zookeeper, and that you might have seen a picture of an elephant recently, may somehow have influenced you internally to see the world as elephants. It may be more interesting to know why I did not see an elephant in order to grasp the sense of the problem.

We need to understand the interrelationship between what we look at and how we look at visual effects. This means that we need to have a clearer understanding of the information space of both motion as a visual language and data sets. Finding an appropriate relationship between motion and data is a challenge:

- Dimensions and attributes:
- What are salient features and dimensions of motion?
- What are salient features and dimensions of data?
- Which dimensions help in projecting legibility?
- Mapping relations between motion and data:
- What are appropriate mappings that construct meaning?
- Should it be strictly structural or functional?
- Should it be systematic but arbitrary?
- What are the dynamics between motion and data?

The first set of questions show that it is difficult to explicitly list all dimensions that describe the essence of a data set (in this case reputation scoring data of Usenet newsgroups). It is not as simple as asking which year a person was born to know their age. We have revealed a list of salient features of Usenet that help it define it as a social space (see Chapter 5). Understanding these dimensions is important but it is not the focus of this thesis. What I am trying to explore here is to be able to better understand the nature of motion and how its properties can be used in expressive visualizations from the point of view of motion as a visual medium.

4 Exploring the Nature of Motion

What is motion? At the start of this thesis, I was convinced to naturally think of the concept of *visual motion,* as being essentially similar if not a categorical sibling to color and shape. In retrospect, this thought was ambiguous in the fact that it reflected a lack of understanding of the constructs of motion as a communication medium. When people talk about motion, generally it seems that people (including me!) usually refer to animation. A classic example is a bouncing ball – we construct an image and understanding of transitions and actions of a ball bouncing.

A bouncing ball as depicted in Disney animation is a good example in differentiating the logic of what I am trying to investigate in this thesis. The ball bounces in space and time; however, there is a fundamental difference when you compare motion qualities to color and shape. Motion does not have the same categorical role as what we know to be a visual element (i.e. color and shape). Its dependencies as an element in visual language rely on visual elements to convey meaning. When we think about a bouncing ball, we need to carefully distinguish constructs of what we are seeing. In the example of a bouncing ball, it is not directly telling us about the nature of motion, but what we are seeing is that the actual ball and its form (i.e. the object itself) is what is carrying the meaning of motion.

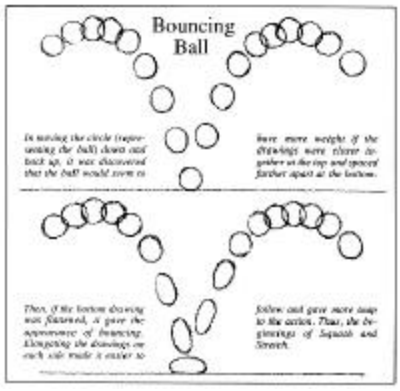


Figure 15 A bouncing ball from Illusion of Life

This chapter discusses my findings on the nature of motion through Motion Sandbox. My assessment and framework of the nature of motion is qualitative, but relies on theoretical underpinnings from other domains such as Graphic Design and Cognitive Science. What is presented here is about basic constructs of motion as part of the visual language, where in Chapter 6 I discuss how these intrinsic qualities can be mapped to data to portray cues for legibility of information.

4.1 Intrinsic Qualities of Motion

This following assessment has been inspired by and based on the Gestalt Laws of Perceptual Organization (Koffka 1935, Kohler 1947). At the same time, I was able to bridge the role of visual motion to how visual language is used in Graphic Design and how we perceive visual grammar in Gestalt psychology. Motion is not a visual element in the sense that it does not have visually tangible properties such as color and shape. We can see objects to have qualities of motion, for instance you can use a shape to show motion like in the example of the bouncing ball; the role of visual motion in itself is more conceptual. Motion is composed of relational elements that make it part of the visual language (Itten 1975). Four variables define visual motion: position, direction, speed, and time:

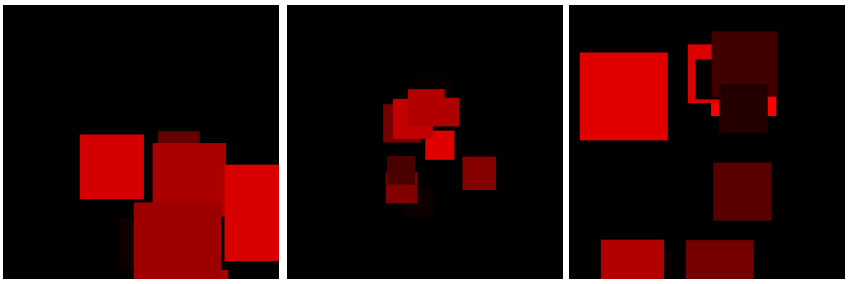


Figure 16 Basic motion qualities applied to square forms

- From what point in space?
- How fast is it moving?
- Where is it going?
- What tempo and rhythm of movement?

The manner in which I describe motion is conceptually different from how it is described in Physics[1] (i.e. distance, displacement, speed, velocity, and acceleration). Although Motion Sandbox allows you to experiment with physical properties to create motion, not all intricacies of physics are visible. For example, we can attribute a motion to be x degrees of magnitude and moving towards x, y, z direction, but such quantifiable relational details get lost in the process of visual translation. What is seen relates closer to what is grasped and felt about the nature of motion.

As I present in proceeding sections, there are limits to degrees of differences in motion properties that we can sense through our eyes. For example there are degrees to which a certain speed of x will be attributed to be of the same as the speed of y; there is a limit to what we sense as slow or fast but cannot be distinguished as slower or faster than what we already see, unless it is juxtaposed to a speed with different value. The motions we model in Motion Sandbox uses three-dimensional space but the composition of what we see is a projection that is planar (Carrier 1980) - a two-dimensional percept of space.

4.1.1 Temporal Aspect in Motion

Figure 17 Moving back and forth from point A to point B

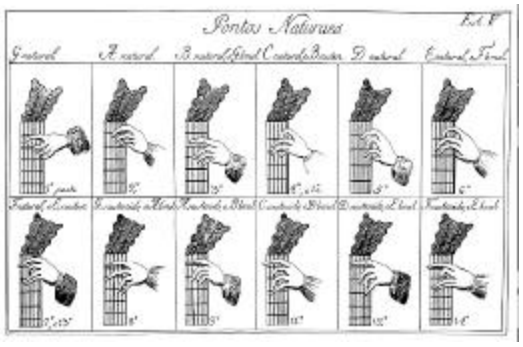


Figure 18 Manoel da Paixao Ribeiro, Nova Arte de Viola 1789

The element of time is unique to motion. When you move back and forth from point A to point B (Figure 17), not only does your position change but also the change in position happens over time. However, the notion of change in motion is not entirely about visually projecting differences in speed, direction, or position over time. This technique is commonly used with other visual elements such as color and shape. For example, in a static state you can juxtapose a small red square next to an enlarged version of the same red square to highlight visual change. In the same

[1] Newtonian Physics: Laws of motion

manner, you can use motion to make something move faster or slower to also show visual change.

Observe the sequence in Figure 18: each image reveals patterns of action. But more importantly, how your eyes move from one image to the next create false 'temporal clusters' - what is lost here is transitions of time and rhythm (Tufte 1997). In this sense, when an object is moving, it projects another dimension where visual discords are resolved. The nature of motion helps visual elements to communicate in two ways: visual attitude and transitional intuition.

Figure 19 Comic strip of the X-Men

Visual attitude is the way motion evokes feelings of what we are looking at. At the same time, the way we mentally construct a narrative sequence without much conscious effort, allows us to holistically intuit what we are looking at (Cutting 1986). Imagine trying to watch an action movie such as Jurassic Park as a set of static frames! Children will no longer be as scared of evil and angry looking dinosaurs running after the little boy, so long as Jurassic Park is presented as a sequence of static images. Without visual motion,

a ‘happy’ bouncing ball depicted in a static sequence will force the viewer to heavily rely on visual cues such as changes in shapes and hues of color to imagine the bouncing ball. However, if an animator designed the ball to project a happy character purely through its tempo and rhythm of movement, it would be difficult to project and sense a happy attitude in static form.

4.2 Constructs of Motion

With a general sense of how relational properties make up motion as presented in the previous section, we will now observe what type of grammar motion holds as a communication medium. We can ask questions like: How do motion properties visually convey its state when it is moving fast or slow? What types of interrelationships between properties of motion construct form? In order to deconstruct motion grammar, let us first observe the bigger picture of what motion can be used for.

- Differentiation: i.e. position A and position B
- Measurement: i.e. rate of speed between each leg
- Representation – Imitation: i.e. bouncing ball
- Enlivened Aesthetics: i.e. textures created by different properties

Surprisingly, the uses of motion are similar to that of color[18]: Here I add two other dimensions in uses of motion:

- Activity - State: i.e. a fidgety character
- Transitions: i.e. conceptual flow to depict a man running

In addition to the similarity with what color and shape can be used for, the temporal aspect of motion allows for two more dimensions: activity – state and transitions. Activity- state refers to the idea that with different combinations of motion properties, circumstance, mood, and sense of information can be projected abstractly. On the other hand, this compilation can also show a sense of presence – for example, there can be a texture of motion properties that evoke feelings of space and character by sporadic (fast) movements amongst calm (slower tempo) movements. As for transitions, we can feel a conceptual rhythm through and across each change in position, direction, and speed; movement is continuous therefore we do not have to consciously add up in-between

frames to understand the sequence. The following sections present a set of principles that help define grammar to which motion can be used to construct visual form.

4.2.1 Form and Structure

When meaning evaporates order remains – everyone has a voice however one voice does not justify the complexity of the visual form. It is not about current taste, style or aesthetics, all symbolic references fade away and order is what remains constant.
–P. McClanahan

In design, visual elements are generally described to have form. Interestingly enough I have found that relational qualities that make up motion convey a sense of form as well. There are two dimensions to how form is constructed through motion:

- Visually intangible trail of breadcrumbs
- Rhythm and tempo of motion

A form is a sense of order that is conveyed through visual language. This can be an expression that shows chaos, unity, or both, but what underlies this is a sense of structure. What I discovered in experimenting with motion properties is that if a single passage of motion maintains visual coherence, our eyes tend to build upon its breadcrumb trail (i.e. the position and direction of movement) to perceive it as form. For example, although your eyes focus on the square that is moving, over time you are able to grasp an overall sense of form by picking up on breadcrumbs of the passage it takes. This square that orbits around a single coordinate shows a sense of form because of the illusion it is creating. Its movement occupies space through motion. It is interesting that motion conveys a sense of space when in actuality there are no visually tangible properties left in space.

Rhythm and tempo of motion also use similar constructs just the way visually intangible breadcrumb trails show form. Although we can visually sense its rhythm and tempo by looking and feeling at the speed and direction of its movement, this dimension is more of an internalized process of perception to how we can sense its flow (Carterette and Friedman 1982).

The following two sections deconstruct these two dimensions to understand how properties of motion interrelate to create form. Both sections highlight details that configure structure - I have divided it into two parts to differentiate its role in motion grammar.

4.2.2 Limits of Distinction

A dot moving quickly back and forth from point A to point B will have different degrees of felt value depending on the context and the viewer. What emotion is provoked when there is another dot moving back and forth at a slower speed moving from point C to point B? What if there are many dots in the same space that has the same property compilations, would you still have a similar response to how it is moving in relation to others? The question we are interested in here is: what creates visual dynamics when using motion properties?

There are eight manners[2] that I discovered that attribute to creating visual dynamics:

- Anomaly: Something looks or feels different.
- Contrast: Comparisons that distinguish clear differences.
- Concentration: Distribution of properties in a space.
- Relativity: How it holds itself together in comparison to other properties.
- Space: Illusory forms of depth and volume.
- Tempo: Active force and pace of movement.
- Texture: Leaving traces or compositions of traces in movement.
- *Preferences: Liking simplicity over complexity.*
- *Emotion: Similarity but fundamental responses to motion form beyond personal dispositions.*

In using motion, all of the above attributes work together as a system to convey a sense of visual order; some are closely related in concept and some are dependent on other attributes to make it work. Let us now see each attribute in detail:

[2] The eight manners that I have discovered do not suggest being a complete listing of what is to be discovered in creating dynamics of motion.

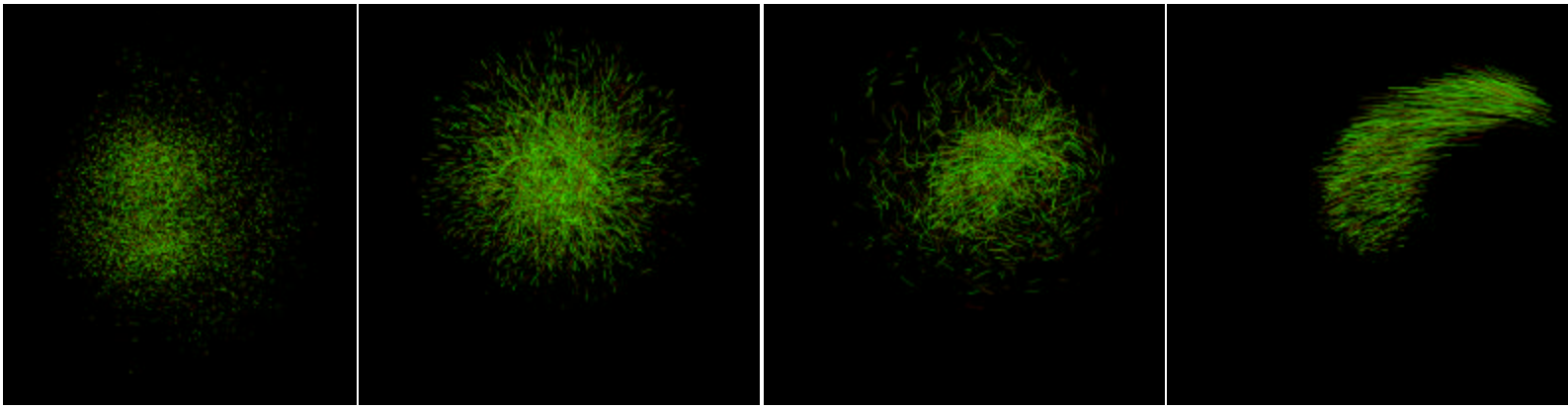


Figure 20 Anomaly as transitions

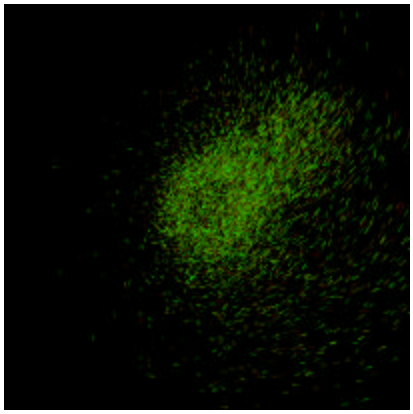


Figure 21 Looser movements away from the core

ANOMALY

Anomaly is a sense of irregularity that can be used for three causes in motion: transitions, attention grabbing, and disorder impact on regularity. Transitions allow us to understand the sequence between what we see and what we are about to see. Its movement such as in Figure 20 makes sense to our eyes when we observe the in-between follow through states between one to another. Attention grabbing and disorders are also anomalies, where in most cases there are restrictions in its space and movements but also help show a sense of unity in form. Figure 21 shows the outer ring movements to stand out because of its looser movements away from the center.

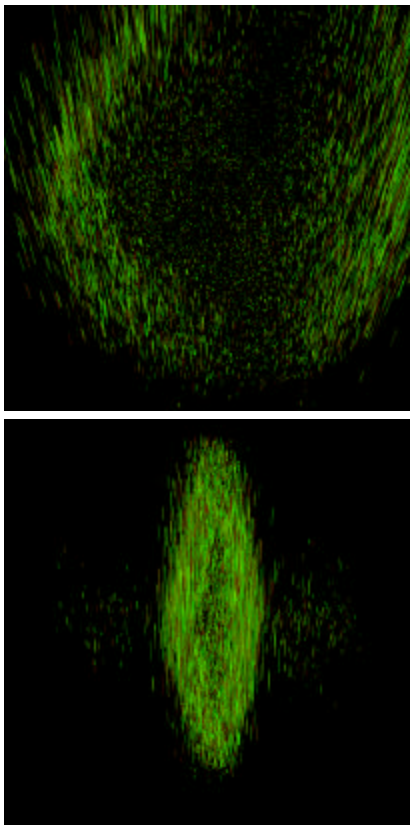


Figure 22 Contrast in distance and speed

CONTRAST

Adding various degrees to properties in movement, sets visual contrast from one state to the next in form. For example, adding greater distance to a slow moving entity sets visual contrasts between the former and the present (see Figure 22). In this example, we can see that it seems to be moving at a slower pace although it is only the distance that was increased between points in space and not the speed. At the same time, superimposing two or more different types of movements allow us to distinguish visual differences between each movement. Having the ability to set contrast within motion properties is important; not only can we see differences, but we can also see similarities through contrast.

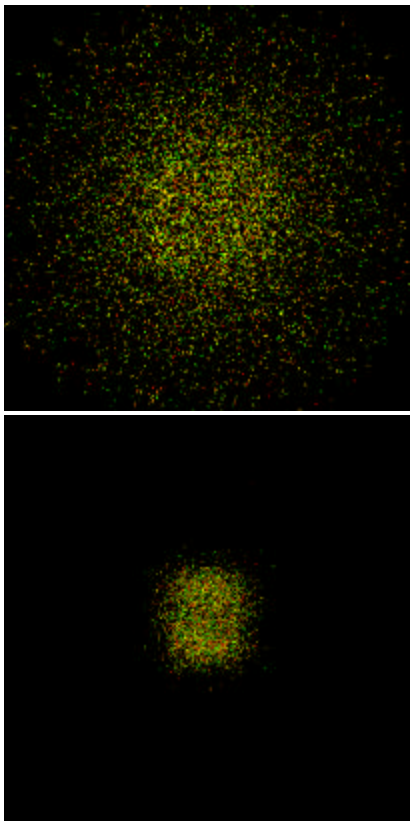


Figure 23 Over-concentration and de-concentration

CONCENTRATION

Concentration accentuates rhythm and the compilation of movements to convey a sense of visual force to our eyes. Without much concentration the order in which motion is presented will seem random and arbitrary. There are degrees of density we can think about: over-concentration and de-concentration. Figure 23 shows how an over-concentrated motion form suggests strong unity and a de-concentrated motion shows a different sense of unity where you feel an entire visual space of movements.

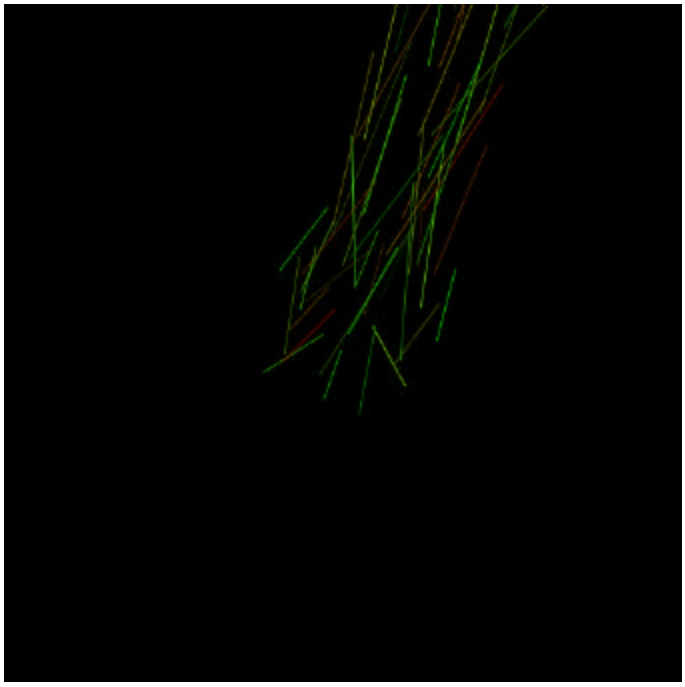


Figure 24 Visual comparisons made through comparing line shapes that are moving in relation to each other

RELATIVITY

When there is more than one entity that moves in space, its relation to how other entities move sets a visual comparison (see Figure 24). This attribute is similar to 'contrast' in the sense that we can see clear differences between two or more movements. However, relativity emphasizes more of the continuous connection and relationship between different movements. For example, a fast motion x will always be faster than fast motion y, only if its properties of speed and direction are in relation to each other. This attribute also affects our optical illusions in identifying a motion to be faster or slower.

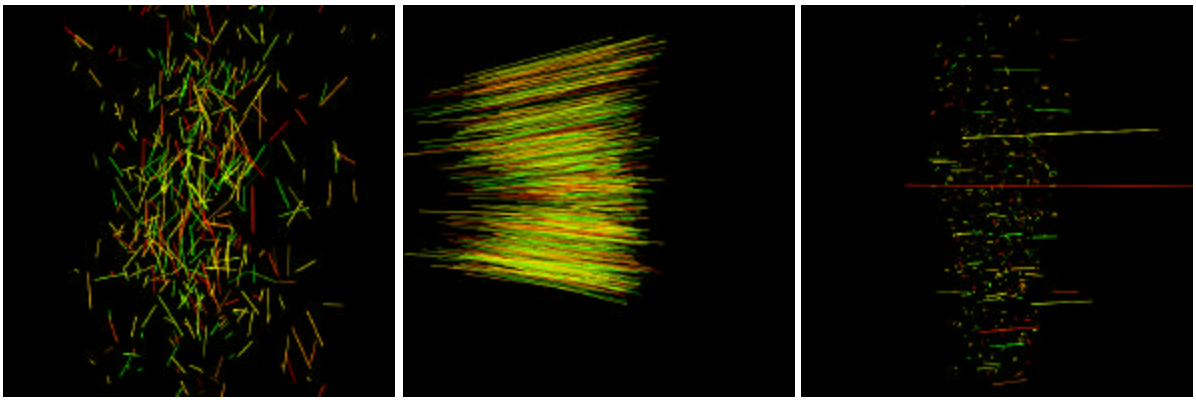


Figure 25 Viewing motion form in relation to its surrounding

SPACE

The manner in which an entity covers space through distance allows us to view its motion form in relation to the surrounding. This allows us to grasp its motion in unity as well as to realize its coverage magnitude in space. Motion can also define a sense of space through paths of movements intersecting with other paths. More interestingly, when a movement overlaps with other movements, we get a sense of depth and volume of the form in relation to the space (see Figure 25).

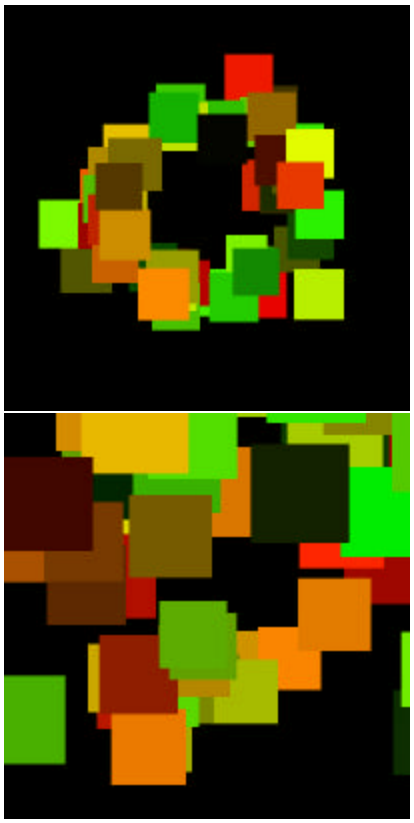


Figure 26 Tempo conveying forces of visual motion

TEMPO

The pace in which anything moves embodies a type of rhythm. A rhythm is when there are patterns to the tempo of movement. Just like in classical music a faster tempo such as in the 'Rhap On a Theme of Paganini' by Rachmaninoff in Concerto No.2 will evoke a different feeling to a slower tempo such as Chopin's Andante piece 'Nocturne' in E Flat Op.9 No.2. Tempo also visually suggests to our eyes that there is an active force in motion. In Figure 26, we can observe how setting a faster pace can connote stronger forces in motion forms. In motion, tempo is one of the more important attributes – the fastness or slowness of tempo and rhythm in motion will affect the visual balance in form and the visual mood or character to the viewer's eye.

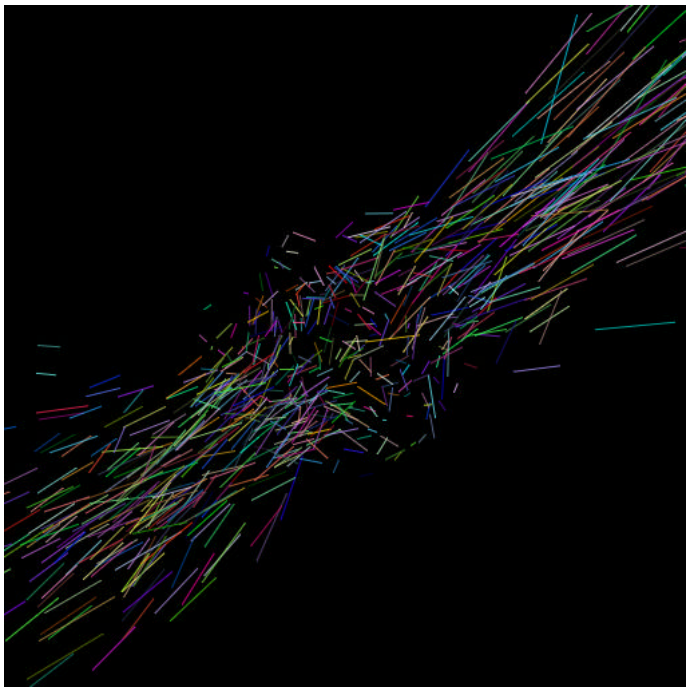


Figure 27 Repeating patterns in motion creates texture

TEXTURE

Much of what motion leaves behind in the visual form is realized through our mental constructions. However, these residues of movements compose texture in our mental constructions. This in turn lets us see it as gestalt[9] than simply properties of motion. For example, repeating patterns of sporadic movements can convey a course texture of movements (Figure 27). Another example of a motion texture is that you can create a rhythm of movements to help transitions between different types of motion to build the viewer's anticipation of what is to come.

I consider the following two attributes to be more subjective than what was discussed in the aforementioned attributes. However, these two attributes are agreeable in terms of how Gestalt psychology discusses perception:

PREFERENCES

As I experimented with both notions of visually simple (i.e. moving in a vertical direction) and complex motion forms (i.e. random movements in space), what I have discovered is that there is much preference over forms that are simple by explanation. Complex movements convey a mystic side to visualizations where some observers have described it as, “intriguing” and “beautiful”. However, such visual effects are difficult to understand and only hinder our process of understanding what it is trying to convey because we have much to discover about its grammar. On the other hand, regular and simple movements do not appeal as much attention as complex motion forms do.

EMOTION

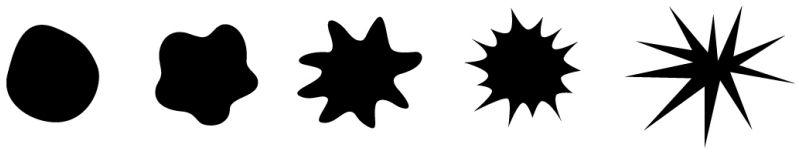


Figure 28 Smooth lines and jagged lines

Everyone is different; the ways in which we see the world is different from one another. Our life history, cultural and social background, and education affect how we see the world. However, it is my belief that there is a fundamental level where a certain motion can elicit similar responses from different people. For example, a faster moving dot compared to a slower one can convey a sense of hastiness in character. In fundamental two-dimensional design, a line with angles versus a line without angles would be characterized as being jagged or smooth (see Figure 28).

The following section discusses ways we can use these limits of distinction to convey a sense of order.

4.2.3 Structure Defining Form

There is a sense of visual order when we put together different types of movements; hence, we are creating structure that can be either visible or invisible. We can design a cluster of chaotic movements for the sake of visual effects or we can just have one type of motion in the visualization. Both have an underlying sense of order and here I have deconstructed three ways in how we can think about building a structure of motion form. The question we are interested in here is: what holds a sense of visual coherence and visual order when using motion properties?

I discovered three manners that define visual coherence and a sense of order in structure:

- Progression: A sequence of movements.
- Radiation: Patterns made by focal points and direction in motion.
- Repetition: Variation of similar or identical relationships.

These three properties are meta-level constructs for structure. Let us now observe each one in detail:

PROGRESSION

Naturally we can visually sense progression when we see motion. We can see visual change in position, direction, and speed. The general idea of progression connotes change or progress and the nature of motion itself is inseparable from the notion of time. Without time, we would not see motion as a continuous concept. In the context of progression, the path and speed of motion are those attributes which act as thresholds. They allow for transition and translation of visual movements.

RADIATION

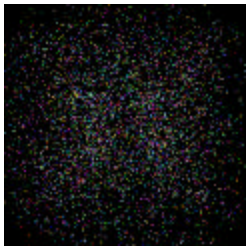


Figure 29
Radiation without any focal point

The idea of radiation structures is interesting because most visual patterns stem off of a focal center point. This focal point does not necessarily have to be physically in the center, however the pattern that is produced revolves around it. I discovered three types of radiation forces in motion: moving outwards (a.k.a. centrifugal movement see Figure 30a), surrounding (a.k.a. concentric movement see Figure 30b), and pressing towards (a.k.a. centripetal

movement see Figure 30c). The direction of flow aids the viewer's eye to capture the motion form as well as the visual energy that is projected from such regular movements. However, without any focal point a pattern of random movements in direction and speed is created (Figure 29).

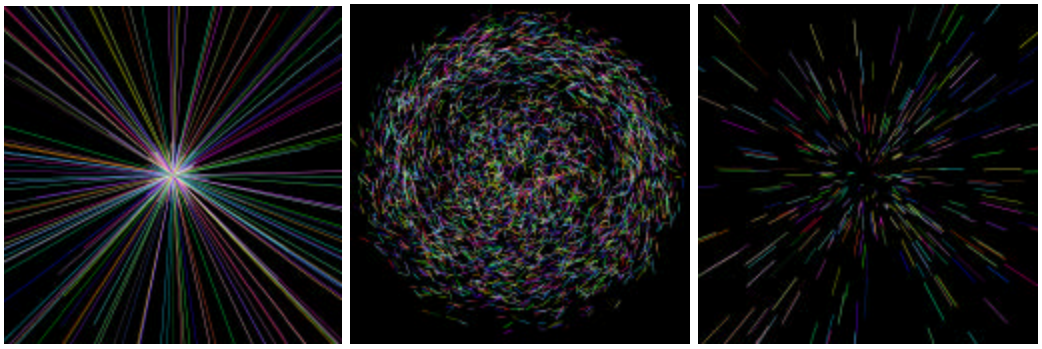


Figure 30a Centrifugal movement; **Figure 30b** concentric movement; **Figure 30c** centripetal movement

REPETITION

The idea of repetition seems to be important in holding structure in motion and creating patterns of motion. The idea that there is continuous movement can only confirm that there is repetition in how it moves. The more repetition there is in position, direction, and speed the motion will seem ordered, coherent, and regular.

4.3 End Remarks

If you observe the visualization examples in this chapter again, you will notice that each image encompasses some or all the concepts that were presented here in section 4.2.2 and 4.2.3. Attributes that define a system for visual order such as 'contrast' and 'tempo' of movements, is used with structural properties such as 'progression' and 'repetition' to convey motion form. These basic elements of constructs of visual order allow for multiple combinations or arrangements that may produce unexpected motion forms. In the following Chapter 5, I discuss the need for understanding data when visualizing information and I introduce salient features of the data set that was used in Socio-Kinetics.

5 Understanding and Correlating Information

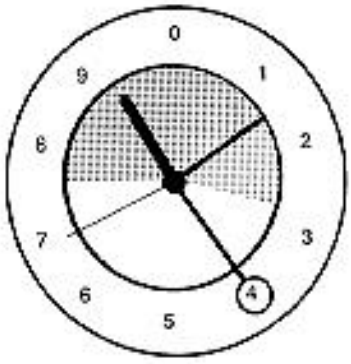


Figure 31 Analogue clock

Information graphics tell us a story or at least tries to guide our visual minds to understand what is presented in visual form. In order to tell a good story in an interesting, clear, and useful way, the storyteller (i.e. design researcher) needs to understand the story well in addition to knowing the grammar and proper uses of communication media. The focus of this research is foremost to understand the nature of motion as a communication medium and see how it can be used to convey information. However, we can only learn more of its nature as it relates to uses in semantic visualization (Donath 2002) when we further experiment with mapping motion properties to data sets.

This chapter opens up more questions than resolutions about how we should think about data as it relates to visualization. In this chapter, I discuss salient features of Usenet newsgroups in reflection of the need to better understand data as we try to visualize impressions of these social information spaces. Much of what is discussed in this chapter stems from the Loom Project (Donath et al 1999; boyd et al 2002), in the Sociable Media Group at the Media Laboratory.

Mapping information is hard; the challenge to this is that we do not have clear frameworks of what types of quantitative and qualitative data helps to convey

impressions of a space. We also do not know to what extent we should reveal information in order to make it legible. In the latter part of the chapter, I introduce the data set I use to explore its relations with motion properties in social visualization.

5.1 Visualizing Usenet

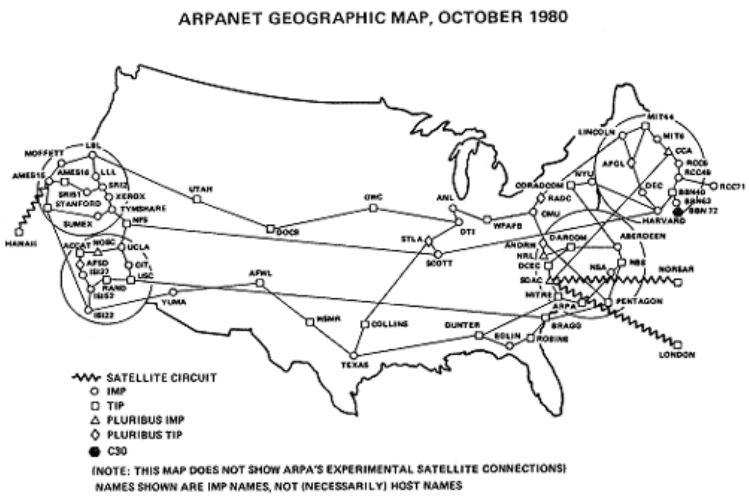


Figure 32 Arpanet 1980, now known as Usenet

More so now than before in 1979 and early 1980's, Usenet newsgroups have evolved into public and egalitarian forums where people gather to have discussions online. These discussion topics are more likely to be relevant to a newsgroup's identification such as their name (i.e. alt.flame, alt.sex, rec.motorcycles); however, discussions in it may be relevant to current events or what participants may prefer to talk about at a given moment.

Usenet is an asynchronous conversational environment where participants post messages to a newsgroup. Conversations are persistent and visible; people post new messages and reply to messages. A newsgroup consists of threaded discussions, which are a representation of participants' interactions but more importantly a reflection of formed communities. What interests us in this research is not merely about the demographics of interactions such as – i.e. how many people responded to person X? - but more of what is signified from these social moirés online. We can attempt to make qualitative

assessments on the semantics of relationships in participants' interactions – i.e. what does it mean when person X is suddenly overwhelmed by many responses? What behavior attributed to such activity? What is it telling us about that the people in the thread?

Figure 33 Example of a Usenet browser today (Microsoft Internet Explorer)

The visual presentation of conversations in current browser interfaces is text-based and in linear form (Figure 33); it shows threading structure that allows users to follow the flow of discussion. The disadvantage to this type of presentation is that it does not reveal the complexity of a social situation in conversations. It allows for access to discussions but does not clearly tell us who the inhabitants are in newsgroups. In the following sections, I highlight salient aspects of Usenet newsgroups.

5.2 Apparent Complexities of a Social Space

In the physical world, we develop a sense of intuition where we are able to infer social situations by picking up on cues (Goffman 1959). These cues can be facial or body gestures, the manner in which a person speaks, the strong grip of a handshake, or the fashion statement that is made through a person's apparel. These cues – visual, tactile, or aural – help us to grasp and formulate an impression of the social situation (see Figure 34; see Figure 2 in section 1.3).

Figure 34 Schmoozers on Seventh Avenue, Whyte, W. H.

In the online world, we rely much more on non-verbal cues. In Usenet, the threading structure holds much of its context together but this does not help to tell us the whole story. We can see the dynamics of mass interaction (Whittaker et al 1998) but it is hard to resolve questions like: Are people supportive? Can I have an interesting conversation

with these people? Are these people flaming at each other? In real world conversations, we are better at grasping the situation because we can hear the tone of voice, we can see how a person expresses themselves while talking, we also may have previous knowledge of what the person is like, or we can feel how a person makes eye contact – just to name a few. In contrast, what we perceive online relies on very limited amount of cues.

Figure 35 3D avatar chat space; activeworlds.com

Figure 36 2D chat space; chatcircles.com

There are two significant ways of online conversations. Avatar-based conversation spaces (see Figure 35) attempts to replicate our physical surroundings in online space. In these spaces our eyes are most likely to be overwhelmed by visual qualities than content and social cues. Formal assignments of how individuals are represented make it all more unnatural; there is a level of deception (Donath 1998) that has to be taken into account as well. A participant disguised behind a graphical form allows for false impressions. Chat Circles (Viegas 1999) (see Figure 36) is another example of online conversational spaces that uses graphical forms to interrelate with participant's actions in the space. It allows the user to concentrate on conversational proxemics and conversational character than be overwhelmed by the visual presentation of a participant.

In Usenet, the only way a person can disguise him/herself is through a false email address. Participant's interactions and behavior can be seen in textual interactions, but these do not reveal the subtleties of social affairs between participants. The asynchronous nature of Usenet can also affect participants in their behavior because their post will be archived allowing for everyone to access it. Researchers have attempted to build tools to reveal social patterns from this nature of a text-based environment: Loom reveals intricate patterns of message interactions by visualizing thread paths of conversations, Netscan expresses quantitative qualities of Usenet to portray sociological aspects of Usenet, and

Conversation Map reveals linguistic aspects of "very large scale conversations" to convey social and semantic networks in Usenet (see Figure 37a, 37b, 37c).

Figure 37a Loom; **Figure 37b** Netscan; **Figure 37c** Conversation Map

5.2.1 Social Beings: Who are the Inhabitants?

Have you ever observed closely at the people who work the streets? There is a multitude in the kinds of people on the street, which includes you and others. That other person can be a familiar stranger (Whyte 1980) – a person whom you do not know personally but see them frequently enough that you are aware of and somewhat used to. S/he can also be a schoolteacher, a homeless person, a vendor, a street entertainer, or the guy who sits on the bench having an intense conversation by himself. It is truly a wonderful sight and feeling to realize the palette of different people on the street.

Whatever they may mean, people's movements are one of the spectacles of a plaza. You do not see this in architectural photographs, which typically are empty of life and are taken from a perspective few people share. It is a quite misleading one. At eye level, the scene comes alive with movement and color – people walking quickly, walking slowly, skipping up steps, weaving in and out on crossing patterns, accelerating and retarding to match the moves of others. There is a beauty that is beguiling to watch, and one senses that the players are quite aware of it themselves. –W.H. Whyte

On the street, there is a sense of social-ness with the help of movement, momentum, and aura defined by the people. An individual may be pacing back and forth waiting for a friend, there may be a lively discussion in a group of people in the middle of the sidewalk, and there may be an individual window-shopping while strolling down the street. Each scenario that we can imagine of reflects the nature of people as social beings.

We relate and interact with other individuals – a form of basic human survival and perhaps a reflection and grounding of the self (Merriam-Webster 2002). However, our

nature as social beings in the physical world does not seem to come through as clearly in the online world. Whyte describes architectural photographs of a plaza to be 'empty of life' – he is referring to life in a metaphorical sense of what is seen at eye-level of people's movements and color in the plaza. Surprisingly, this is similar to what is seen of Usenet today (that is before you start reading the actual threads). It is difficult to get a sense of 'life' as how Whyte described it. These 'life' qualities of individuals and communities are hard to see.

There are two types of participants in Usenet: one who reads messages and one who reads and posts messages. In this research we only recognize inhabitants of the space to be those who contribute messages to discussions. Let us observe what we know about a participant of Usenet from a researcher's point of view:

- E-mail Address: A unique identification of an individual.
- Messages: All posts by an individual.
- Message State: Responses, thread starts, and orphan messages.
- Message Content: Words written by an individual.
- Newsgroups: All groups that the individual has posted to.

An inhabitant seemingly weaves their identity and behavior by posting their messages throughout Usenet, as seen in Loom (see Figure 37a). What types of data reflect who that person really is? There is a need for linguistic analysis on messages posted by a participant to understand their regularities and irregularities of behavior.

Newsgroup communities on the other hand also have their own characteristics aside from individual participant characteristics. This may be a summation of all participants' behavior, but the sense of a unique culture that emerges from each newsgroup may suggest otherwise. We discovered in Loom2 (boyd et al 2002) (see Figure 38) visualizations, to realize that at some participatory level the ways of interactions from participants may be expected to conform to a newsgroup's culture.

Figure 38 Loom2; alt.sex.bondage and soc.support.transgendered

5.3 What types of social interaction and behavior can we find in Usenet?

In Whyte's view, mankind is instinctively centripetal. He believes that desire for concentration, and not scatteration, has been characteristic of city dwellers since cities began… - Brendan Gill, the New Yorker

A social space can be described as a place that allows for population density and crowding. What is interesting to think about is: What happens when people gather together and inhabit a space? In Usenet, people gather to exchange thoughts and ideas. There are three main types of interaction states between participants in Usenet:

- Person A responds to Person B.
- Person B responds to Person A.
- Person A and Person B are corresponding back and forth.

However, there are different message states that result from these types of interactions:

- Person A/B posts the very first message that evolves into a discussion.
- Person A/B never get any replies.

If you browse through thread headers that indicate the number of messages present in that thread, it is surprising to find as Whittaker (Whittaker 1998) found in his analysis of interactions of Usenet, that despite the anarchy structure of Usenet there are 'participation inequalities'. In other words, there are a vast amount of threads populated by small number of participants who accentuate the characteristics of a thread. For example, you may see 20 messages in a thread, but you will discover that 6 participants instead of 18 participants posted all of the 20 messages. This indicates that we cannot strongly rely on a threaded structure to decipher social information in a threaded discussion. It raises the need to find ways to understand who the minorities are and what types of interactions and behavior populate a thread.

The next section describes the profiling system and the data set that was used in Socio-Kinetics.

5.4 Loom2 Profiles[5], a Reputation Scoring System

The reputation scoring system highlights seven different behavior characteristics[3]:

- Thread Starts: Number of threads started by participant that indicates her/him as a parent poster.
- Responses per Post: Average number of responses to each post.
- Activity: Average measure of posts by a participant in comparison with others in the same group.
- Netspeak: Average number of net lingo used (i.e. emoticons).
- Anger: Average measure of angry features present in posts.
- Wordiness: Average word count of a post.
- Orphan: Number of posts that has no responses.

How are these social attributes? A group with many thread starts may indicate that there are vast amount of topics that people are interested in. However, responses per post may indicate the lack of deep conversations in a thread. A post with no response (a.k.a. orphan post) may indicate that it is not an interesting post to reply to or that it may be attributed to as spam. The wordiness level in a newsgroup may show the verbosity of the community.

This system calculates two types of profiles: a group profile and an individual profile. The question we are asking about the newsgroup is: What is the group's behavior like? The reputation scoring of a group profile takes into account the context of the thread; Golder calculates an average characteristic basing it off of all the users in the group:

> *… if a group has 20 posts that start new threads, and a total of 400 posts, the (average) thread start rating for the group is (20/400) = 0.05. –Excerpted from Loom2 Profiles*

[3] These descriptions were summarized from Loom2 Profiles white paper. May contain similar or identical phrasing descriptions.

As for an individual profile, he offers two types of data sets: How does this person behave in this newsgroup? What is his overall behavior through all newsgroups he has participated in? A local profile (group specific behavior) is calculated in a similar method as the group profile:

> *… if a group averages 40 posts per user, and a given user posts only 30 time, he or she will have an activity rating of 0.75. –Excerpted from Loom2 Profiles.*

The overall individual profile is calculated in the following manner:

> *… if a user has a wordiness rating of 1.3 in a group in which he posts 30 times and a 0.7 wordiness rating in a group in which he posts twice, his overall wordiness rating will be ((0.7 * 2) + (1.3 * 30)) / (2 + 30) = 1.2625. –Excerpted from Loom2 Profiles.*

These profiles are calculated to highlight those participants that are not the norm of 1.0000. Any profile values that fall under or above 1.0000 are most likely to be reflecting interesting social dimensions of a space of participants who make up the community as a whole.

5.3.1 Newsgroups in Socio-Kinetics

We pulled out ten newsgroups and one-month worth of threaded discussions from: alt.adoption, alt.callahans, alt.flame, misc.kids, rec.arts.theatre.musicals, rec.collecting.books, rec.gambling.poker, rec.sport.football.college, sci.chem., and soc.singles. By looking at the raw data, we could start to see differences and similarities between groups as well as its magnitude in relation to the norm value:

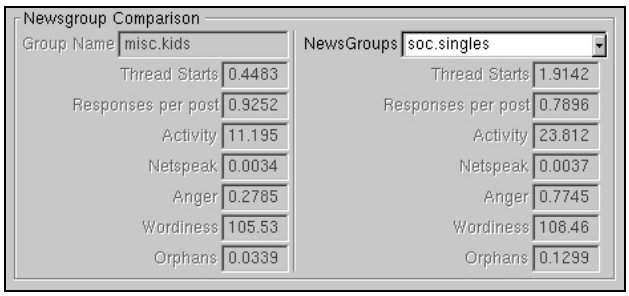


Figure 39 Group profile of misc.kids and soc.singles

Misc.kids is a newsgroup where most participants discuss and share their experiences and issues concerning their kids and soc.singles seem similar in the way that participants also share experiences as single adults. When you read through different threads in both newsgroups, you can sense a general atmosphere in characteristic and personality of the community. Their content and interactions project to the viewer, in this case [me], to be a discussion and support group despite all the irrelevant topics and uses of profane language and spam found in both spaces. How then did I come up with this perception?

Much of what is internalized and how meaning is derived from following the threads is complex and perhaps a mystery. However, consciously I did notice few things: subject headers somewhat reflect the discussion content and the total number of responses indicate the depth of discussion. I also noticed participant's presence through different threads. The manner in which participants responded to posts is what convinced me at the end, of their supportive attitude in the group. What are the dimensions that sum up this type of perception of a group behavior? The Netscan (Smith 2002) data-mining project is a good example of all the possible patterns of social interactions one can imagine. The challenging question is which combinations and to what extent should data be revealed to portray a quality of experience just as how I perceived the space to be? How do we visually represent these quantitative figures and relationships to evoke qualitative feelings of a community and their space?

It is interesting that each characteristic in the profile shows a dimension of behavior to have different and extreme figures. What does it mean when the anger level is at 0.2785 in misc.kids? What can we tell about a newsgroup when it has few thread starts with much activity and wordiness level in the content? The data in the profiles is both interesting and complex. As we progress further in thinking about semantic relationships between each behavioral attribute, we need to find deeper forms of data mining its characteristics to understand the value as it relates to visualization.

6 Exploring the Relationship between Data and Motion

Perception is discrete (Bergman et al 1995) therefore it would not be intuitive to be able to configure all motion properties to one behavior attribute. In Socio-Kinetics, the one-to-one model of mapping motion properties and behavior attributes together allows the viewer to control what is explicitly being visualized. This approach allows us to visually grasp the nature of motion as it relates to data and reveals potential uses of motion properties in the context of social visualization.

In this chapter, I discuss significant points about motion in relation to data. The first section exemplifies a set of visualizations that compare different newsgroups. In the second section, I discuss what I discovered to be the essence of visual motion as it relates to data. The question we are asking here is: which motion attributes are intuitive in the sense that we can gain an insight of what it is telling us? There are successes in this research – important visual aspects of motion is revealed. But, there are also shortcomings that lead to opportunities and future directions in research – future work is discussed in Chapter 7.

6.1.1 Visual Comparisons: Newsgroups

Observe Figure 41 – what you are seeing in this figure are newsgroups that depict a combination of their anger level and wordiness level. It is interesting how we can immediately sense visual differences between newsgroups despite the unison in the type of movement we are seeing. There are two aspects that stand out in the visualization: the energy of visual movement that is being projected and the concentration of movement at the core of the visualization.

If we compare each newsgroup to the model that it is based on (i.e. the norm group – Figure 41a), clearly we can sense that there is much more activity and energy that is

being projected from each newsgroup. The motion structure in each newsgroup carries most of the formal attributes that was presented in 4.2.2 and 4.2.3 (i.e. concentration, tempo, texture, repetition, radiation, etc.). However, what is striking about these visualizations is that the nature of motion itself is carrying the meaning of social information.

Let us compare the culture and behavior of two newsgroups: alt.callahans and alt.flame. Alt.callahans is a space where there are 'no strangers – everyone is welcome'. This newsgroup bases their concept and group spirit on a book called Callahan's Place by Spider Robinson:

"Shared pain is lessened, shared joy increased; thus do we refute entropy."

As you can imagine, it is a pub-like scene where people come and go and have conversations (Addendum B: alt.callahans). Therefore, one can imagine this group to be a lot about conversational interactions between participants. In this group, there are a lot of threaded discussions and people tend to be wordy and interested in what people have to say to carry out a conversation. On the other hand, alt.flame has a different culture:

"To flame and be flamed."

In this group, you can immediately stand out amongst the crowd to be a newbie if you have never flamed in the way old-timers do in alt.flame or if you fall for newbie traps. As you follow the conversations in threads you will notice that there are different degrees to how people flame (i.e. kindergarten level to perfection level) as well as different rankings of being a flamer (i.e. perfect flamer, the conspirator, the wannabe, the hit 'n run, etc.). There are many ways to flame (Addendum B: alt.flame) therefore messages tend to be concise and bashing.

Observe Figure 41b and Figure 41c – alt.callahans and alt.flame. What you are seeing are two visual results that are different in how motion is projected. There is a bigger concentration at the core in alt.callahans than in alt.flame. However, the movement is faster in alt.flame compared to alt.callahans. Here, we are seeing two types of visual energy that is being projected from these two newsgroups. Both newsgroups have different felt values – here I collected some observations from colleagues:

- alt.callahans: heavy, crazy, messy, big blob, alive

- alt.flame: faster, sharper, confined, pointy star, organized

From these observations, all ten people had similar responses to both newsgroups. What I can deduce from the feedback are:

- In alt.callahans, the visual significance lies in the concentration, density and course texture of centripetal movements.
- In alt.flame, the visual significance lies closer to the nature of motion – the concentration in the speed of centripetal movements.

If we now observe the statistics between the two newsgroups, we can see that alt.callahans is almost triple the number of thread starts and 25% more of wordiness level than alt.flame. At the same time, alt.flame holds almost twice the anger level than alt.callahans (see Figure 40).

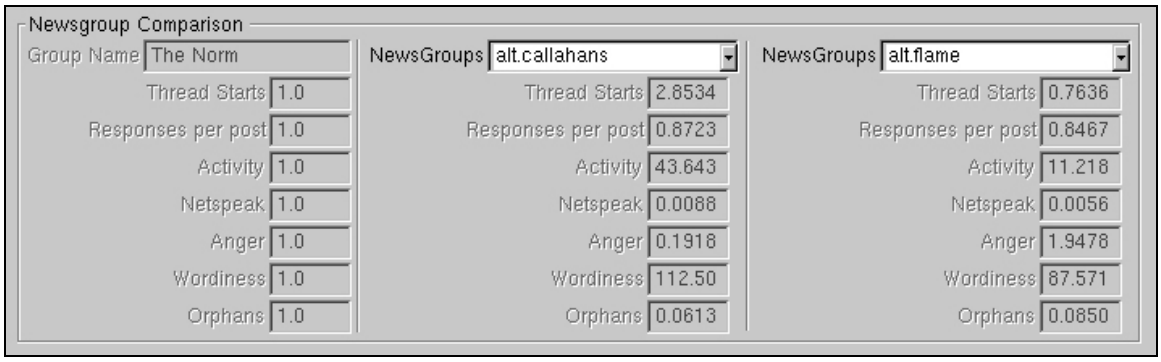
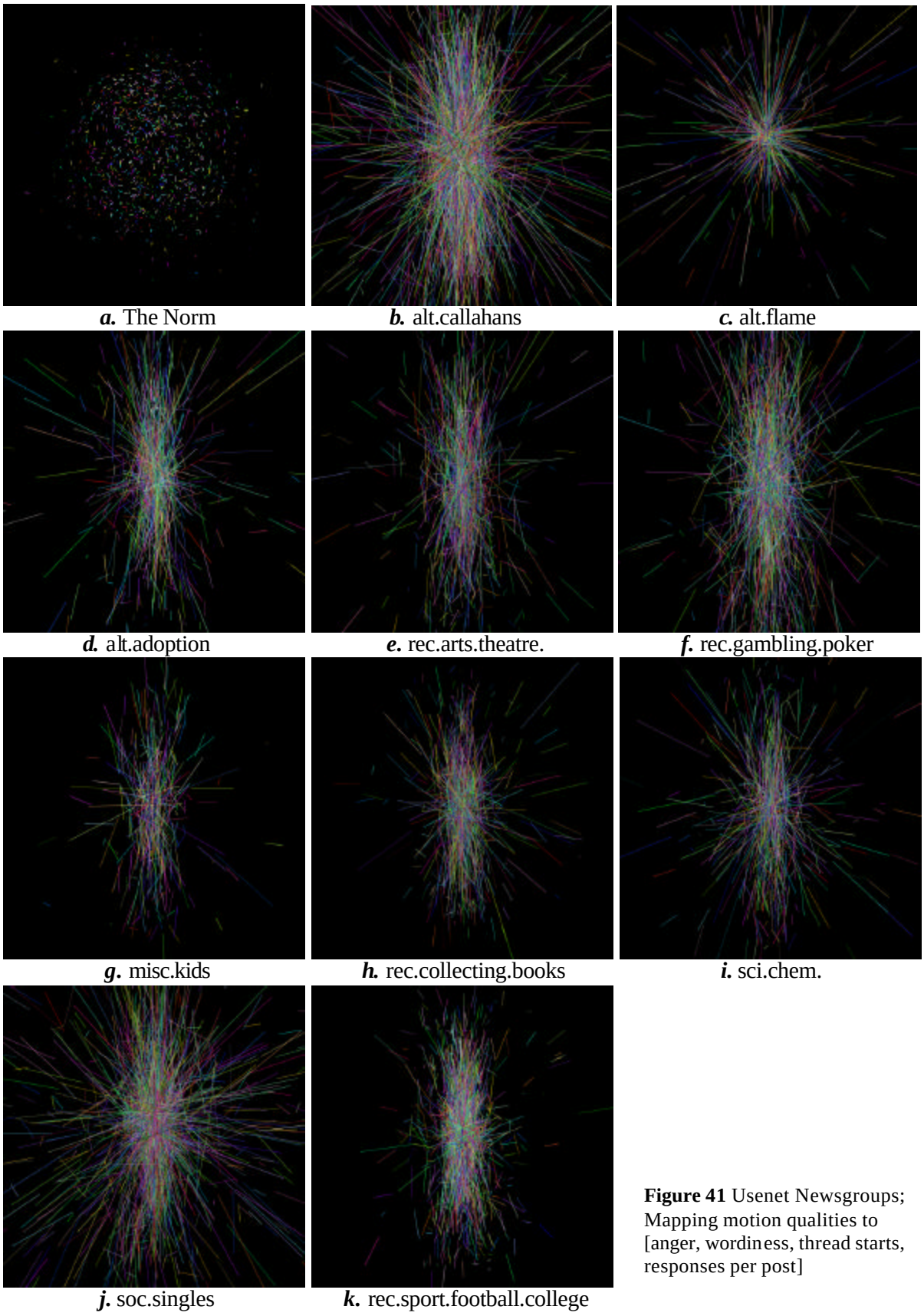


Figure 40 Statistic figures for the norm, alt.callahans, and alt.flame

What is interesting here is that we can see that both newsgroups in Figure 41b and 41c show different magnitudes of motion properties as it relates to data. In the actual statistics we can see clear differences (i.e. number comparisons) but in the visualizations we can feel differences that is more subjective and related to our emotional responses. The manner in which the basics of motion properties (refer to 4.2.2 and 4.2.3) convey motion form, guides us to infer what to make of the visual representations.



a. The Norm ***b.*** alt.callahans ***c.*** alt.flame

d. alt.adoption ***e.*** rec.arts.theatre. ***f.*** rec.gambling.poker

g. misc.kids ***h.*** rec.collecting.books ***i.*** sci.chem.

j. soc.singles ***k.*** rec.sport.football.college

Figure 41 Usenet Newsgroups; Mapping motion qualities to [anger, wordiness, thread starts, responses per post]

6.1.2 Visual Comparisons: Participants in Newsgroups

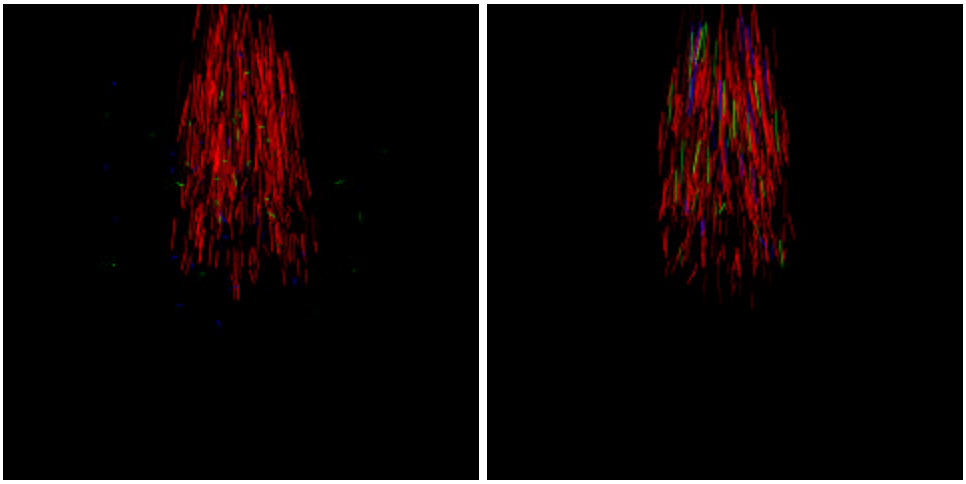


Figure 42a-42b Participants superimposed onto alt.callahans representation

By design, I decided to include the feature of superimposing a participant's behavior profile in a newsgroup to a group's profile. The design rationale behind this was to get a better sense of the group's behavior. However, putting more context in the visualization did not make much of a difference in making it legible. In contrast, what we saw was participants' behavior to be either in sync with the group's behavior or diverge from the group's behavior (see Figure 42a and 42b).

6.2 Most Significant Aspects of Motion in Relation to Data

I discovered two salient aspects of visual motion as it relates to data:

- Motion properties can carry information to guide our perceptions to draw meaning from representations.
- Motion properties can work together as a whole for the transference of information.

I elaborate these two points in the following sections and relate this analysis to the previous assessment I made in Chapter 4.

6.2.1 Sensing the Nature of Motion

The most significant discovery about visual motion as a communication medium is that there are some qualities of motion that we see and some that we feel. An example of this is that we can see a dot move back and forth (see Figure 17) however, the tempo and rhythm of movement and the manner in which it is being pulled from one position to the next is an aspect that we feel visual motion.

Here are other discoveries that relate to this theme:

- There are also degrees for us to be able to visually distinguish types of motion – this is when the concept of 'what we see and what we feel' merges. For example, a dot moving back and forth really fast will visually look and feel the same as another dot moving in a similar fast manner. I discovered that there is a limit to how we can distinguish and make visual sense in motion – there is a limit to what we can see as moving really fast or moving really slow. Extreme degrees to using motion properties in this manner only blur the concept of using motion and make it difficult to understand visual differences in motion.
- By observing different newsgroups, I discovered that the nature of motion becomes more apparent when there are less visual elements on stage. When there are more visual elements that are moving on stage, it projects more of an order of visual form than conveying the intrinsic nature of motion.
- We can reinforce our perception of motion qualities if we concentrate all visual elements to have identical movements. It seems that motion properties are strongly tied with visual elements (i.e. shapes). I discovered that a single shape moving in manner x can convey similar information to many shapes moving in manner x as well.

Because we used a direct mapping relationship between motion properties and data, the information attitude that is projected from the visualizations is straightforward. The direct relationship affords it to reveal attitude – in the case of alt.callahans and alt.flame for instance, we observed the different visual energies projected through the concentration in texture of centripetal movements and the concentration in speed of centripetal movements. At the same time, viewing newsgroups in parallel helps the viewer to understand and grasp the information attitude as well. This juxtaposition helps to reveal similarities and differences between groups.

6.2.2 Motion as Affordances: Narrative Quality

The continuous movement in motion affords to help in the visual translation. The in-between steps from one position to the next suggest that not only does it help us to make sense of what we are seeing but also that motion is narrative in form. In this aspect, the way we use motion to convey information has similarities with processes in animation.

I have extracted the following processes (Disney 1981) used in animation that is similar and relevant to motion as it relates to data in this research:

- Anticipation: a motion that leads into an action, i.e. a look before a grab
- Timing: fast or slow moves that define the personality
- Follow-through: helps viewer to absorb the motion attitude
- Appeal: simplicity, pleasing, and magnetism to your eyes
- *Secondary action*: supports the narration of the main action
- *Exaggeration*: extreme uses of motion properties to make it believable

Anticipation, timing, follow-through, and appeal are qualities that help give narrative form. Secondary action and exaggeration also help in narrative form but may not be necessary and will depend on the context of use. In using motion as narrative forms, these processes details in motion sequence are what will hold it together to convey information. For example, if all the timing in movements were too fast across different newsgroups, it would be visually difficult to make sense of it other than its hastiness in character. In Disney animation, character personalities were defined more by their movements than their appearance (Disney 1981).

6.3 End Remarks

The two ways in which motion is perceived (i.e. some we see and some we feel, narrative form) leads to opportunities in how we can visualize 'legible' social information spaces. Careful combinations of motion properties will allow us to convey information attitude and the manner we use motion as narrative form will also help in conveying information. The following chapter discusses opportunities and future work.

7 Future Work

In this research, I have revealed intrinsic qualities of motion as well as how we may use motion to convey information. These initial steps are the beginning to a system of motion grammar which informs how we may go forth in visualizing legible social information spaces. With the current structure of Socio-Kinetics we were able to see visual comparisons in magnitude between newsgroups. The explicit mapping relationship between motion and data allowed us to carefully control and view how motion functions as a communicator of social expression. The research had shortcomings; however, this reflects opportunities and questions we should be asking.

The current visualization toolkit allows us to experiment with the nature of motion as it relates to data in a one-to-one mapping setting. The visualization result does not evoke emotional responses in the way we react to human gestures in physical circumstances, as is an eventual goal. We were able to reveal the magnitude in the dynamics of behavior attributes. We were able to better understand the essence of motion – we learned and have exposed a great deal in what motion is and the various ways motion can be used to convey information.

Understanding intrinsic qualities and uses of motion is important and leads us to our next steps in research:

- We need an in depth understanding from other research domains on vision and motion perception such as cognitive science and Gestalt psychology. These fields do not inform us how we may visualize information, however, we can extract from the ways we perceive visual elements and relationships to convey information.
- We need to push the grammar of motion to convey gestures we know of (i.e. happy, sad, frustrated, angry, etc). For example, what does a group of people laughing look like? This may also include a feature to combine different qualities of motion to make it one motion type. We need to lay out a perceptual motion map so that we can build libraries and algorithms to use motion appropriately in context of social visualization.
- We need to find better forms through data mining – the current state of data may be too abstract. Are these data groups sufficient for what we need to visualize legible constructs?
- The algorithm for weighting data will need to be revised. What if we started to reveal all or some of the participants' behaviors to visualize a newsgroup? We need to find ways to show the emotional qualities as well as the dynamics within a set of behavior attributes. We need to try out different relationship models such as one-to-many, many-to-one, and many-to-many. Experimenting with non-linear hierarchies in mapping relationships would be interesting and most likely give us unexpected results. For example, if wordiness level had the highest rating in all the behavior attributes – should this behavior override or stand out more than other attributes?
- There is certainly an advantage to a top down approach in visualizing information – it offers flexibility and allows us to have careful control of manipulating details in the visualization. We can push this methodology further by including features in the GUI. For example we can offer features to create different types of order (i.e. patterns) and relationships between properties of motion, visual elements and data.

In conclusion, there are greater opportunities and future work to be done in this research. This research has brought us closer to understanding what visual motion is and how it may be used for visualizing legible constructs. It has become evident through this

research that visual motion is an essential communication medium that conveys information.

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9 Appendix A: Object Map for Socio-Kinetics