motion for interface

interface is programmed performance

a taxonomy

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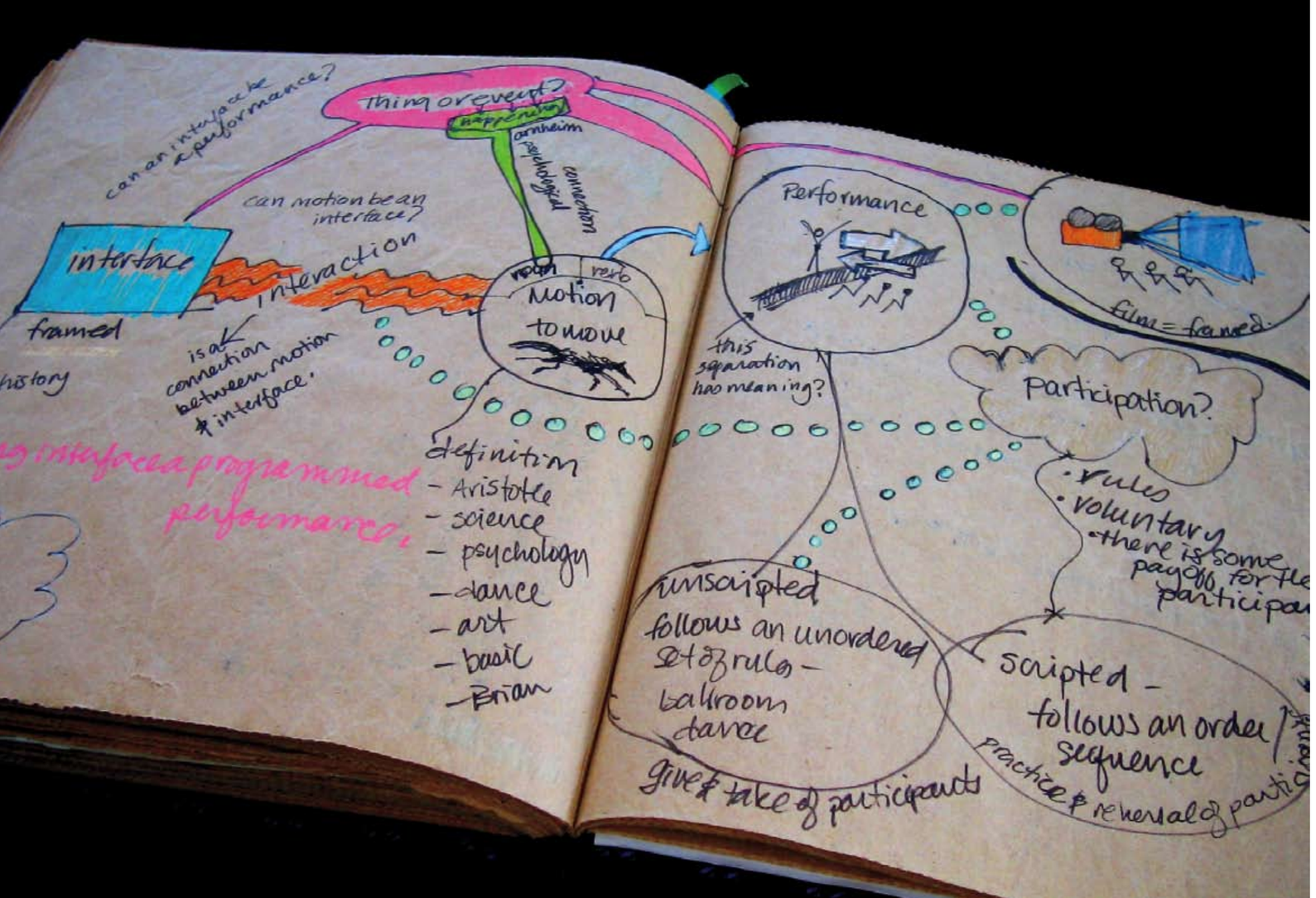


introduction

an introduction

making motion have meaning

your computer interface

abstract

Paul Klee dedicated his life to the study and teaching of motion. “Ingres is said to have created an artistic order out of rest. I should like to create an order from feeling and, going still further, from motion.” (Klee, 5 of preface). *The Thinking Eye* documents his explorations from simple to complex studies of motion in a lifetime of progress toward order created from motion.

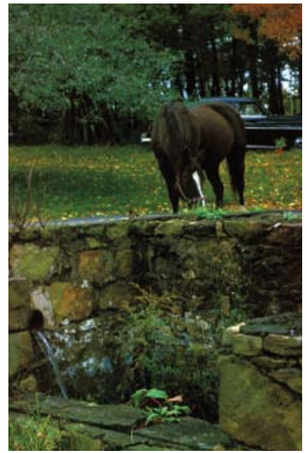
The human brain is hard-wired for motion. Our physiology has evolved systems and organic structures that instinctively respond to motion, particularly organic motion. Using motions in computing devices inspired by the natural world will create deeper, more emotionally engaging experiences.

The natural state of interaction with digitized information includes motion. New environments and new concepts in computing, multiple user environments, streaming data, layers of interaction or interconnected mobile devices need new, unique strategies for interaction, including the use of motion.

I propose that motion in interface is programmed performance. I’m studying motion in order to understand and use it as a component in the design of digital interfaces. My research explores motion from several perspectives with the goal of understanding its fundamental qualities, building a taxonomy to describe motion used in the 2-dimensional, framed space of a screen. The resulting research, experimentation and documentation will define a language for motion in interface.

introduction

Interface as programmed performance?



Water coming out of a hose represents a classic problem in the obscure engineering discipline called Computational Fluid Dynamics. If motion is information, what does water coming out of a hose (or any motion that is based on scientific inquiry), tell us? Motion is integral to any user interface. Can the meanings of physical motion be transferable to screen based interfaces? Interaction itself is engaging, when that engagement includes motion it takes on richer, more natural, life-like qualities. I'm studying motion in order to understand it to use it in the design of interfaces.

Motion without information is confusing. Why is that? I grew up with horses. This is Elmar. When you're born to run with a herd you have to be able to communicate at a full gallop. While hanging out with their buddies, horses communicate mostly through their movements.

Humans understand that way as well.

Shortly after I got this horse we shared an experience that illustrates the point. This happened the day after she was delivered from the sale barn in Virginia. She was staying in the lower section of an old, classic Pennsylvania barn. They build them into hillsides giving two floors ground level access due to the way the structures intersect with the hill. In this barn, the top floor also cantilevered above the bottom floor, with the edge hanging over by about eight feet to provide protection from the elements. It had dutch style doors split in half so the top half could be opened to let in the air while the bottom half stayed closed to contain the animals.

I opened the top part of the door that day and she put her head out to see her new world for the first time. She was standing directly in front of me, the bottom half of the door hitting her about mid-chest, the top half hanging free in the air to the right of my head. She was a medium-sized but powerfully built horse with a wide body that promised strength. Her chest was solid and well muscled.

the quest to understand

motion is inspiring to humanity

to understand motion

As I stood there wondering what to do first, I saw those chest muscles tensing slightly under her skin. "Uh oh, not good," I thought. It happened so fast I did not realize that I had understood what I was seeing. It seems to have taken me a long time to act. The actual time must have been a fraction of a second. On impulse I dove to the left. The memory of 1800 pounds of hot determination flying past me as I fell scares me even today.

That rippling of Elmar's chest muscles communicated danger to me at a level beyond my conscious control and I responded instinctively, without thinking. If I had hesitated at all, collision with horse and door would have produced dire results.

If movement communicates in real life, can it communicate within the frame of an interface as well?

My projects:

All interface is about the dynamic flow of data and flowing data is better understood when it is in motion. In order to understand how to use motion in interface design, I set about work that would help me understand the use of motion on screen as a way of communicating data. One project is a series of short, discrete videos of "ideas" of moving things captured from life compared to formal and conceptual criteria as a way of understanding those motions. The second project creates programmed motions using geometric shapes. Comparisons between programmed motions and the video begins to translate from lifelike actions to symbolic expressions of motion. Time, seen as a constant flow of data translated into motion on screen applies thinking gained from the analytical projects as an interface to flowing data.

When I started this project I was overwhelmed by the complexity and magnitude of the task. At each step the approach I took was based on my best guess at the time. The result of each experiment gave small illumination on the way motion could be understood, never overwhelmingly successful or even progressing enough to make me confident I would succeed at all. When I tried to imagine adding motion into interfaces I am already familiar with the result was always a useless hack. It wasn't until I started to organize notes for this document that I saw what I had created: a simple, logical and elegant flow of research projects that resulted in a way of thinking about the elements of motion as valuable principles to apply to the design of interfaces.

From the beginning I have been convinced that interfaces should move. Used as a way of communicating information, motion will make the experience of using an interface deeper and more emotionally engaging.

For this thesis I focused on thoughtful, experimental projects on the nature of motion rather than case studies placing motion into interfaces because I was at first confounded by the complexity of a more applied task. From the start the area seemed to have no bounds. I decided to approach the topic from a theoretical point of view because it is different from the way I usually work, challenging me to learn new approaches and try our new ideas. I hoped that I would create a body of understanding about motion.

Many times I wished I could find an interface to use to experiment with motion ideas but each time I tried, I was confronted with another massive task: to define an interface before I could add motion to it. That effort may have yielded some interesting ideas but not the depth of understanding of this more academic approach.

My goal in this process is to understand motion well enough to be able to apply what I have learned to the design of an interface one day. In the process of learning for myself I have documented my ideas that others may use them.

Interface is flowing data

The world is changing from a focus on industrialization to a focus on biology. In a presentation at MassArt in the spring of 2009, Hugh Dubberly said, "from the Industrial revolution up to today, mechanical metaphors have dominated our thinking. Mechanics was used as a system for describing the clockwork motion of the heavens. The rise of engines, engineers, and engineering dominated the way we designed and organized products, communication, education, even society. Yet now, we are in the early stages of a new revolution, this time in biology. How will it reframe our view of the world? Will the revolution in biology give rise to new metaphors? How will this affect design practice and design education?" (Dubberly, MassArt 04.08.09).

This change in metaphor from engineering, industrialization and production to flow, relationships changing over time, and lifelike processes applies to flowing data as well. It shows up in the way we speak: "Where once we described computers as mechanical minds, increasingly we describe computer networks with more biological terms–bugs, viruses, attacks, communities, social capital, trust, identity." (Dubberly, Design in the age of Biology).

Motion can make a machine feel like an organism. The world is changing from a focus on industrialization to a focus on biology. We see this change happening in design as well, as we move from producing multiple copies of individual designs to design for changeable systems that can reconfigure themselves depending on different variables. Chris Pullman of WGBH in Boston described it as Composition changing to Choreography. "Once the designer's art was composition. Now it is choreography. In a fluid, four dimensional world, the problem is not so much to get the fixed thing right as to find an elegant sequence of evolving relationships." (Heller, Pullman, 168).

Inspiration about motion

As children we learned of our environment by our motions through it. Watch a baby reach with new arms, turn its head, kick. Before eyes can fully see, information streams in through movement. "The body learns through moving through the world." (Lopez, The Journal). The study of motion has had a significant influence on human thought from the early years of civilization. The quest to understand motion has contributed to an understanding of the natural world from the time of the first philosophers.

During the centuries of Greek civilization, sculptures of standing male youths called kouroi, thought to be representations of Apollo, had great popularity. The style of the sculptures originally mimicked similar standing males from Egyptian models. The earliest of the sculptures opted for expressive pattern rather than realism. Over the course of about 100 years, the Greek style evolved from stiff, geometrical, schematisized abstractions to more naturalistic, lifelike interpretations. In 480 BC with the addition of a slight twist in the hips, the Kritian Boy took the final, definitive step into the true Classical style. He stands naturally, his right leg bent and relaxed at the knee, his weight supported on his left leg. This small innovation, adding subtle motion to the figures, began one of the great artistic movements/ moments of all time. (Gombrich, 117).

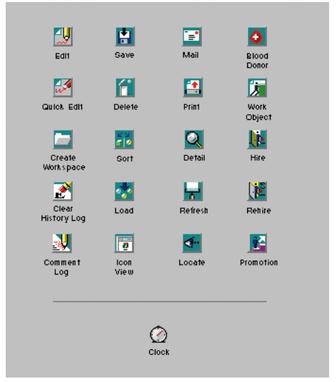
In the 16th century Nicolaus Copernicus watched the motion of stars and planets in the sky and determined that the earth revolves around the sun and not the reverse, moving the earth out of the center of the universe and, in the process, humanity from the psychological center of existence.

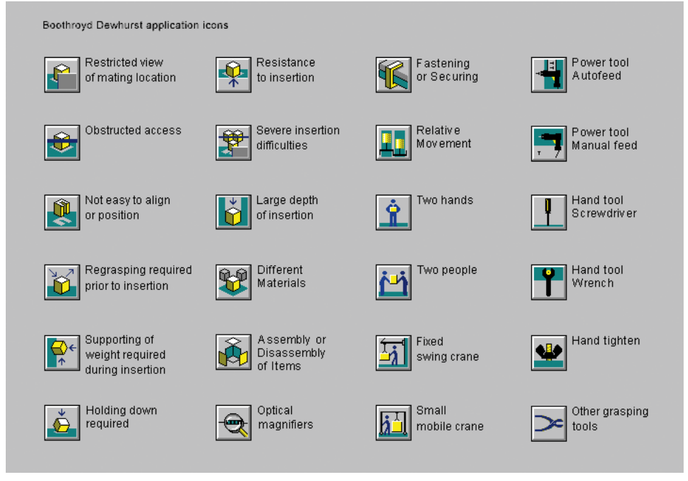
One of the forces studied in astronomy is gravity; relatively weak compared with other forces in nature. But a celestial body's gravitational pull affects other bodies in space. A universe's gravity will rip a lesser universe apart. Look out. Andromeda, (one trillion stars) is on a course to collide with the Milky Way only 8 billion years from now. (Reese, Long Now Foundation).

Evolution can be understood as a kind of motion, organisms moving from one state to another over time. This way of thinking about motion goes beyond the simple definition of motion as a displacement of an object within a coordinate system.

"This that you call Ursus maritimus, this polar bear. This is a being who came from somewhere and is going somewhere. It's not locked in time. And that–the great resistance to Darwin is, I think, he told us that it's all moving. And it's headed in no particular place. And then particle physics comes along. And quantum mechanics come along. And these physicists tell us the same thing." (Lopez, Moyers, The Journal).

In the movie, "Rivers and Tides," a documentary on the sculpture of Andy Goldsworthy, he describes his approach as "working with the sense of natural change across time." He chooses natural materials that degrade with time. Even when using stone, he puts his sculptures into contexts of change. He builds in tidal zones on beaches where the rising ocean will interact with the objects he has created. To him, stone is fluid. He always looks for a sense of visible movement to bring out the energy within. At one point in the movie while working on an egg-shaped sculpture at the side of the road, a quiet rain came up. He lay down in the middle of the road for a few minutes and allowed the rain to fall on him. When he stood up he revealed the beautiful temporal image of the shape of his body on dry pavement as the rain immediately began to obliterate it.

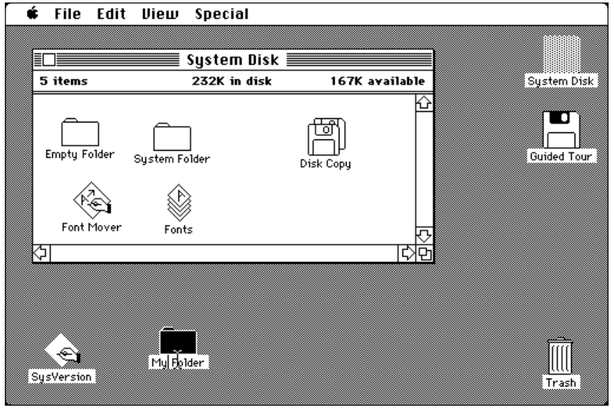




Why do I want to understand motion?

Applying motion in an interface complicates an already complex process. Being able to understand the basic components of motion should make it easier to use in a design. When I think of motion, I imagine motions in space but in interface design, the motion would be on a screen; a changeable 2-dimensional space within a frame.

When I imagine motion I think in terms of my experiences of motions. The movements I make as I follow through my daily life, the motions of other people, entities and things in my environment, the natural motions of life and the world going through their daily rhythms. Sometimes the motions of my life are big, like when I fly in an airplane; and sometimes they are subtle or small, like when I sit still and a light breeze stirs my hair. But a huge part of my experience of motion comes from film. I have flown through the universe with the Star Ship Enterprise, leapt between the buildings of New York with Spiderman, driven the hills of San Francisco with Steve McQueen, chased trains on horseback, floated in hot air balloons, hunted with sharks, all thanks to the magic of film. Everything from high-production, Hollywood blockbusters to gloriously produced documentaries to amateur bits on YouTube, the way I think about motion is influenced by the frame of the camera: the cut, lighting; the rhythm and pace of things moving on a screen.



Early Macintosh screen with windows, menu bar, icons and folders

What makes interface fascinating?

I wish I knew what about designing interfaces fascinates me so much. Early in my experience designing interfaces I would attend hours-long meetings to discuss projects where the level of detail made my head spin. Later, during the design of those projects I was amazed at how important all those details were to the design decisions that were made.

It started for me with designing icons. The first icons I designed were small, 32 x 32 pixels or 18 x 18 pixels to be used in a business management product that was changing from a command-line, green-screen, text input system to a Graphical User Interface (GUI) running on the now defunct IBM operating system called OS2. In those days, limited color monitors were still the norm and interface elements had to conform to a 4-bit palette of 16 colors created with a limited number of RGB color values; 0, 128, and 255 in this case. Finally, the concepts that needed to be communicated at these small sizes with these uncooperative colors could be difficult to achieve with the highest resolutions and more precise technology. On that first icon project the client suggested the use of a conductor in front of an orchestra for one icon, at 32x32 pixels! As I worked on that project and others that followed, I learned how to get a lot out of those restrictions. I found that if I thought about what I needed to accomplish and kept my mind open, I could create tiny images that used the mind of the viewer to interpret ideas the resolution couldn't support.

The process of finding that moment when the project went from impossible to wonderful intrigued me. All the interface projects I've worked on had that feeling for me. Like finding the hidden trap door by pressing just the right way on just the right place on the wall to reveal the secret room.

What about this combination of motion and interface attracts my interest?

Interaction with an interface creates a life-like entity and things that are alive tend to move. In my experience, motions were added to interfaces to mask processor delays, using the motion as a distraction to cover what the programmers considered poor performance. In the finished products, those motions became the personality of the interfaces, the things that made them compelling. In some of our favorite digital products those motion sequences create their defining personalities. At DMI final reviews in the spring of 2010, Toby Bottorf, Principal in the Service Design group at Continuum became animated when talking about the personality of his iPhone. He wondered if his frequent stroking of the screen was affecting him psychologically: "I don't pet my dog this much!"

Interface mimics biological movement, whereas performance IS biological movement…

In the process of investigating motion for this thesis, I have looked at things moving from many points of view: motions already used in interfaces, video of motions from life, motion created using code and a visual interface to the flow of time. Some similarities of motion in interface and motion in film seem obvious to me because of the two dimensional space and the frame of the screen. I have thought much about a choreographic approach for using motions in interface but haven't defined a methodology yet. Rather than a narrative the motions would be non-linear segments; the sequence the motions take would be predicted by a set of rules rather than a structured linear story.

Creating a symbolic motion that has a meaning to a user is the ultimate goal. Groups of motions that share qualities would unify and separate, or "brand," one product from another even if they were used in an undefined area like an interactive wall rather than a traditional screen.

How is this approach different from traditional interface design? More traditional motion graphics? Film/video?

One of the projects I was thinking about when I started this line of research is an interface for a medical device I worked on. The project was initially described to me as having more than 400 screens. Before even starting the project I studied a giant flow document (it looked like it was made in Viseo) that showed all those screens and their interactions with each other. Every screen was conceived just like that, a paper form with some data input or readout areas. That data might change but usually by progressing to another screen, which was another paper form where data was input or displayed and so on. Sometimes little icons or small text elements changed on the screen but the screens themselves were more or less static.

That project follows the pattern of design using a traditional Information Architecture model. It imagines bits of information as discrete "pages" where a user can interact. Ted Nelson points out that much of the software we use today was designed to replicate paradigms from the real world, negating the opportunities that digital media present to improve the ways we communicate rather than replicating the old without regard for the new opportunities digitized media makes possible.

Observations of current trends tell me that interfaces DO move; and in the future will move more. I think those motions should be functional rather than gratuitous, add information value not act as entertainment.

time

"in practical life, time is a form of wealth with which we are stingy. in literature, time is a form of wealth to be spent at leisure and with detachment."
(Calvino, Quickness, 46).

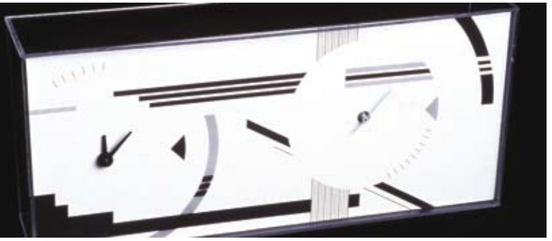
When is now?

20th century physics has broken the unidirectional nature of time. In the June 2010 edition of Scientific American an article called "Is Time an Illusion?" presented views of physicists who wonder if time really even exists. The problem comes from a discord between the largest and smallest of scales. Astronomers use mathematical modeling from the *Theory of Relativity* to solve problems dealing with mass, gravity and speed at galactic scales; proving that time can be affected by speed, mass and point of view. Chemists studying atomic phenomena use quantum theory to model behavior of the smallest elements; math that describes motion at minute scales in their attempts to understand matter. When astronomers and chemists extrapolate their theories in or out to meet the others' subatomic or super-galactic equations, the math doesn't entirely agree. In searching to unify this discordant math in a way that "handles both the gravitational and quantum aspects of matter," (Scientific American, 62), some physicists were surprised to find that time disappeared in their results. This phenomenon is causing them to question the very existence of time. (Rees, longnow.org).

The illusory nature of time is not foreign to me, though for other reasons. In my first typography class at RISD Franz Werner proposed a class project to design a clock face that expressed our personal relationship to time.

I hate being late but I can't tell time. I mean, I can read a clock, but the resulting information usually lacks meaning for me. On top of that, I am so absent-minded that I'm practically non-functional in the world. It extracts a toll on my perception of time. As I considered solving that class project, I decided that sometimes I feel confident in discerning passing seconds, much less in noticing the passing of minutes. Beyond that, time to me, seems like the illusion that the physicists discovered. I lose track of time after the smallest of increments. Sometimes I can discern times of the day, probably because I've learned there is an event associated with that time. For me, being on time for any appointment is predominantly an iterative learning process.

I designed my clock to have two faces, one for the seconds that I can perceive, the other for the minutes and hours that elude me. I put marks in an arc in certain places to correspond with some seconds on the second side of the face. The minutes and hours that pass me in their imperceptible manner, I obscured. For those I used black bars and lines confusingly aligned to correspond with the numeric increments but far away from the moving minute and hour hands. On the day when Franz announced that we needed to build the clocks we had designed I despaired. Why didn't I anticipate that request and make something simpler to construct? Breaking time into multiple displays so appropriate to my sense of it became a different kind of problem. With trepidation I took apart two electric clocks and wired them together and "Voila!" my clock worked. I glued a print of my design to the face of a Plexiglas sheet, drilled a hole each for the second and minute/hour works and built a Plexiglas box to hold it. My clock worked in my home studio for the rest of the years I was in school. Fortunately for me, I did not live alone. I could never tell time with it. When I looked at it, I was in perfect tune with my own confusion. My house mate, Karen, loved my clock and easily read the correct time for me every time I asked. Today the clock is lost. Though I am seldom late now, my perception of time continues to pose challenges.



Context: History: Time orders events.

They say you should never define a word using itself. A history of time? Time is required to have a history. Time orders events. "The narrative nature of the universe does not unfold in space. It unfolds in time." (Scientific American, 62).

Time started with the big bang, born at the creation of the universe like a cosmic Siamese twin with space, different but inseparable. Einstein's *Theory of Relativity* created a coordinate system for the idea he called the *Space-Time Continuum.* "The only reason for time is so that everything doesn't happen at once." (Albert Einstein). In space motion is not restricted in any direction on the x, y, or z axes. Time is unidirectional, restricted to going relentlessly forward and never backward, at least not as we experience it. A point described in this system tells "where and when;" can pinpoint with accuracy any place at any particular time from the moment of the big bang till the end of the universe. Using the coordinates of three dimensions in space and one of time, any event in the universe can be located and separated from any other event. I find it difficult to imagine time as having a beginning or an ending, let alone it being slaved to the relatively forgiving dimension of space.

Euclidian geometry defines time as a constant. It follows a very particular mechanical pace. This is time as we experience it. For my investigation, I take the stand that those Relativistic cracks in the single directionality of time only appear at the extremes of speed or mass; something human beings may never be able to experience, or understand if we do. My experiments assume that "all observers in principle agree on the sequence in which events happen." (Scientific American, 60).

Time is also required for motion. Perhaps that is why it feels so fleeting, difficult to capture. It lives in the restricted, unidirectional temporal flow that we experience in only the most fleeting of ways. When we design on a time line we create motion.

What Is Motion?

Webster's New Collegiate Dictionary defines motion as "an act, process or instance of changing place." If we search for definitions of motion from throughout history we find approaches to investigating it from different fields.

how do people from different media define motion?

what is motion?

definition

"Aristotle's definition of motion preserves a generality we can reconstruct only with great effort: Motus est actus entis in potentia secundum quad in potentia est *(motion is the actuality of that which is potentiality, viewed from the standpoint of potential being). Here motion denotes any transition from potentiality to actuality, whether this change be generation or corruption of a substantial form, whether it be alteration of quality or quantity, or whether it refers to occupation of a different place (local motion in the narrow sense)." (Holton, Kepes, 24).*

I understand this statement this way: I am here in the center of the room. Yonder is a wall. To approach the wall is a potentiality for me; I can go there. Motion is the actuality of me approaching the wall. Between me and my reaching the wall, motion happens.

Some of the other conditions in Aristotle's definition challenge our understanding. For example, generation or corruption of a form might be defined like the story of the polar bear above. This is not motion as we know it from our daily experience. The idea that motion can be described using evolution opens new ways of thinking about it. Alteration of quality or quantity does not fit into my usual idea of motion at all but I'm still mulling that. Possibly the idea could be shown through the example of a change of color or opacity over time.

Aristotle's *Physics* defines motion based on the object in motion. The object can be natural or artificial. Natural objects move according to what they are: growing, acquiring qualities, displacing themselves, being born and dying. Artificial things move according to their component parts, what they are "made of." He defines three preconditions for motion: place, void and time. Place defines an immobile container or vessel, possibly a conceptual one. His use of the term void refers to a defined boundary or surface where motion could take place, (not our contemporary definition of void as a vacuum). He considered time an attribute of motion rather than a thing that exists. Our contemporary understanding of time being the fourth dimension (of the space-time coordinate system of Albert Einstein's *Theory of Relativity*) makes this way of thinking of time feel very foreign to me. In my world, time is a separate thing, a container for motion not a property of it.

Science has its own ways of understanding motion. Sir Isaac Newton is described as having been knocked on the head with a falling apple. An apple thrown in the air follows a parabolic curve as it rises and falls back to earth. The parabola of the apple describes the apple moving in its ascent and subsequent descent. Newton's laws of motion are an attempt to define motion for the purpose of the study of physics: A body at rest tends to stay at rest until an external force propels it. A body that experiences an external force will accelerate proportionally to that force. A body responds to an applied force in equal and opposite proportion.

In his laws, Newton is trying to create an understanding of motion that will allow him to describe more complex phenomena. The laws are based on observation and analysis that unlocked mathematically provable ideas about motion.

As humans we use our huge brains to understand our environments. Those big brains like to think they understand everything but they are limited by their own physiology. When it comes to motion, understanding can be influenced by many factors: point of view, frame, speed of the motion, relative objects in the environment.

Science tries to take an objective point of view without personal bias but when we observe motions our perceptions often prove to be different from an objective description of the phenomenon.

In "Art and Visual Perception," Rudolph Arnheim distinguished "things" and "happenings." For me it helps to think of them as nouns or verbs, as in interface design. A file is an object, a thing. Print is a command, an action. He defines motion as "an activity performed on a persistent thing." (Arnheim, 372).

We experience some events as happening in space and others as happening in time. Arnheim links the concept of space with simultaneity; looking at a painting as happening in space, not time, because you take it in all at once. "Order, sequence in this case are irrelevant. Each viewer sees the painting in their own unique order." (Arnheim, 374).

Paul Klee in his book, "The Thinking Eye" mirrors this sentiment: "distance is time, whereas a surface is apprehended more in the moment."

Events that move along a path seem to happen in time. In temporal works, the sequence is "essential" to the understanding of the work. If the parts are taken out of sequence, the work is destroyed. Arnheim sees an event that takes place as a "sequence of phases." Phases might present a theme or take their turn in altering or varying it. Or the theme might build throughout the work, only to appear at the "climax," emerging out of the slow build up. Two very different experiences come from the two approaches.

> *"...What distinguishes the perceptions of happenings from that of objects is not that the former involves the experience of passing time but that during a happening we witness an organized sequence in which phases follow one another in a meaningful, one-dimensional order." (Arnheim, 375)*

Arnheim presents three definitions for movement:

Physical movement: to see something moving because it is actually moving.

Optical movement: the way an image projected on the retina moves when the eye focuses on different areas.

Perceptual movement: the experience of focusing attention on an object; like watching a passing jogger; even possibly keeping the jogger in the center of the visual field by moving the head, yet perceiving that the jogger is moving.

He also refers to kinesthetic factors that cause a sensation of motion where the visual experience is overridden by input to the bodies' other receptors; like the sensation of vertigo or when feeling your bus is moving backward when an adjacent bus moves forward. (Arnheim, 379).

A dancer would define movement from the point of view of the movement possible by a human body for the purposes of expressive communication.

> *"According to (Deborah) Hay, 'Everyday the whole day from the minute you get up is potentially a dance.'... her choreography is informed by her willingness to see the world as motion, to see that movement is everywhere–in the tree branches shifting, the cars rolling by, people pausing at a street corner, a newspaper blowing down the sidewalk, a bird landing on the telephone wire.... Dancing is the activity of being present in and consciously aware of one's own movement as a part of this flux." (Foster, 6-7).*

In "Reading Dancing: Bodies and Subjects in Contemporary American Dance," Susan Leigh Foster identified five conventional kinds of movement in dance, five types of movements that might also be applied when thinking about using motions in interfaces:

> *"1. The frame–the way the dance sets itself apart as a unique event;*
> *2. The mode of representation–the way the dance refers to the world;*
> *3. The style–the way the dance achieves an individual identity in the world and in its genre;*
> *4. The vocabulary–the basic units or 'moves' from which the dance is made; and*
> *5. The syntax–the rules governing the selection and combination of moves." (Foster, 59).*

Early 20th Century designers investigated materials as they searched for the natural order of things. Many designers, like Moholy Nagy below, attempted to define motion for themselves:

> *"Vision in motion*
> *Is seeing while moving.*
> *Is seeing moving objects in reality or in forms of representation as in cubism or futurism. In the later case the spectator, stimulated by the specific means of rendering, recreates mentally and emotionally the original motion.*
> *Is simultaneous grasp. Simultaneous grasp is creative performance – seeing, feeling and thinking in relationship and not as a series of isolated phenomena. It instantaneously integrates and transmutes single elements into a coherent whole. This is valid for physical vision as well as for the abstract.*
> *Is a synonym for simultaneity and space-time; a means to comprehend a new dimension." (Moholy Nagy, 133).*

Sam Montigue evaluated "motion and its representation" and concluded that: "The Visual Representation of Motion is the Displacement of Objects through Space and Time." He was interested in both static and dynamic forms of representation of motion. In his definition of *motion, objects, space and time* each experiences some form of displacement. Objects can be hyper realistic, realistic, simplified, abstract or coded. They experience displacement that is positional, transformational or object-related. Space he defined as 2D flat space or 2 ½D, space with implied depth. Time might be represented as real, expanded or compressed by technology. (Montague, 38).

These definitions of motion contain much similarity but still they vary. Motion is a natural state. It needs frame, space, time; what we perceive and what actually happens are not always the same. For this document I would use the definitions this way:

Motion = properties changing over time;
Behavior = motion with meaning or motion used with intent.

"we can perceive rhythm with three senses at once. first we hear it, secondly see it, thirdly feel it in our muscles. this is what gives it such power over our organism."
(Klee, 262).

klee studied motion, and its relationship to form
klee dynamics
statics and dynamics

Paul Klee

When starting to think about motion, a common first step appears to be finding the extremes where motion can be identified. Designers of the early 20th Century took a strong interest in motion.

Paul Klee dedicated his life to investigating motion. *The Thinking Eye* documents his exploration of motion in design taken from his personal notes after his death. In the book, the text and lavish illustrations in the forms of diagrams and actual black-and-white and color artwork shows a fertile mind exploring the visual idea of motion. The fact that his medium was static did not even slow him down. He seems to have understood that at a deep level, the mind does not differentiate between stationary and moving representations.

Klee was fascinated by dynamic processes as ways to think about form; statics and dynamics emphasized as the core of his artistic method. His concept of dynamic processes is motion. There is motion in space, the motion of growth, motion at microscopic and galactic extremes. His concept of dynamic and static forces at first surprised then delighted me. He defines dynamic as "accentuated mobility or free spiritual mobility" and static as "steady," meaning attached to the vertical. In another chapter he defined dynamics as *energy*, "the controlled harmony of free movement," and static as "checked or fettered mobility." He explained it like this: "Dynamics is the great, the principal area, the endless area of the cosmos. Statics, by comparison, is an exception, where gravitation kills motion by subjugating it to an alien law," gravitational force. (Klee, 183). Since first introduced to this idea I have encountered many thinkers about motion referring to stillness as arrested mobility.

To the concepts of dynamics and statics, Klee added the idea of countermovement. For every motion he anticipates "a countermovement, without which there could be no balance." He makes reference to "statics as a theory of balance; dynamics as a theory of forces in a state of motion and kinematics as a theory of motion." (Klee, 393).

He also looked for the forces responsible for motion: "The principle force of nature is attraction, we will call it gravitation." (Klee, 413). When motion is caused by a force, one will find cause and effect relationships. "Movement and corresponding countermovement lead to balance." (Klee, 386).

In one moment he wrapped up his entire theory as follows: *"The development of movement, that is, the composite (simultaneous) operation of organic parts in an independent whole, characterized by calm movement and mobile calm; a statically dynamic or dynamically static whole, which can be achieved only when movements are joined by counter movements or when we find a solution whose movement has no end." (Klee, 427).*

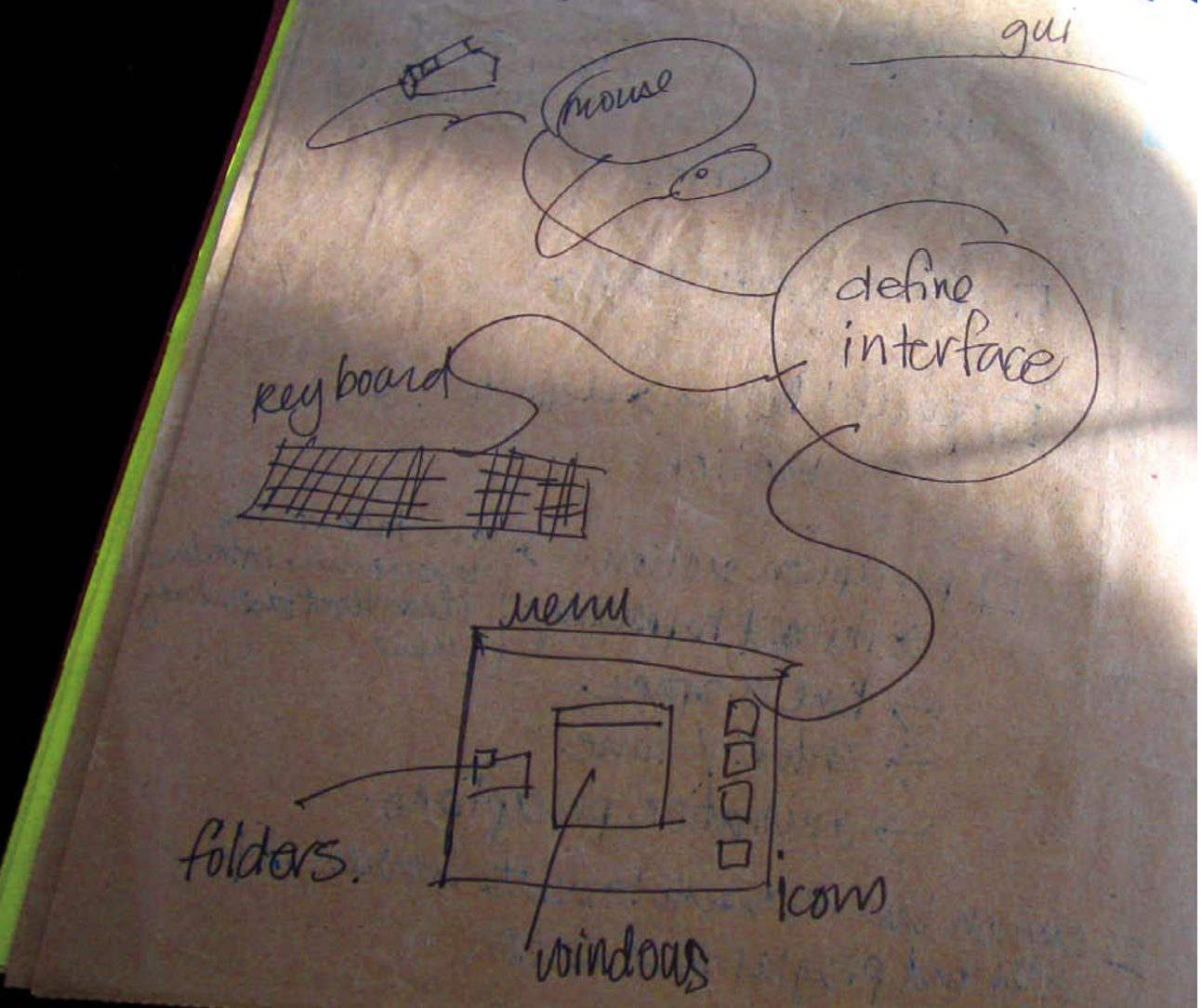
In his memo on *Lightness* as a poetic concept in literature, Italo Calvino talks about the way words can call a certain lightness to mind. He puts forth some symbols that always speak of lightness: the moon, flying, the winds and clouds; an approach to life that moves away from heaviness. He sees software's lightness encased in the heaviness of hardware, where he finds "'bits in a flow of information traveling along circuits in the form of electronic impulses." (Calvino, 8). I read this essay in order to take a break while reading Klee's *The Thinking Eye*. When I returned to Klee's book, where I had left him analyzing motion, the experience of thinking about lightness as an attitude in literature and poetry changed the way I read what Klee had written. This concept from my reading on lightness and the poetic ideas it draws up transformed Klee's words for me. They now echo back to a poetic as well as the more analytical tone I perceived earlier:

"The eye like a grazing animal feels its way over the surface, not only from top to bottom but also from left to right and in any direction for which the occasion presents itself. The eye moves, grazing from values that attract it, towards values that draw it on after the first values have been grazed bare." (Klee, 188).

In every area of motion that I have investigated the same themes keep repeating. Motion in science, motion at extremes of size, motion across long stretches of time, the comfortable middle ground of motion. Too fast or too slow and motion ceases to be registered as such.

When watching my motions studies I am frequently taken by the poetic attitude of the gesture fragments. It is unlikely that adding a poetic attitude to interface will ever become a standard industry goal but when poetry invades an interface, it changes the experience of using it in fundamental ways.

While reading Klee's book, I wrote that I felt I was reading the best novel ever. Klee keeps articulating and articulating and articulating his ideas about motion. He breaks down motion into component ideas that address different kinds of contrasts or relationships, each time from a new perspective or drawing out a different conclusion. He always begins with the most elemental features and elaborates from there to more complex areas of the topic. This thesis seeks to do justice to Klee's study in determining the basic elements of motion in interface.



the space between
computation and user
interface
definition

"before computers, the idea of interface described the mechanical parts a human used to control a machine. 'an interface is the contact surface of a thing'."
(Laurel, The art of…, xi).

What is interface?

The ubiquitous adoption of computers into the daily life of the planet changed our definition of interface. Fluid metaphors have already been mentioned as influencing the way we think about things. As computers became more and more common, the term interface came to mean the tools to interact with a computer. At the same time that computers were becoming prominent in daily life, the use of heavy machinery by the average person began to decline. Over time the use of the word "interface" came to mean the Graphical User Interface and when discussing design considerations, machines with control devices were called human-machine interfaces.

It seems like everyone has a definition of interface and they seem to be based on individual experiences of working with them. The difficulty in making a clear definition, I believe, stems from the fact that the interactions we have with computers are more like the interactions we have with beings than those with machines.

> *"The way you accomplish tasks with a product–what you do and how it responds–that's the interface." (Humane Interface, 2).*
>
> *"Interface: Human Computer Interface. Technology and logical framework for input and output of work" (Digital Design Media, 474).*

Finally, I decided to consult the source that has had the greatest influence on the adoption of computer user interfaces: Apple.

> *"A graphical user interface (GUI) (sometimes pronounced gooey) is a type of user interface item that allows people to interact with programs in more ways than typing…with images rather than text commands. A GUI offers graphical icons, and visual indicators, as opposed to text-based interfaces, typed command labels or text navigation to fully represent the information and actions available to a user." (Apple Interface Guidelines).*

Apple also sees the power of using motion as part of the interface, actually has been revolutionizing the idea with every product release:

> *"Often, you can use animation to make clear the relationships between objects and the consequences of actions. Mac OS X uses animation to subtly but clearly communicate with the user in many different ways.... To communicate the relationship between a sheet and a window, the sheet unfurls from the window's title bar.... You should consider using subtle animation effects such as these to enhance feedback in your user interface." (Apple Human Interface Guidelines,)*

Because computers behave like entities more than things, interacting with them becomes experiential. This forwards the idea that interacting with more traditional products and services should be conceived as experiences.

"When the concept of the interface first began to emerge, it was commonly understood as the hardware and software through which a human and a computer could communicate. As it has evolved, the concept has come to include the cognitive and emotional aspects of the user's experience as well." (Laurel, The art of..., xi).

In creating interfaces, patterns could become vehicles for making the complex clear. Eventually, the idea of pattern matching links the creation of patterns in motion compositions as a way of indicating dynamically visualized data flowing between human and source.

> *"A visual interface is based on visual patterns... Notice that I did not say pictures or images or icons. Representational images are useful, but patterns are the engine of unconscious recognition. ... The pecking order of visual understanding always regards visual pattern matching as superior to verbal or pictographic reading." (Cooper, 44).*

The idea of using patterns already influences the design of more static interfaces. If Alan Cooper is correct in his assertion that visual patterns help with recognition, the possibility of using motion to effectively communicate in an interface has a strong indication. When I imagine that large amounts of information might be represented using motion, learning to read those motions could pose new challenges.

In my search to define interface, I found one quote that fits with my approach, though I lost the source. It said that interface lives "between medium and message," that design "relies on sign, symbol, metaphor and codes" to communicate. If you imagine the computer not as a tool but as a medium, and the interaction as the flow of messages between a user and the system, the interface becomes the intermediary.

history of interface
where did interface originate?
a brief history

"many familiar components of modern user interface design appeared in the fifties and early sixties, including pointing devices, windows, menus, icons, gesture recognition, hypermedia, . . . and more."
(Human Computer Interface Design, Kay, 191).

History of interface

Early computes were used for air traffic control and defense. Later, commercial desktop systems, Mac and PC, moved to GUI interfaces. Limitations of processor speed and hard disk space forced screen displays to be efficiently stationary. Even those early interfaces used moving icons to tell their users a process was under way. One good early example of interface motion is the progress bar. In recent years, thanks to more powerful processors and large hard drives, capacity limitations have largely been eliminated. Since I began my research in 2008 Apple has done more to include motion as part of the interaction plan in their products than any other entity. With updates to OSX, the release of the iPhone and iPad, Apple expanded motion communication with the user.

> *"Modern personal computers have all moved away from command-line interfaces and created graphical user interfaces... In a GUI, there are menus or pictoral displays showing all the programs that you can run and files that you can access. A pointing device (usually a mouse) is used to select items from the menus or displays. Individual programs open a window within the monitor to display their output, and can display either text or color graphics as needed. The keyboard is primarily used to enter text or data, although there are often keyboard equivalents to the various menu options." (Using Unix, Stanford University, School of Earth Sciences).*

Alan Kay is considered the father of the "personal computer" because he described one in his 1969 doctoral thesis. He says he was looking forward to the day everyone could have a notebook computer on their desk. When he said "personal" he was thinking of intimate rather than describing one for personal use, but history has spoken. (Laurel, *Computers as Theatre*, 192).

From the earliest experiments with screen display of data, computer interfaces moved. The open source community has created numerous scripting libraries that use communication between the server and the browser to easily build motion into web sites. Even the latest Cascading Style Sheet (CSS3) coding permits simple animation on web sites.

The elements we use to interact with digital information today are the mouse, keyboard, menu, windows, icons and folders. They can be separated into control devices and graphical display.

Control devices:

Douglas Engelbart invented the mouse while working at the Augmentation Research Center at Stanford Research Institute in Menlo Park, CA. On December 9, 1968 he and his group made the famous, 90-minute presentation of the NLS (oN-Line System) they had invented at the Fall Joint Computer Conference held at the Convention Center in San Francisco. "This was the public debut of the computer mouse. But the mouse was only one of many innovations demonstrated that day: hypertext, object addressing and dynamic file linking, as well as shared-

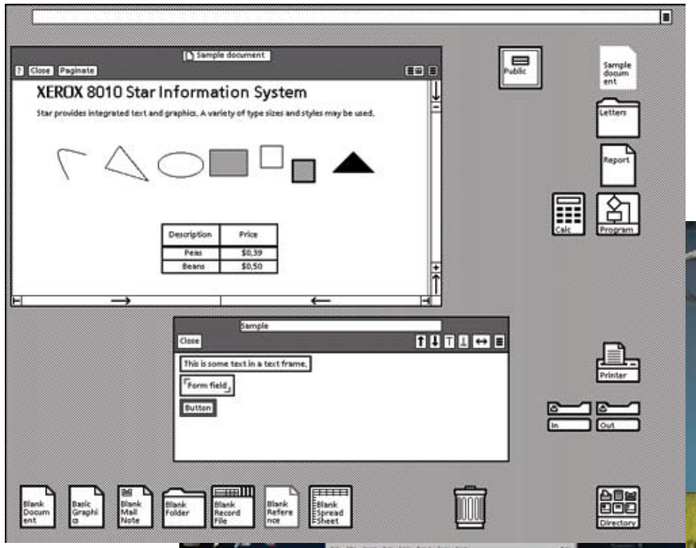
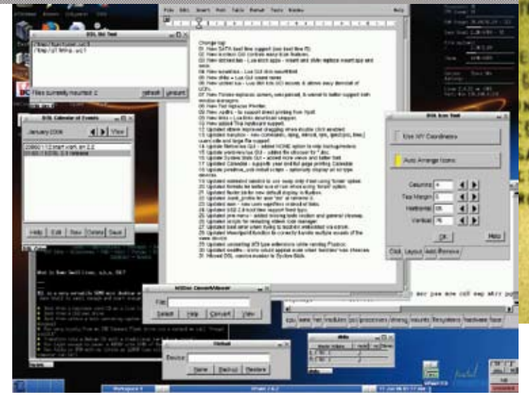


Image: ViewPoint, 1981. from http://arstechnica.com/civis/viewtopic.php?f=14&t=39073&start=120



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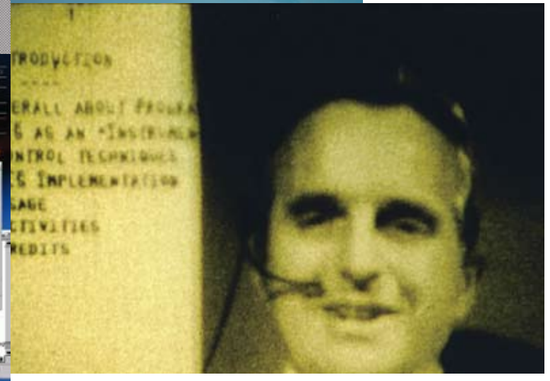


http://www.britannica.com/EBchecked/topic-art/627912/50965/Computer-interface-pioneer-Douglas-Engelbart-Engelbart-holding-a-video-conference

Clockwise from the left: A screen from the Xerox PARC Alto, the first computer to use icons in a graphical user interface to interact with data. The first mouse and first video conference of the NLS in the 1968 presentation by Douglas Engelbart and a desktop screen from Ubuntu.

screen collaboration involving two persons at different sites communicating over a network with audio and video interface." (http://sloan.stanford.edu/mousesite/1968Demo.html). Engelbart apologized for the name saying they had called it a mouse for no particular reason and they never changed it. The original one had two wheels that rolled at perpendicular angles. One rolled while the other slid to measure the "horizontal and vertical components for where to put the tracking spot." The operator watched the cursor on the screen to manipulate data.

Douglas Engelbart also invented a chording keyboard with five keys that could produce characters depending on which keys were pressed. There were 31 potential combinations, creating the possibility for simultaneous use of the mouse with one hand while typing in the other. The difficulty of learning the chords proved more than a world already touch-typing on traditional keyboards could bear and it was lost. Unfortunately, the Qwerty keyboard layout was optimized for mechanical typewriters. Originally those keys were positioned strategically to slow talented typists to avoid crossing the mechanical striking arms. Today, with no mechanical impediments, we continue to use the awkward keyboard layout to avoid the difficult task of learning a new one.

GUI: windows, menus, icons, folders

The GUI translated the command line interface into a screen of metaphoric elements to allow users to interact with information stored on the computer. The suite of visual cues, windows, menus, icons and folders revolutionized the way we work with computers. This change to using images as intermediaries permitted high-level interaction with files on a system without requiring high-level programming skills.

In 1973 Xerox PARC developed the Alto, the first personal workstation including a developed Graphical User Interface with windows, menus, icons and a hierarchical file system that showed storage areas as folders. Steve Jobs make his famous visit to Xerox PARC in 1979 where he saw the Smalltalk-80 programming environment that incorporated networking and a mouse-drivern graphical user interface in use on the Alto. The GUI interface impressed him so much that he incorporated it into the Apple Lisa and the Macintosh.

"I was so blinded by the first thing they showed me which was the Graphical User Interface. I thought it was the best thing I'd ever seen in my life. Now remember it was very flawed, what we saw was incomplete, they'd done a bunch of things wrong. But we didn't know that at the time but still though they had the germ of the idea was there and they'd done it very well and within you know ten minutes it was obvious to me that all computers would work like this some day." (Jobs, Cringely).

Graphical interfaces use windows, menus and icons to communicate instantly. Alan Kay imagined papers piled on a desk into overlapping windows on screen. He liked the idea that several open windows make visual sense if they overlap the way papers laid out on a desk overlap. It allows more open windows

when implemented that way. Since screen resolution is low and space is at a premium, allowing stacking of information creates room for more.

Bill Atkinson designed the pull-down menu while working at Apple on the Lisa team. The original menu buttons were at the bottom of a screen, slaved to a series of unlabeled buttons on the keyboard. Pressing a key would pop up a menu but you had to look at the key and then the screen to see what mode the button was in when pressed. They tried putting the buttons at the top of the window but had problems when the screen was very narrow because the buttons would wrap and take up more vertical space. Bill went home one night and came back with the entire design. He had placed all the buttons along the top of the monitor screen. "…Each menu would pop down, and they would ruffle as you went back and forth, and appear so that you could scan them all…" (Moggridge, 95-96).

Icons allow manipulation of digital information using images. David Canfield Smith created an office metaphor for his 1975 PhD thesis: "An icon is a graphic entity that has meaning both as a visual image and as a machine object. Icons control the execution of computer programs because they have code and data associated with them as well as their images on the screen." (Moggridge, 21). Icons are small images that clue their functions. Some indicate things you can use: pen, pencil, document, program, some indicate actions to take, print, quit, save; or to put it more succinctly, some icons show nouns and some show verbs; things and happenings. They allow access to data stored on a computer or ways to interact with software.

A folder is an icon with a particular kind of behavior. Folders are containers for files, applications or other folders. They create a metaphorical display for hierarchical file systems that people find easy to understand without excessive explanation. The folder is one of the important elements of the desktop metaphor used to introduce many people into computing environments.

The desktop metaphor allowed people to understand and interact with their computer without learning programming skills, fueling the exponential growth in sales of desktop computers. The original designers Tim Mott and Larry Tesler were not creating a desktop. Their idea was to give users single icons to manipulate to perform tasks: print, file, etc. They asked themselves what would someone do if they were working in a real office. They wanted to make the interaction very simple to understand. The original sketch showed a desk, file cabinet, printer and a waste basket. Those were later interpreted into the concept of the desktop. That metaphor remains essentially the same today as it was in 1974.

The metaphor also limits understanding. The problem rests with incompatibilities when "combining information access and information display." (Kaptelinin and Czerwinski, 6). For example, Alan Kay hates file system folders that act like their real-world

Ted Nelson explaining that imitating paper in a user interface fails to take advantage of the opportunities inherent in electronic documents.

counterparts. He wonders "Instead of passive containers, why not have active retrievers that are constantly trying to capture icon instances that are relevant to them?" (Kay, Laurel, 200). I wonder, when he says "active retrievers" is he imagining them actually moving around the system?

Ted Nelson continues to lament the limitations placed on computer information because of the replication of analog objects in interface conceptual models:

"Now, most people think they know what electronic documents are because they've seen them. They've seen Microsoft Word, they've seen Adobe Acrobat. But what are computer documents like? They imitate paper. Well, when I was learning to write in my teens, it seemed to me that paper was a prison, four walls, right (he gestures a box with his hands). And it seemed to me the ideas were always trying to escape. What is a parenthesis but an idea that is trying to escape. What is a footnote but an idea that jumped off the cliff? Because paper enforces single sequence and there's no room for digression it imposes a particular kind of order in the very nature of the structure. When I saw the computer I said 'at last we can escape from the prison of paper,' and that was what my whole hypertext idea was about in 1960 and since. Contrarily, what did the other people do? They imitated paper, which to me seems totally insane!" (Nelson, YouTube).

Orient
Mac OS X interface,
login user change.

Catalog of motion in interface

I have long believed that movement could be designed to carry the information in an interface. How is motion used in interfaces today? As a way of answering that question, I searched for examples of motion being used in interfaces. One of the biggest concerns with using motion in interfaces questions the distraction it creates. One obvious use of movement was in obnoxious ads to distract diligent web surfers. The fact that it has been used so crassly leaves no wonder that many people fear excesses of motion in a critical working space like an interface. Before starting my collection of movements used in interfaces, I could not name more than one or two instances. Once I started looking I found much more than I expected.

catalog of motion in interface
who uses motion and how
how is it used now?

I started the project to collect and analyze examples of motion used in interfaces in the Spring of 2008. Yes, only two-and-a-half years ago. Much has changed since then. I made a library of interface movement to start to think about the problem. I have tried to separate out movement that exists purely to entertain, but in some instances I kept those kinds of examples because I think they point to opportunities for informing that haven't been applied to the more demanding area of communicating in an interface. I think it's significant to note that some of the first examples of movement providing information I found came from very old operating system processes that were used in the earliest computer interfaces like progress bars and the animation that shows the de-fragmentation process on windows.

I captured clips from applications, web sites, operating systems, the new iPhone, and organized them on two axes: by the trigger for the motion and by the messages sent by the motion. I collected as many examples as I could find and organized them categorically by trigger and message type. Later, I picked representative examples from the collection and created a linear movie showing one example of each kind of trigger and one of each kind of message. The result was four triggers for motion in an interface: the computer, the user, data flow, and software context. As part of the analysis I consolidated five messages shown by motion: *show, tell, acquaint, warn and orient.*

Movement is characterized by four general initiators:
initiated by the user,
initiated by the computer,
initiated by software context,
initiated by data flow.

The first two are obvious. I imagined the third option should exist but had trouble finding examples. In my collection I included ideas in this area that I hope can lead to more fruitful possibilities.

The messages that motion imparts in this library begin to show the power and importance of motion when it's used to communicate in an interface:

show: inform someone about something visually,
tell: communicate, impart, express thoughts; give an account of;
acquaint: introduce, make familiar;
warn: give notice of danger;
orient: set context;

I thought I have been taking excellent notes during my time at DMI but there is little to find of the steps I took in this project. I reviewed my notebooks and my presentations from Spring semester 2008. All my references from the time talk about my confusion in researching the topic, the vastness of the landscape of motion, my difficulties with narrowing down identifiable projects, and my own lack of confidence in my ability to take on the complexities of the task. The approach of using motion as part of a user interface has roots deep in the history of GUI interfaces but shallow application due to the computer's rudimentary capabilities for most of its history. The conceptual needs have been well enough served by static interfaces. After creating my theoretical structure for using motion in an interface I found that years ago Baecker and Small had made a similar evaluation that resulted in an extremely usable framework for evaluating the motions in interface as well:

"Animation can cut through the complexities of an interface. Animation can: review what has been done, show what can be done, show what cannot be done, guide a user as to what to do, guide a user as to what not to do. In other words, animation can help us review the past, understand the present, and describe the future. It can answer the questions: 'How did I get here?', 'Where am I?', and 'Where am I going?'" (Baecker and Small, Laurel, Art of..., 257).

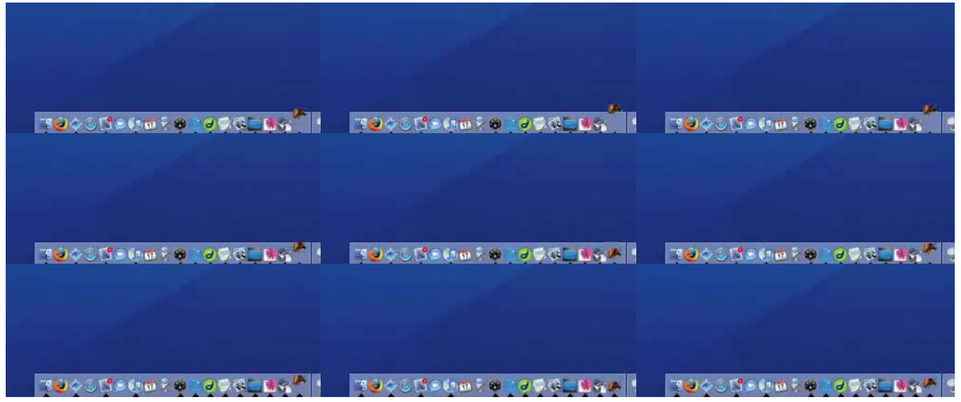
They use motion to answer a list of questions the interface might pose at any given moment.

"Identification: What is this?
Transition: From where have I come, to where have I gone?
Choice: What can I do now?
Explanation: How do I do this?
Feedback: What is happening?
History: What have I done?
Guidance: What should I do now?"
(Baecker and Small, Laurel, Art of..., *257-258).*

Tell
Apple iPhone,
reorder app icons.

Show
Mac OS X dock
Pop-up of folder
icons fan onto screen.

Warn
Mac OS X dock
Dog icon jumps up
and down to warn
that a process needs
attention



Apple seems to be doing much using movement as part of interfaces. This series of movements using the dock shows how movement can help communicate.

The sequences on these two pages show examples of interface motions that communicate. Below interface motions connect to the types of communication they display. These descriptions of types of communications are behaviors used as a way to make information understood without using words.

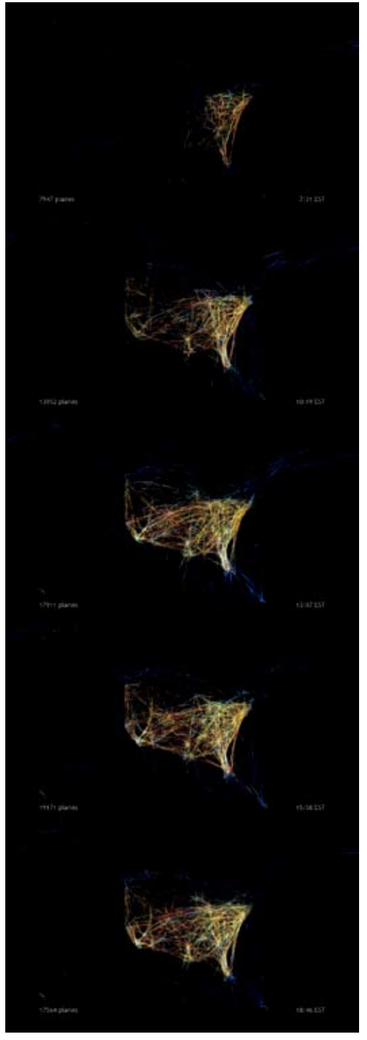
show:
- *dock magnification*
- *add to dock*
- *remove from dock*
- *show, hide dock*

warn:
- *icons bounce in the dock*

orient:
- *widget appearance animation*
- *mac os user change*

tell:
- *iPhone icon arrange*
- *Koblin flight paths*

the wristwatch, the hour glass, the progress bar



Show.
Aaron Koblin
Data visualization
tracing the paths of of
flights in the US.

performance

(or with the drama)

stage, silver screen, small screen

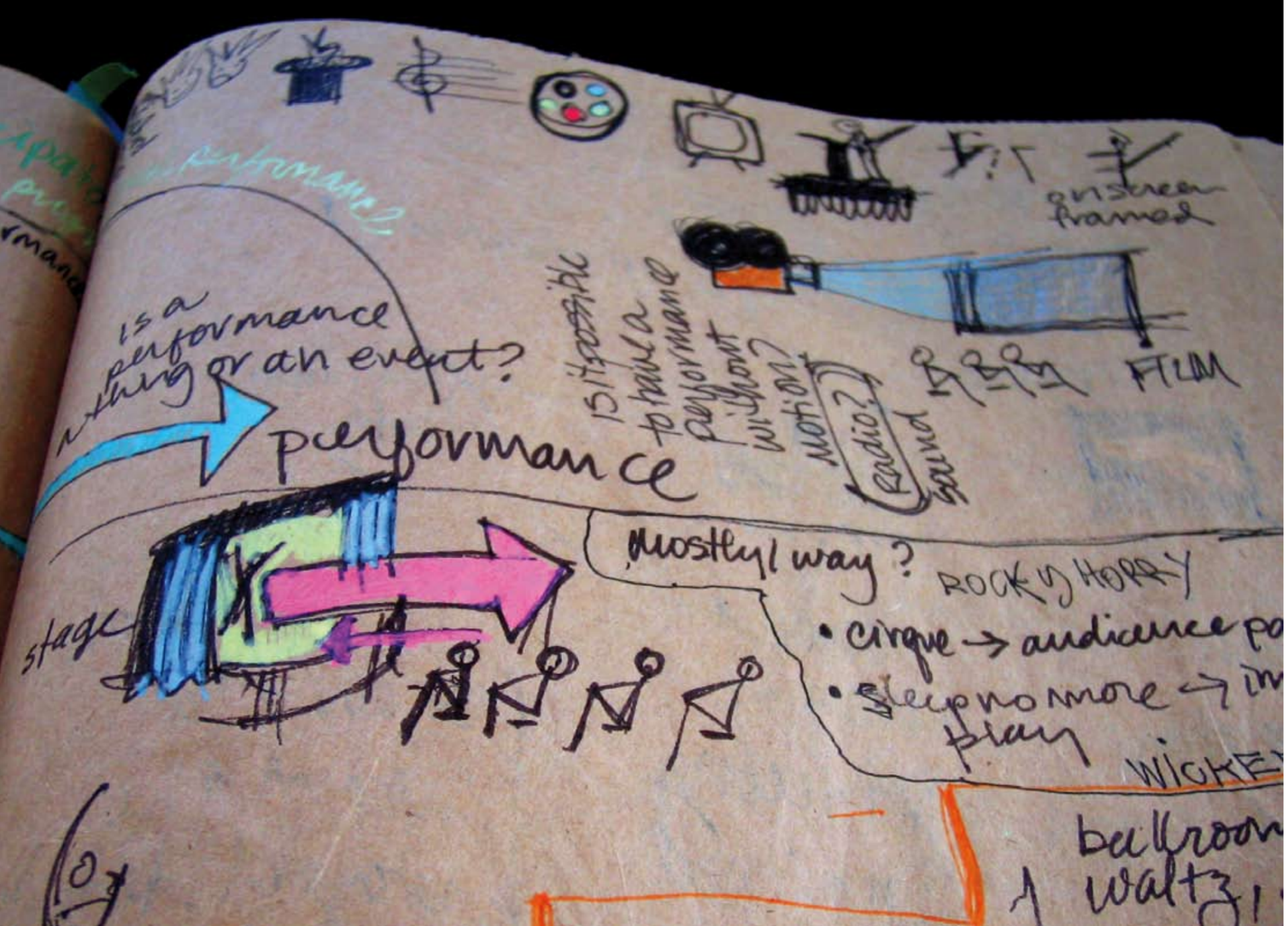
scripted and unscripted

What is a performance? A performance is a group of people acting out a narrative to tell a story for the enjoyment of others, except when it's a group of people playing music or executing a magic act. One way we know they are performances is because we call them that: theater, music, magic, dance. Or they use that word in the name: street performance or performance art. Some of them are derived from something we call a performance, like film or TV. Stage, silver screen, small screen; we know them all as performance spaces. Anything we view on a screen has an element of performance to us, we have been trained to regard it this way. Even news broadcasts contain elements of performance. An analysis of the number of repetitions of any scary news event will likely uncover interesting relationships to performance. (Ask yourself why they track ratings for the news.) Within the above groups there are performances with more or less engagement power for the audience.

There are some events that I would define as performances that fall outside the standard definition: parades, flash mobs, teaching. Children playing cowboys and indians or cops and robbers create imaginary performances for themselves that exist only in their own minds. Role playing games on the computer or off (World of Warcraft or Dungeons & Dragons) have costumes, characters, goals (plot?) and setting that contextualize the play.

There are two kinds of performances: *scripted* and *unscripted.* A scripted performance follows an ordered sequence practiced and rehearsed by the participants, usually occurring at specified dates and times. The sequence carries particular importance. If the piece is disassembled and reassembled in a different order the integrity is destroyed.

Unscripted performances follow rules. They can be enacted in various orders. "A dance composition is likely to happen logically in sequence from start to finish. A waltz in a ballroom is not." (Arnheim, 376). Think of the dancers in the show "Dancing with the Stars." The routine they dance in the competition is absolutely scripted. The steps follow in a strict order that has been studied and practiced. When they go out to a club after the show to celebrate not being voted off and dance together, they improvise. Ballroom dancers play through a catalog of motions in connection with each other as the feeling of the music moves them, without pre-defined order.



A dance, to have internal cohesiveness will contain various themes throughout. Style of motion, costume and scene set one dance apart from another. Recurring motions or themes repeat or evolve throughout the composition. Dancers sometimes dance their own motions and sometimes synchronize with other dancers. When designing motion into an interface, repetitions of similar or contrasting patterns can be used to create motions that disturb, distract or adapt to the environment. Theme and phase become higher-level components in a composition of movements. Arnheim believed that the earlier movements in a dance are as affected by later movements as the later movements are connected with the ones that came before. A dance performed for an audience requires the linear structure that unfolds over time to be understood, to make its statement. Motion in an interface will depend on pattern and rule to communicate.

Does the open interaction of dancers unfolding the dance as they go along create a performance? I would say that watching a well-trained couple improvise on the dance floor for their own enjoyment is a performance. Partner dancing is interactive, changeable. The dancers cycle through a series of rules for movements together. This kind of open structure built of lead and response follows the same style as a "conversation" between a computer and user.

Many types of performances may be scripted or unscripted depending on the context. Many performances of music are scripted but others include improvisation. All film by definition is scripted. TV can be scripted or televised live and while a live performance might wish to be scripted, unexpected events may force it to become variable without warning. Some kinds of performances, like flashmobs, exist as a set of rules: "show up at Grand Central Station in New York at a certain time and stand absolutely still for five minutes. Then unfreeze and go calmly about your business." Consider the dancing traffic cop. Here is a guy doing his job directing traffic but also entertaining while he works. I have been lucky enough to live in two cities with dancing traffic cops and have been crossed safely by both of them many times. I could go on about the differences in their styles for pages. In both cases I understood without question the authoritative instructions of their dance-like movements.

When I look at motions in interfaces, I see them as performances. A progress bar or rolling beach ball may stretch the idea, but the popping of menu items or windows in the Mac OSX, while short, still carry an element of performance into the working space of the interface, just as the dancing cop brought performance to the busy streets of Providence.

What is the role of observers and participants? Does the question of passive vs. active participation affect the definition of performance? In an interview about magical performances, William Kalush responded to the question of whether magical performances are threatened by tremendous special effects in movies that seems like magic by saying, "… from my perspective, a great performance of magic always involves the audience… whether they pick 'this' card, when it's a mind reading effect, what have I done with 'this,' these are all things that affect the outcome of the show so the audience becomes integral." (Kalush, NPR Pop Culture). The fact that an interface is a more or less intimate conversation between computer and user, creating an active audience of one does not exclude it from the definition of performance.

Stage performances

Formal dance is completely controlled: choreography, costume, set and lighting combine with music to create what the audience experiences as dance. The main features are bodies in motion but dance companies use the details of setting to control the experience. Early in my research on motion I had the chance to attend a presentation by the Boston Ballet on building the components of a dance performance. When I think of dance I think of human dancers moving. But the dance performance is actually the final mixing of music, choreography, spatial relations, lighting and costumes on humans moving. Lets review the steps to creating a dance performance.

dance: bodies moving to sound

dance is more than that

stage, light, costume count

The presentation I attended started with the Choreographer, Heather Myers on stage, moving with no music. Her motions became sequences of a dance. After a few moments she walked over to the podium and talked about how she began to work on her first commissioned dance, *Gone Again*, performed by the Boston Ballet in 2008.

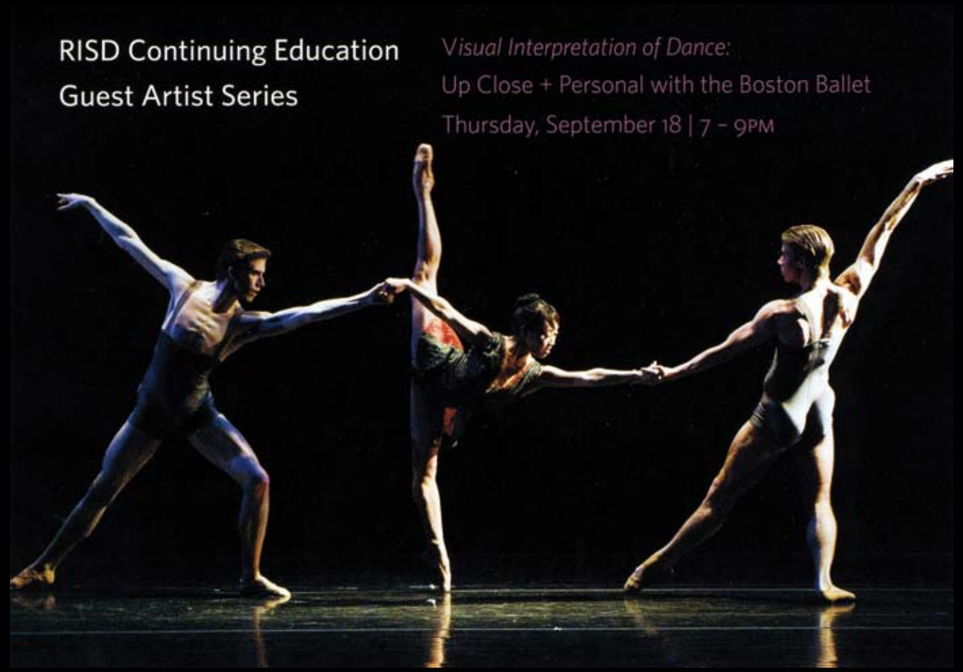
The beginning of a dance performance usually starts with a choreographer working alone. It may begin with a piece of music or with a concept that conveys a feeling. The choreographer builds a "palette of raw movement to work from." As the choreographer builds motions into sequences and sequences into phrases of motion, the dance takes shape.

Heather then invited a male dancer onto the stage with her. She showed him the moves she had been working on and they acted out the process of refining the dance together. Then two more dancers joined them in their dance. At that point in the presentation Heather returned to the podium. She explained that we had just seen dancers creating movements to a musical score but it was most decidedly not a dance performance. The critical elements of costume, lighting and setting were missing. She pointed out that the dancers were all wearing warm-up cloths. I hadn't noticed it.

She invited Charles Heightchew, Manager of Costumes and Wardrobe at Boston Ballet, to join her at the podium and they discussed the process of creating the costumes for *Gone Again*. They talked about the engineering of the garments for the dance. The music was somber and sweet but the movements were modern, lower to the ground than classical on-toe ballet.

To illustrate the point, the dancers came back to the stage and danced the same fragment but this time in brocaded classical tutus and tunics. It was amazing to see the dance looking wrong because the costume didn't fit the motions. The costumes should not "take away from the physicality of the dancers. A costume can hide what the body is doing."

They considered a fabric that would move with the dancers as opposed to period costumes that would be evocative of a more traditional story. They described how they created a palette of colors for the dyes of the fabrics. After discussing ideas for the



costumes, the dancers returned one more time to dance the fragment again in the correct costumes, flowing tunics and pants in rich, warm, muted hues. This time the motions felt right.

Next was a visit from the set designer, Benhamin Phillips, Production Manager / Technical Director of Boston Ballet and scenic designer for Heather Myers's *Gone Again,* to talk about the scenic design for the dance. He asked us to consider the palette of lighting and stage design as a way of using imagery to create ideas for the performance. "The scenery is an ambiance, an enhancement of what the dancers are doing. It creates a mood. [The] lighting designer establishes where the lights go. They need to understand what light does. It all enhances the dancer's energy." The dance happens, "not against a backdrop but inside it," an "invisible balance of dancers" and setting.

At this point, they showed a video recording of the fragment of the dance we had now seen four times at four stages of completeness. The scenery didn't fit this auditorium so they played a video of an actual performance. We watched costumed dancers on the dressed stage lit to enhance their bodies and motions. From the presentation I came to view ballet as a vocabulary of dance steps with costumes, lighting and scenery added to tell the whole story. Texture and depth come from the layering of these elements to create the performance. At the end of the talk, one of the presenters mentioned that a good performance "needs a terrific audience."

One last observation from this presentation seems significant. The dancers danced on stage four times during the evening in the process of describing choreography, costume, lighting and scene. At the end of each performance of the dance the audience applauded. At the end of the video of the dance no one applauded. I wonder if this impulse to recognize the performers is part of what we consider a performance.

Design for motion in interface will use all these elements of environment, external visual characteristics and appropriate motion to create the moving communication in an interface.

film and interface

are they different or similar?

how is interface like film

How is a moving interface like film?

In "The Art of Human Computer Interface Design," Ted Nelson makes a strong argument that design of software is like filmmaking. "Making software is like making movies because both are about how moving presentations affect the mind and feelings of the viewer. …" (Nelson, Laurel, *The Art of…* 238). He clearly views the potential of software as motion. What are the similarities between film and the screen interface? Obviously there is the frame. Film and interface are both 2-D representations within a defined surface. The second obvious similarity is change over time.

"I would like to consider software and movies both as parts of the same field, which I call virtuality." (Nelson, Laurel, *The Art of…*238). Nelson's idea of *virtuality* "has two aspects: conceptual structure–the ideas of the thing–and feel–its qualitative and sensory particulars. …in almost all forms of design, we are concerned with feel: we want the details of the finished work to be welcoming, pleasing and easy for those who will see and use it." (Nelson, Laurel, *The Art of…* 239). He is making a high-level connection between the design of movies: concept, plot, style, characterization, cinematography, with the design of software: structure, interaction, display; as a unified composition creating an experience that is at once self-contained and complete.

His interpretation of the word "moving" could as easily refer to moving elements used in the interface (display) as to the path taken through a piece of software in the process of using it. My earliest research about motion in interface found motion was used in the earliest GUI interfaces. At the time when Ted Nelson wrote this (1990) computers had a fraction of the power they have today but in true form, Nelson sensed the future and spoke of a vision of the possibilities that proved true over time.

While he hasn't come right out and said that the language of film, that is framed motion, is part of the design of software, the implication seems obvious. "What we need in software is what people are taught in film school…" (Nelson, Laurel, *The Art of…* 243). I think when he says the skills of a film director he means the ability to create the cinematographic experience of the film.

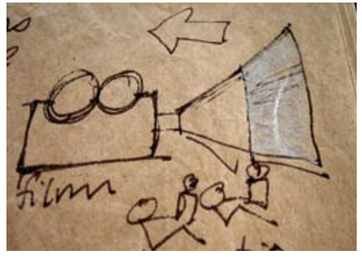
His suggestion is to replace metaphors in software design with adherence to design principles. Tuned as we are to the idea of the desktop, this concept seems difficult to imagine. Take some more contemporary web-based application interfaces as examples and you will see places where structure and organization come together without the need for metaphor. He defines principle as "an idea that other ideas are going to fit into or under." (Nelson, Laurel, *The Art of…* 239).

Although it's been at least twenty years since Nelson mused on the connections between designing software and making movies, the crossover skills haven't been deeply explored as yet.

> *"Actively influencing a person's emotional state throughout an experience – in particular, his or her sense of anticipation, involvement, and desire for a certain outcome – is still an evolving concept in the realm of user interface design. However, this is very familiar territory for makers of music, film, television, and video games. While UX designers may not be storytellers, we can create more engaging product user experiences by learning from their examples." (Follett, UX matters).*

Can an interface be a performance?

When I think of a human-computer interface, I usually think of either a familiar software working space or a web interface that allows me to access information. Both of these ideas are influenced by my experiences with those objects. Change seems to be on the horizon for digital tool interactions. The introduction of computers into different environments including mobile, multi-touch, multi-user, and interconnected, widely distributed networks of small devices will introduce new interaction paradigms into computing; possibility translating them back to more traditional interfaces. (Jesse Schell, Gamepocalypse). From this perspective the question of interface as performance is easier to grasp. Think of Tom Cruise in *Minority Report* walking into the mall and being presented with several holographic projections, advertisements customized to his personal tastes, or more precisely, to the tastes of the man whose eyes he was wearing. That environment, particularly if a transaction were to take place, would be considered an interface and the performance aspect or the potential for performance seems obvious.



programmed participatory performance

DMI Portable Light Orchestra

Fall 2008, Design for Experience, Professor Gunta Kaza.
The assignment: Light.
Respond in any way you like.
Represent the quality of the word.
Try to relate it to your thesis.

As a final response to the assignment I created a programmed participatory performance. My first idea was to put light bulbs inside a container to project some light verse onto a wall. In the *Light Verse Quarterly* I found a humorous poem about a firefly.

Animal Epitaphs, J. Patrick Lewis

For A Firefly
She was not the sun
She was not the stars
But she was lots of fun
In mayonnaise jars

I tried to project the words as a shadow on the wall using a cut-out shape and a flashlight. The idea could not have failed more miserably.

The attempt got me thinking about projected light in general and I tried shining my flashlights through various things. I started looking for pieces of colored glass. In a jar on a windowsill I keep a collection of colored glass disks and marbles that I tried but they were too dark for the feeble light of a flashlight. They appeared as black shadows rather than colored lights. I went to a Dollar Store and collected a basketful of different glass elements. I favored colored things but there was a set of blown glass Christmas ornaments made of thin strands woven together in a lattice as well as a crocheted doily that caught my eye for its texture. When I exited the dollar store I heard a car crash at the adjacent intersection and, yes, I did go over to see if there were some broken tail lights I might pick up.

I collected every piece of colored transparent material I could find and every flashlight I had into a pile on the living room table and started projecting through them, trying to make them dance on the ceiling. The results were vague and formless but I kept trying. I shifted the idea to light music rather than poetry. In general I prefer melancholic music so my choice for something light from my music library was limited. I picked "The Lion Sleeps Tonight" from the Disney movie *The Lion King*.

The performance I gave in front of the group was not as good as the performance I practiced at home. A good performance is the result of repetition and after practicing many times I was able to play the lights well. All my practice was at home in my living room. In the classroom space the hanging light fixtures created interference I did not anticipate. Having an audience distracted my attention and that changed my performance as well.

Later I went back to experiment with the lights to try to work around the interferences. I could only work at night, and preferably when the neighbors lights were off.

It was chilly late one Saturday. A few feeble lights shone from the street corner but the houses on either side were dark. I was playing around with the flashlights, shining lights on the ceiling for the sheer pleasure of it. At some point I noticed the red laser pointer I was carrying around. I don't remember exactly when the idea to shine it through the glass occurred to me. I picked up the kitty laser and pointed it through a clear, Plexiglas cube for the first time. The result on the ceiling was a perfect red dot the same as if the beam wasn't passing through the plexiglass cube. Uninteresting. Etched in the middle of that cube was a textured horse head. It brought to mind a sculpture show I saw many years ago that had textured images etched into tall blocks of glass with blue light projected from above and below. Where the light hit the etched glass, the images glowed in tones of blue. I tried to see if I could illuminate the horse head that way. I watched the cube and not the ceiling. I couldn't get that beautiful light effect to work. Over my head the red dot on the ceiling was shifting from a bright point to a red halo of diffusion. Fortunately, I chose to look up.

After finding the first diffusion pattern with the laser I picked up another piece of glass from the pile at random. I pointed the light through the glass. As it moved, the diffusion pattern fragmented into discrete bands of light that changed with every subtle change of position, seeming to dance on the ceiling in the dark. Magical and beautiful and entirely unexpected, this new phenomenon fascinated me. Frantically I projected through the rest of the glass in my collection and then, every clear thing I could put my hands on to see what would happen. Different objects created different kinds of patterns. Flaws in the glass seemed to create the most incredible shapes. Different projections created different sizes of shapes. Pieces of glass that had failed for the flashlights became the star performers.

At this point I enlisted the help of a dancer to work with me on choreographing the lights to music. Just as I had, she became fascinated with shining the laser through every clear object she could find to see how the light might be effected. Repeatedly I had to call her to focus. We coordinated the lights to the sound of some musical scores and worked out a couple of dances.

For "The Lion Sleeps Tonight" we produced our best composition, a narrative story about the jungle using a very dim flashlight to play the moon slowly rising and a clear bottle half-full of water that transferred the motion of the water to the screen via the dancing laser; implying the feeling of a river in the jungle.

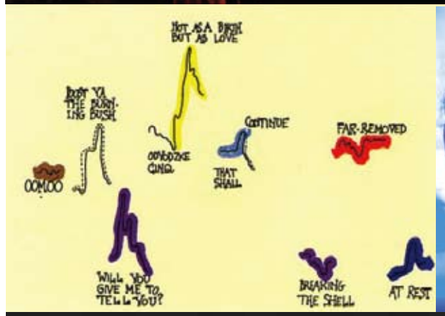
I brought those things to the next class session. Eun Kyoung Lee arrived early and I convinced her to practice with me, then enlisted her to play the moon for that evening's performance. This time my project was a hit. Everyone wanted to play along. People took turns making light patterns and playing to the music. I decided to repeat a longer performance for final presentations. I made 3 different compositions. First, the well rehearsed, narrative "The Lion Sleeps Tonight" piece with Kyoung taking the roll of moon again and me playing the laser through the bottle of water. I noticed that Kent Millard and Kat Take had a natural capability to play to the light instruments while we were sharing so I chose them as performers for a duet. I gave each a laser in advance plus a piece of glass and "Everything is Wrong" by Moby, and asked them to improvise something. They had some time to prepare. The last composition included all the members of the class. They did not have the lasers until the day of the presentation and they did not know what music would be played. It was complete improvisation. I used an instrumental piece called "Bizet Carillon" performed by the Seattle Symphony.

The day of my review, I spent the seconds between every presentation preparing. One at a time, I handed out packages to each member of the orchestra with a laser, a piece of glass and a little card with their name and instructions. I built a portable screen out of a sheet and two oak rods. A week before reviews I ordered a green laser, hoping to add a touch of color to the very dim red of the kitty lasers. The green laser is advertised as "sixty times brighter than red." It arrived just in time. I asked as many people as I could to help, to further involve the audience.

As I stood up for my presentation I gestured to someone to carry in the screen coiled around itself. I asked two members of the audience to unroll and hold the screen. Then at my signal, the lights went out and the room was plunged into darkness. For the "Lion Sleeps Tonight," Kyoung and I were projecting from behind the screen. For their duet, Kent and Kat were in the audience projecting from the front. I had hoped the change of the source direction for the second piece would enhance the element of surprise. The rest of the class played the last segment together I also hoped they would be able to make a good showing of themselves since they had to learn how to play their light instruments as they were performing. Their instructions were to play the third musical piece, project on any surface they found interesting and to avoid shining the lasers into anyones' eyes. The idea was that the change from a few, discrete lights on the screen to a room full of lights would create enough excitement that their elementary skills would not be noticeable. I did not know how the whole thing would work, but that was part of the experiment.

All the participants enthusiastically took on the challenge and the performance worked better than I could have imagined. Once I discovered the phenomenon of creating dancing light by projecting a laser through glass the rest of the project came together by incorporating collaboration, the element of surprise and using a set of simple rules to guide the result, allowing for randomness as it might happen. I learned some new things in the process: setting is important; involving the audience made it their performance as much as mine; casting performers is great when it works well but there is a huge risk of possible mistake. The final performance was a result of all those steps added together. The advice of experts at certain points also contributed to the final success. Without willing collaborators there would have been nothing. I thank my classmates for all their help in putting that temporary, temporal experience out into the world.

The resulting event showed participatory performance. Designing the rules and setting them loose created the experience in this case. As I continue to think about using motion to carry information in an interface I find the concept of creating rules that direct the action more and more essential.



Examples of interactive performances

This page from the top:.

Sleep No More was performed in Old Lincoln School on Boyleston Street in Brookline. The play allowed the audience to wander freely between rooms in the old school where scenes of the play told the story of Macbeth with the suspense of a Hitchcock film. Audience members wore masks to make clear who was a performer and who not since the barrier of the stage was eliminated.

Improv Everywhere set up an attendant in the men's room at McDonalds on Broadway in New York. Agent Simmons had sample sizes of toiletries, hand towels and candies to hand out. He even convinced several employees he was sent from "corporate" to test the idea. Most of the performance was captured on a hidden camera.

John Cage's opera Aria has a 20-page visual score of variously colored wavy lines and some black squares. The colors denote changes to the singing style, the sounds to be determined by the singer. Each singer's rendition is unique.

Zombie Flash mobs have become popular. Groups of people dressed in Zombie cloths and makeup turn their imaginations loose in search of "brains."

Krzysztof Wodiczko created If You See Something in 2005; projects images of people behind frosted windows on multiple walls, showing them exchanging stories that allude to the abuse of power.

This page from the top:.

The Rocky Horror Picture Show, a tragic story of Rocky, the transsexual from Transylvania, plays weekly, late at night at movie theaters around the country. The movie premiered in London England in August 1975. Audience members dress up as characters, act out scenes in front of the screen and interact with various objects during the course of the film. Playing Saturday nights at midnight at Lowes in Harvard Square.

Flash mobs have become the tools of large corporations. This group came to Heathrow airport to sing to the passengers on arriving planes. Brought to you by T-Mobil.

Improv Everywhere gathered 200 performers for a stunt at Grand Central Station in Manhattan. The group memers froze in place at a specified time for five minutes then went back to their daily business.

As a way of thanking God for answering their prayers and sparing their village from war and plague in 1633, the residents of Oberammergau Germany participate in a passion play telling the story of the life of Jesue every ten years. About half of the population participates in the event that requires a whole year of preparation.

motion and the brain

(organic architecture and psychological underpinnings?)

sight and interpretation

behavior counts

How the brain recognizes and interprets motion.

Motion attracts attention.

The fundamental tools of human perception are the senses and the brain. Once motions have been recorded, sorted, parsed and interpreted in our brain's hardware, we interpret what they mean to us. Science strives to understand the world through repeatable experiments. The results of scientific experiments record information that transcends human perception to tell the truth of nature. What we understand about our brain is that it filters and ignores many things so it can make sense of the world.

In order to understand what motion really means as a form of communication, information on the brain's system for interpreting signals illuminates many important features: the hardware of the visual system, eyes connected to brain. How the brain recognizes and organizes those signals into thoughts illuminates the role of motion. The software of human perception records what it needs to ensure the organism's survival. When studied carefully it shows an amazing propensity to ignore information.

We think what we perceive is reality but in fact, what we perceive is what we need to know in order to survive in our dangerous world. Much is eliminated in the process. Our bodies move, our heads move with our bodies and in addition our eyes constantly scan the visual field. They never rest. Yet, we don't notice these motions. Our brains ignore them in order to make sense of our complex environment.

"all motion perception is basically stroboscopic. when a bird flies through my field of vision, its physical displacement is continuous. what I see of the flight, however, derives from a sequence of recordings by the individual receptors or 'receptive fields' of the retina."
(Arnheim, 378).

physiology *physiology rules*
the visual cortex

Mapping the functions of the brain. Researchers have been trying to understand how the brain works since the beginning of modern medical science. Our brain dedicates a significant area to processing visual information. The Visual Cortex is its most massive system.

The brain categorizes and understands visual impulses based on variant and invariant properties. It ignores a lot of variant information in order to simplify the process of understanding what it sees. For example, the brain will ignore the true variation of a color in different kinds of light so that it can consistently identify the hue as it compares to other hues in its vicinity. The actual amount of light reflected from an object in bright light might be very different from the amount reflected in much dimmer light but the brain will ignore the actual lumens seen and render the message of the color. The banana appears to be a particular yellow color regardless of how well or poorly it is lit.

Most people are aware that there is an area in the brain dedicated to processing color information. Medical history has examples of people losing color vision (called Cerebral Achromatopsia). Approximately 8% of caucasian males experience some form of color blindness. More rarely, examples of people experiencing either the lack of the perception of motion (called Cerebral Akinetopsia) or seeing only things in motion have also been documented. Both of these maladies create significant challenges for the afflicted person. They also point to the idea that the brain has a motion center.

The 'brain seeing' executes a series of highly specific tasks performed for the parameters of color, form, movement; at specific locations in the visual field. Those signals are processed and reintegrated into consciousness as recognizable, understood things. The experience of a healthy brain is that the color, shape, position, speed and direction of movement of an object are assessed and analyzed in a fraction of a second. In some parts of the brain the functional areas have been identified down to the cellular level. These mappings of functions allow researchers to understand how visual signals are being interpreted in very specific ways.

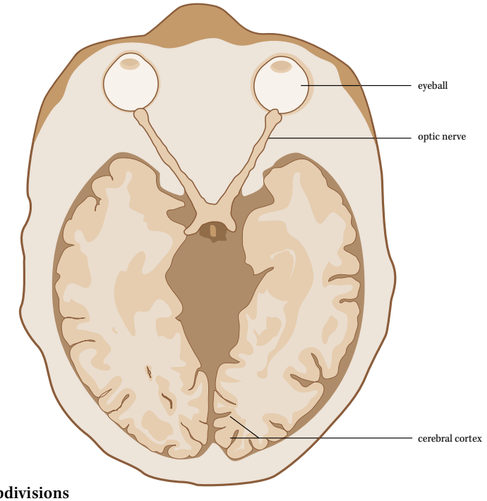
The brain's processing of visual information can be understood by looking at the organic structures found connected to the eyes. Our eyes connect to the visual center of our brains via the optic nerve. The optic nerve is a rope-like collection of nerve cells that transmit signals recorded in the retina to the visual processor of the brain. The optic nerves cross inside the skull at the optic chiasma to connect the right eye to the left hemisphere and the left eye to the right hemisphere.

The optic nerve connects to the Visual Cortex through a 6-layered structure called the *Lateral Genticulate Nucleus* that extends from the ends of the optic nerves back to the series of folds of tissue that comprise the Visual Cortex at the back of the head. The Lateral Genticulate Nucleus is separated into layers of Parvocellular Ganglion Cells (P layers) and Magnocellular Ganglion Cells (M layers). The P cell layers transmit signals that relate to form and the M cell layers transmit information that is related to motion.

The Visual Cortex is located in the occipital lobe, at the bottom, back of the head between the parietal lobe and the Cerebellum. It lies on either side of the Calcarine Fissure, a deep fold that bisects the brain horizontally near the bottom. If you put your fingers together on the back of your head, you will be touching the area outside of the Visual Cortex.

The Visual Cortex is comprised of a series of folds in the brain called sulci (singular sulcus), that wrap in and out from the back of the brain toward the center of the skull; literally folds of tissue that contain cells. The sulci create the characteristic, lumpy texture of the brain. This folding puts some areas in close proximity to other areas that would be far apart if the brain were flattened out on a table.

The Visual Cortex itself is composed of two major sections, the Striate Cortex, (also referred to as the Primary Visual Cortex or V1), sits at the back of the head and the Prestriate Cortex lies buried inside, toward the center of the brain, within the folds of the Calcarine Fissure. V1 seems to act as a generalized sorting area for visual signals. The Prestriate Cortex contains specialized areas referred to as V2, V3, V4, V5 and V6, differentiated by the specialization of the cells located in them.



Functional subdivisions

Much research on the Visual Cortex in recent years has resulted in the understanding of the locations of many of the functions of sight in great depth. V1 and V2 of the Visual Cortex are two of the most highly studied and understood areas of the brain for anatomical and functional architecture. "They both have cells that are selective for motion, orientation, wavelength [color] and depth. They send signals related to different aspects of the visual scene to different specialized areas of the Prestriate Visual Cortex." (Zeki, 177-178).

V1 and V2 can be thought of as the "post office" areas of the brain. They sort input and send signals to the specialized areas to be more finely interpreted. Area V2 has larger receptive fields and more analytic functions than V1. V1 has a very precise mapping of the retina, allowing for precision in locating visual input.

Signals from the retina pass through the P and M layers of the Lateral Genticulate Nucleus to V1. V1 contains two structures called the blobs and interblobs. The blobs transmit information dealing with form and color and the interblobs transmit signals dealing with motion. The P layer ganglion cells connect to the blobs and the M layer ganglion cells connect to the interblobs.

Like V1, V2 receives signals directly from the retina as well as from area V1 and, like V1, it acts as a segregator, sending specific signals to each of the other specialized areas. V2 has structures of cells in stripes called thick, thin and interstripes. They connect to the blobs and interblobs of area V1. The thick stripes connect with the interblobs of V1, continuing the chain of connection between structures that interpret motion.

The cells in V3 respond to "lines in specific orientation." They interpret form and dynamic form. Cells activate only when they are presented with lines oriented at specific angles. It's like each cell is waiting for input to be received at precisely the angle it will notice and when it does, that cell sends feedback to area V1 that it is reading an input for its angle. V3 does not respond to color.

V4 is the primary color area, though it also processes some kinds of "form in association with colour…" It gets input from the blobs and interblobs of V1, the thin and interstripes of V2.

Area V5 processes motion. Buried in the Superior Temporal Sulcus, it receives input directly from V1. The majority of the cells, about 90%, are directionally sensitive. The mapping here is less precise to the retina than in other areas of the Visual Cortex. It's not a map of the retina, it's a map of the activity of motion. "… perhaps we should think of these areas as labeling a particular kind of activity in a region of visual space." (Zeki, 155). Cells in V5 have large receptive fields. They are not precise. They only respond to movement in specific directions, rather than being mapped to exact areas in the visual field; more like the generality of the position of the mouse cursor than the specific positioning of the stylus and tablet. They respond to any motion at any point in the visual field that is going in the appropriate direction.

In addition, further research points to the idea that there are other areas of the brain that respond to motion: "… recent physiological evidence suggests that there are cells in the Superior Temporal Sulcus of the monkey which are able to respond specifically to patterns of motion characteristic of biological motion." (Zeki, 193).

Motion is an important function of the brain. Humans are hard-wired to recognize motion. Our brains have evolved physiological architectures whose functions are to interpret motion from the input impulses of our eyes. We respond to motion naturally. The motion our brains respond to most is organic motion. It is natural for humans to respond favorably to interfaces that move, they become part of the natural world.

"constancy and invariance in perception: "unless an observer holds his head unnaturally still and fixes his eye, his visual field is alive with transformation."
(Kepes, Wallach, 61).

Perceptions

Once motion is registered in the Visual Cortex, how is that motion interpreted? Our brains evolved for survival. What we see and what we perceive are in fact very different things. The human perception of motion is relative to the human organism and in some instances is interpreted at a level beneath awareness.

As science builds its understanding of the world around us it slowly uncovers discrepancies between what we perceive and what is. Our world is one of constant motions, "molecules move and collide or they swing and rotate while forces hold them together; other dynamic processes make up chemical bonds; electrons move, revolve and spin, causing fields and all manner of radiation; nuclei are held together by mysterious forces, and at the other end of the scale, a living organism is an intricate array of a huge number of chemical processes. As opposed to this, the external world as we experience it through perception is mostly static." (Kepes-Hans Wallach, 52).

how do we understand what we see?
perception interpretation

Scientific descriptions of motion help to clarify the difference between motion as it exists and motion as it is perceived. Physics tries to explain the world from an objective perspective. "Motion is primarily displacement of an object in relation to other objects–which object is displaced and which serves as a frame of reference is here merely a matter of description." (Kepes, Wallach, 52).

We perceive motion as an attribute of the moving object. For our common purposes, the way we understand local motion can be stated simply as: "Motion in a strict physical sense, is a change of position with respect to a reference system of space coordinates," (Kepes, i); although I might add that we require time in this definition to experience the motion. But the complexities don't stop there. Motion and perception of motion are very different things.

We naturally ignore huge amounts of data that are coming at us all the time in the way of motion. What about the perception of movement are we interpreting differently from the scientific facts of motion? A lot, as it turns out.

Take these two examples:

"We move our eyes from one fixation point to another several times a second during waking life. We also blink frequently. The sense impressions, therefore, are highly unstable and interrupted. But an obvious characteristic of perception is its stability and continuity. The world does not seem to move as the retinal image moves over the retina." (Kepes, Gibson, 61). "Just as the visible world does not seem to rotate 90° when one lies down on his side, although the retinal image does. ...instead of the ground changing, one feels that he has changed and the earth has not." (Kepes, Gibson, 63).

These examples show just how much and how constantly our perceptions are different from reality when it comes to motion. The adaptations seem obvious once you think about them. If all the motions of our organism were recorded just as they happen, interpreting information important to survival would be much more difficult. What then, about the perception of motion might be important to its use as a communication system in an interface?

To start, lets differentiate the world into things and actions. "The gestures of a speaker are actions, but the speaker himself is perceived as a persistent thing..." (Arnheim, 373). In programming, we would describe the differences as being objects and behaviors. An object is seen as being "persistent," it lasts. Actions, motions, are considered to be variable, or time-based. Of interest to me is the pervasive idea from many thinkers that unmoving forms are actually forms experiencing arrested movement.

It's not the passage of time, Arnheim believes, that distinguishes perception of happenings from objects but that in happenings "we witness an organized sequence in which phases follow one another in a meaningful, one-dimensional order." (Arnheim, 375).

One idea critical to the understanding of the perception of motion is called *object relative displacement,* "the displacement of one object in relation to another object in the field of vision." (Kepes, Wallach, 53). Motion is always relative or it cannot be perceived. Either the motion is judged relative to an object in the scene or in relation to an edge, a framed space, a field, a background; in fact the relative objects may be different things or may change from one object to another during the motion. That relative object may or may not also be in motion.

Angular displacement refers to the "displacement of a seen object in relation to the observer." (Kepes, Wallach, 53), as opposed to object-relative displacement. In this case, the observer becomes the framework against which the motion is perceived. Often, an object being displaced in relation to the observer is also being displaced against other objects in the visual field.

Generally speaking, when an object moves within a setting, we perceive the setting as stationary and the object in motion. In a scene where a fly is buzzing around an elephant, we would perceive the elephant as stationary and the fly as mobile. If that elephant were to start walking, we would then perceive the mobile fly as following the mobile elephant on the immobile savanna. When viewing motion, some objects will function as *framework* and be read as immobile. Moving objects are viewed as dependent on the immobile framework.

"When no dependence exists, the two systems may both be seen to move symmetrically, approaching or withdrawing from each other." (Arnheim, 380).

We ordinarily perceive motion only when something changes its position more or less continuously relative to a more stable environment. (Zettl, 247). Researchers Karl Dunker and Erika Oppenheimer outlined concepts dealing with dependence. The enclosing area, the ground, seems to stand still and the figure appears to move within it. The concept of variability states that "if one object changes in shape and size and the other remains constant–for example, a line 'growing out of' a square–the variable object assumes the motion. The observer sees the line stretching away from the square, rather than the square withdrawing from an immobile line." (Arnheim, 380).

Motion is relative to the environment and objects in the environment. In one experiment a moving dot of light was observed. Over time the speed was reduced until the point where the motion was imperceptible. Then, a second, stationary dot was added near the first one and the motion of the first dot became apparent again. The motion of the first dot remained visible as long as the dots remain relatively close together.

Time, sequence and phase are identified as elements important to the human perception of motion. Time and timelessness are both elements of the information that we interpret into motion. It's along the timeline that motion becomes perceptible. Sequence creates order out of chaos. Groups of sequences create phases. "There is a question posed about the relation of time to the idea of movement. For us, the setting we perceive as existing outside of time. The motions that happen in those spaces are events that are influenced by time." (Arnheim, 373).

A further clarification of the role of time in a moving composition says that motion for the sake of motion does not create understanding. It's the relationship of the phases and sequences that create the meaning in a happening. Sequence is tightly tied to time, essential to understanding complex motions. Sequence orders events but Arnheim observes that, like a static composition, all the phases of the work create its meaning. "... in order to create or to understand the structure of a film or a symphony, one has to grasp it as a whole, exactly as one would the composition of a painting. It must be apprehended as a sequence, but this sequence cannot be temporal in the sense that one phase disappears as the next occupies our consciousness. The whole work must be simultaneously present in the mind if we are to understand its development, its coherence, the interrelations among its parts." (Arnheim, 374).

Organizing principles and the ability to distinguish motions that stay true to their meaning creates communication rather than confusion with motion.

on the use of motion in interface

(it moves, therefore it is)

research on the language of motion

supporting works

The following projects represent a three-year process of articulating ideas of motion in relation to interface. The projects described in this section are landmarks of that process illustrating my conclusions and pointing toward practical ways to create a choreographics for the design of interfaces.

Initially, a taxonomy for understanding motion in interface is presented. The projects undertaken as part of the research for this thesis are then discussed as they relate to the taxonomy. The projects and taxonomy link back to the ways motion has been used in the collection of moving interfaces from the Catalog project; connecting the ideas with the functional criteria.

organization and structure

a taxonomy for motion used in interface

building blocks for motion

Component parts

When designing motions for interface, the designer becomes a choreographer, encouraging participation in the interaction by using motion. This section presents a breakdown of motion into component parts, setting the context for better understanding of motion as it relates to interface. On the following page is a list of the ingredients needed for any kind of motion gathered from research and conversations with other people interested in motion. They all share similarities but show extraordinary differences. The rest of the section consists of a taxonomy for motion by screen area, direction, attributes, principles, and behaviors. These lists relate to the matrix of motions and the kinds of motions I will show in my projects. Possibly more research applied to these concepts by connecting examples of video as illustration for the ideas will clarify meaning relationships for using or understanding motion.

Building blocks for motion

Everyone seems to have an idea of what is needed to create motion. I collected this list to make a comparison between all the ideas and I found it so interesting that I wanted to share it.

Aristotle
- Place
- Void
- Time

Sam Montague
- Object's
- Transformation
- Space
- Time

Brian's Lucid:
- Space
- Composition
- Time

After Effects
- Position
- Scale
- Rotation
- Transparency
- Center Point

Mine
- Screen area
- Direction
- Parameters
- Principles
- Behaviors

Heather Shaw's elaboration based on Sam Montague's definition:

Properties:
- Shape
- Color
- Surface
- Size
- Dimension

Behaviors:
- Direction
- Gesture
- Displacement
- Kinetics/physics
- Velocity

Space
- Staged space
  - location
  - position
- Perceived space
  - frame
  - focus
  - point-of-view
  - depth of field

Time
- Sequence
- Real time, implied time, abstract time
- Time manipulation
- Tempo
- Transitions

screen area *vertical, horizontal, diagonal* motion location

Analysis of motion in areas of the screen.

Aristotle defined place, void and time as three preconditions for motion. He defined void as an area or boundary where motion can happen. My first approach to thinking about motion in an interface looks at the screen broken into sections.

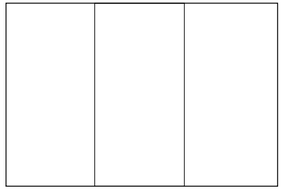
The screen will contain areas where motion is located and in most cases, areas that are still. Motion may transition from one area to another. Sometimes the motion covers the screen, sometimes it is localized. This analysis looks at the screen cut into thirds in three different ways, horizontally, vertically and on the z-axis:

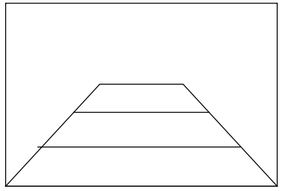
Position:
vertical: left, center, right;
horizontal: top, middle, bottom;
z-axis: foreground, middle ground, background;
as a way of thinking about the motion in these areas.

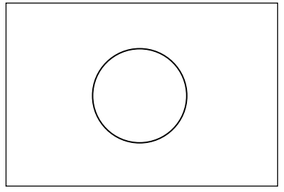
And at a couple of geometric shapes that motion can take on the screen:

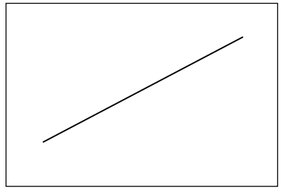
Geometric:
circle,
oblique
square
triangle

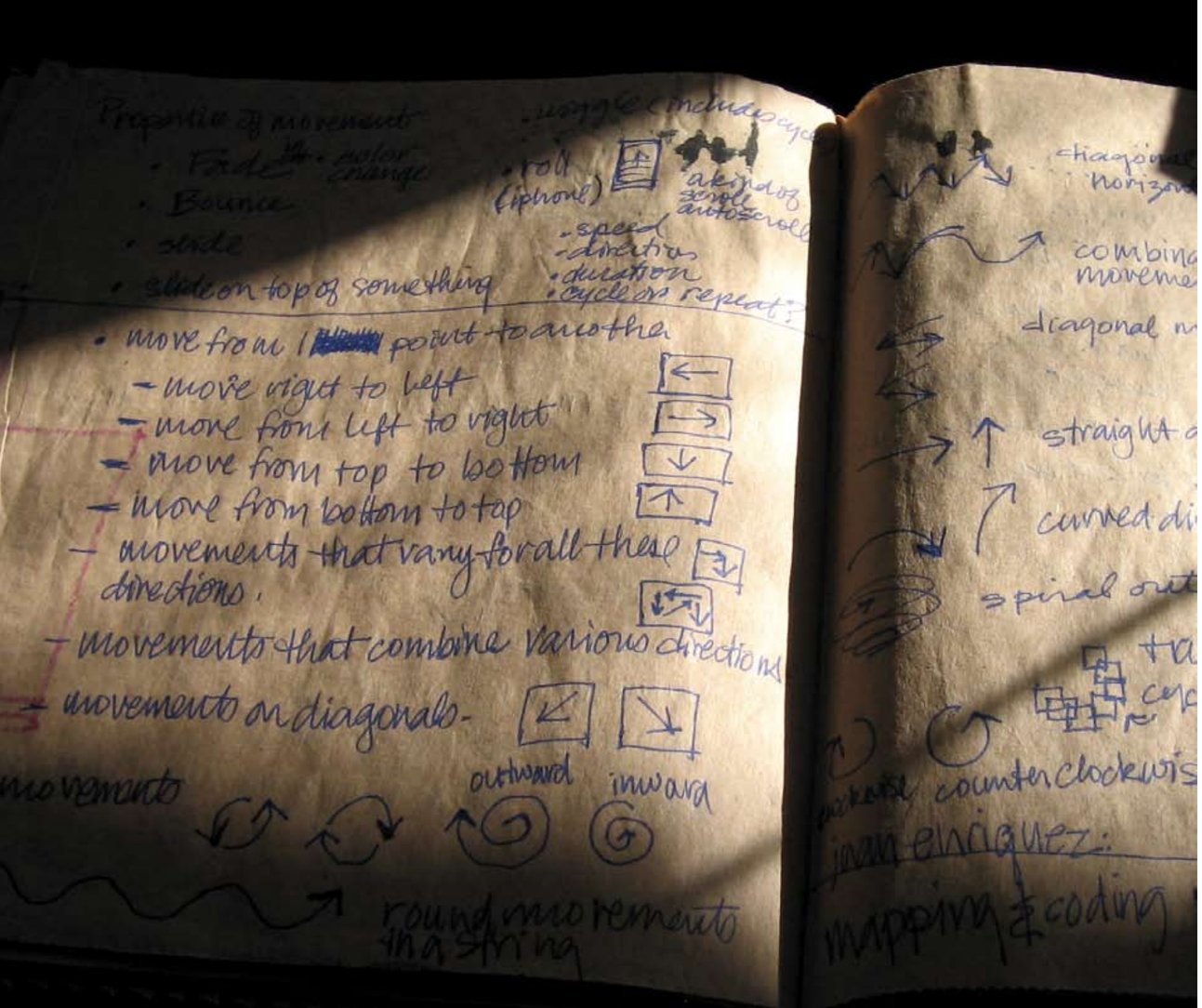
Area:
whole screen, part of screen,
center of screen, edges of screen;











direction

left, right, up, down, around

which way

Motion on the screen takes a vector we call a direction.

The screen holds motion that may be described as being in an area but that motion also shows change over time. One of those changes can be identified as direction. Direction seems to be such a powerful and obvious attribute that I have elevated it to a section of its own although it is clearly similar to the other elements in the principles section. For the studies I have tried to keep my clips to short, discrete gesture fragments of single motion ideas. In this section, the general direction of the motion is considered, motion that moves:

up,
down,
left,
right,
toward,
away from,
at diagonals,
concentric (toward center),
eccentric (away from center);

and variables to direction :

straight, or
turn;
and any combinations of the above.

A change of direction produces a point of emphasis that warrants additional study.

attributes *in pairs of sets of three*
describe things moving

motion spanning a range

Attributes of motion,
The quality of motion on the screen has many attributes. Generally a motion can only be evaluated in contrast with another motion. The attributes apply to the motions of the objects in the videos rather than the objects themselves.

Parameters:

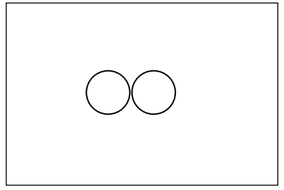
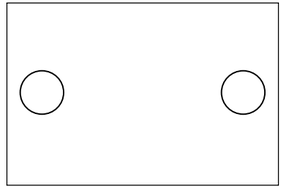
These can apply to thing that are stationary or moving

proximity: together, apart;
density: consolidated, dispersed;
distance: near, far away;
quantity: single object, multiple objects;
depth: pass in front/behind.

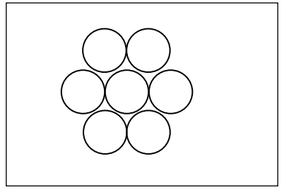
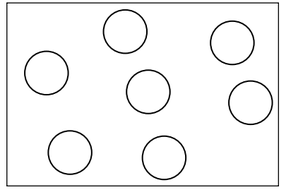
These pertain to only things moving, those that require change over time to apply:

size: large elements move; small elements move;
speed: fast, medium, slow;
scale: toward, away from;
coincidence: before, after, during/simultaneously;
noticeability: obvious, subtle, ambient;
cause & effect;
change of focus.

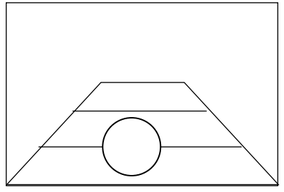
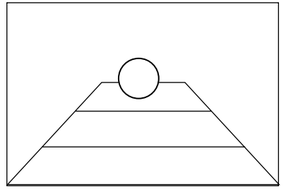
Un-categorized:
moving camera.

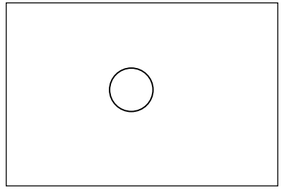
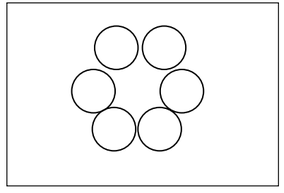
Together, Apart

Consolidated, Dispersed

Near, Far

principles in motions
in motion

Underlying design principles

When looking at the experimental video and animation examples, there are identifiable sequences that I would describe as principles. Certain principles can be applied to still or mobile examples equally well, and used to create visual communication. When the element of time is part of the example these principles become the building blocks for motion ideas that have meaning.

These can apply to things that are stationary or moving:
rhythm,
texture,
pattern,
contrast,
repetition,
theme,
continuity.

These pertain only to things moving, those that require change over time to apply:
sequence,
interval,
velocity,
synchronize,
pace or pacing,
transition,
order of events,
change of focus,
flows from past to present to future,
accumulation or reduction of moving elements,
direction,*

Multiple parameters,
Changes to any of these

* Explained in detail on page 67.

Synchronize

Synchronize

Texture

Interval

Splash

Turn

Ripple

Sway

Bob

behaviors *properties + parameters = behaviors*
motion makes ideas

Properties plus parameters

Dubberly and Pangaro, in describing the difference between hand-crafted design, an "individual artifact" created by an "individual designer" and "service-craft:" "the design, management, and ongoing development of service systems," separates them into things and behaviors, respectively. (Dubberly, Design in the age of Biology). In thinking about motion as a component for use in interactive interface, it will fall into the area of behavior.

When an object moves on the screen the first thing we see is the narrative, what that object is. If a ball bounces across a playground, we make many assumptions about what is happening in the environment around that ball. A small bird jumping across a lawn might share several qualities with the ball bouncing, but the subject of the image, the bird, overwhelms our interpretation of that motion.

Does it make sense to separate motion from subject? Is there value to be had in creating qualities of motion that embody the nature of the motion? When using motion to communicate ideas in an interface, simple motions combined become behaviors.

Properties + Parameters = Behaviors.
Or: Fall + Rise + Direction Change + Easing = Bounce.

These ideas communicated through motion are collected in a matrix showing rows of similar ideas that increase in intensity.

The behaviors on this page have been arranged in increasing intensity from left to right. A choreography of information created using the ideas of the behaviors can help create motions that communicate in an interface.

"the main characteristic of rhythm is the repetition of small groups with or without evident division."
(Klee, 269).

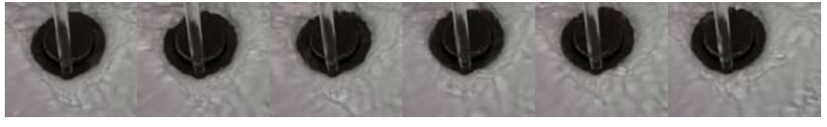
Breathe	Sigh	Pant	Heave
Bob	Pitch	Bounce	Jump
Couple	Flock	Cluster	Swarm
Twist	Twirl	Swirl	Spin
Flutter	Flap	Wave	Undulate
Wiggle	Worm	Snake	Swim
Sway	Tremble	Shake	Rock
Slip	Slide	Glide	Skate
Crisscross	Zigzag	Teeter-totter	Seesaw
Hover	Rise	Float	Fly
Dribble	Drizzle	Drip	Pour
Touch	Bump	Swat	Kick
Push	Block	Punt	Thrust
Kneel	Crawl	Walk	March
Twitch	Tremble	Jerk	Flip
Drip	Plop	Splash	Shower
Tilt	Yaw	Swing	Roll
Face	Align	Row	Rank
Pull	Stretch	Spring	Snap
Simmer	Bubble	Boil	Percolate
Drift	Lift	Rise	Float
Pitch	Yaw	Roll	Vomit
Dangle	Hang	Fall	Plummet
Hang	Lower	Drop	Dump
Cut	Slice	Chop	Guillotine
Bubble	Percolate	Burst	Explode
Follow	Chase	Pursue	Pounce
Pat	Pet	Brush	Stroke
Swivel	Wobble	Quake	Oscillate
Float	Rush	Shoot	Jet
Pedal	Paddle	Row	Scull

Drizzle

Dribble

Drip

Pour



video captures

"if you stand still and watch something move, you see it change its location from a 'before' to an 'after' position relative to you. but if you move with the object at the same speed, you may not perceive any motion at all."
(Zettl, 254).

Studies using motion

The video capture of motion project started as a way of gathering real information about motion from life. I bought a small video camera, light enough to carry in my bag all the time. "Motion that goes unrecorded because the camera is at home does not find its way into the thesis documentation," I thought. There I was, armed with the tool to collect motions happening all around me, ready with my excitement to videotape nature. I looked around. Everything was still. It was winter; the outside world a frozen landscape smothered in snow, the inside world, insulated from exterior stimuli. Nothing moved. People were locked inside their homes behind their closed shuttered windows. The animals had gone to their winter haunts.

> *"Things grow and disintegrate; they change their shapes, size and position relative to themselves, each other and to us. These dynamics of the outside spatial world are amplified within us by our never-resting eyes, which are carried by our moving head and moving body. But in spite of all this mobility, the essential characteristic of the world as we perceive it is, in fact, constancy and stability." (Kepes, ii).*

One evening I brought my camera to school and sat in studio, waiting. Mike Golembousky and Dennis Ludvino sat behind a giant TV screen having a discussion but while I could hear them, I couldn't see them at all. Uncharacteristically, no one arrived that evening. My trusty camera recorded only the motion of my own breathing.

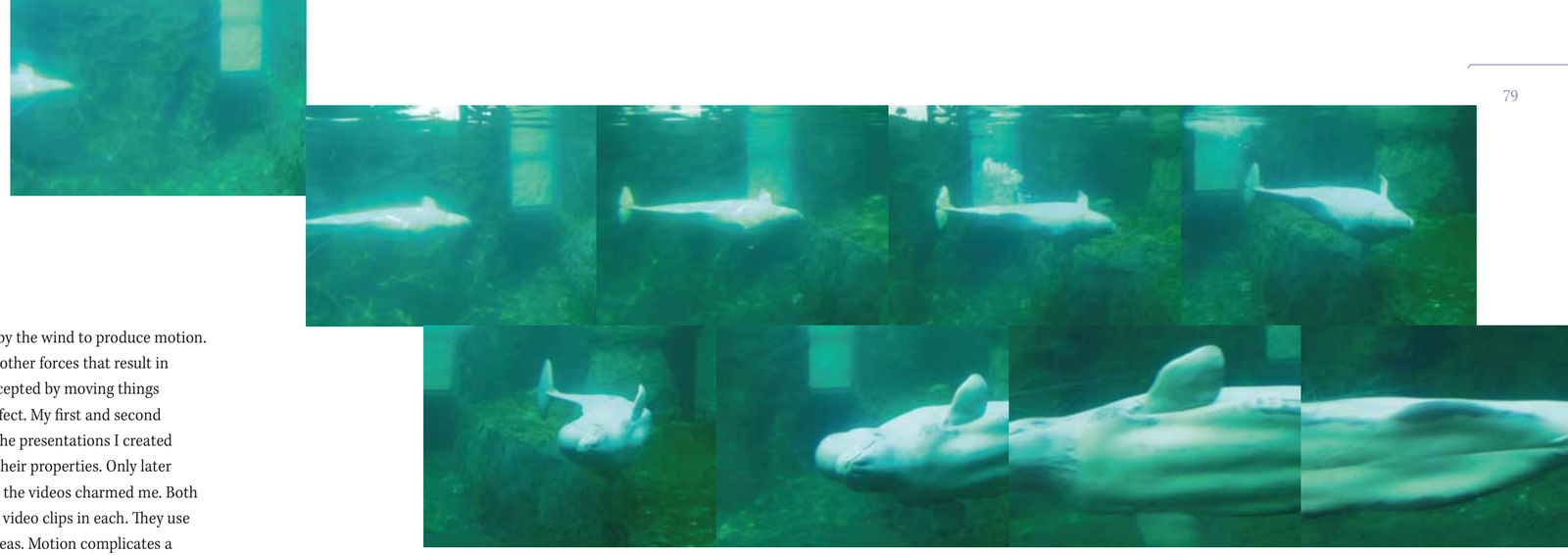
I had to think about where I might find motion. Slowly I started to discover events to record: a tiny kitten happily playing with a toy mouse, a storm of angry gyrations in the bare branches of trees, traffic making it's orderly way down the street, a school of feeder fish moving as one unit in a pet store aquarium, the tension and release of an aikido belting exam, birds in flight. (Birds are really hard to capture but the way they move through the air can serve to define space in a way nothing else does.)

powerful large smooth

For my first set of videos, I found things had to be alive or affected by the wind to produce motion. (Something, a force, always produces motion?) Later I found some other forces that result in motion: gravity, flowing water, mechanical things, light when intercepted by moving things or moved as with a flashlight, sports and motion from cause and effect. My first and second presentations of the videos were all about living things and wind. The presentations I created were more a celebration of things moving than a sharp analysis of their properties. Only later could I identify kinds of motions in them. As I clipped bits to show, the videos charmed me. Both presentations share exactly the same text sequenced with different video clips in each. They use short, discrete movements, as short as possible to capture single ideas. Motion complicates a scene as it intensifies. Sometimes the video has too many things moving in too many directions to easily analyze. Sometimes the changes over time or as entities enter the frame also creates more challenges to analysis. In those cases discrete motions need to be isolated to be considered separately. These considerations describe critical elements for including motion in interfaces.

Changing the sequence of the videos changed the ideas of the motions. That makes me think that motions can be manipulated by the way they are sequenced in an interface. This could be a next step in research. The arrangement of the two presentations showed just how little of a motion is needed to understand the idea of that motion. When I first made those sequenced presentations, my understanding of what I was looking at lacked depth, clarity or a way to translate valuable parts of those movements into an interface .

I continue to capture motions where I find them. Today I have many hours of motion video capture in my unedited database. Some themes I capture no matter how many times I see them. Birds in flight are an endless obsession to me. Water in all its forms attracts my recording attention. I have started to look at balls or round things moving. I go back to wind from time to time, but when recording wind, I want to capture different qualities in it.



beluga whale turns captured august 2010
mystic aquarium

Walk from above

Ocean waves going to the left

Sometimes I find something unique, the motion of sleet falling in front of a streetlight onto the roof of my car in just that way, or the reflection of rain on the dashboard creating a pattern of motion I couldn't imagine without having filmed it. One day, sea gulls on the roof of my building became interested in a cloth jellyfish hanging in an adjacent office window. I was able to film them as they moved back and forth studying the odd jellyfish habitat until finally they leapt into the air and flew away.

Scott Murray, in his DMI final presentation in May 2010, stated that "we're not able to track many motions at once, it's too distracting," reflecting a sentiment that is voiced by many involved in creating interfaces. But I find myself in many situations where the motions around me are extremely distracting. I'm thinking particularly of the grocery store parking lot on a busy day; cars, people, carts, all going in multiple directions around me. I don't have trouble tracking those motions. My survival depends on that.

I made video of students using design software in class. The video shows the extent of interface movement when controlled by a user. When we are driving the interface, we don't notice exactly how much it moves. In my opinion, the computing environments of the future will challenge our ideas of how much motion we can accept. We will be forced to resolve these issues of motion as a by-product of creating computing experiences in new operating systems, new environments or as we connect devices that have not been connected before.

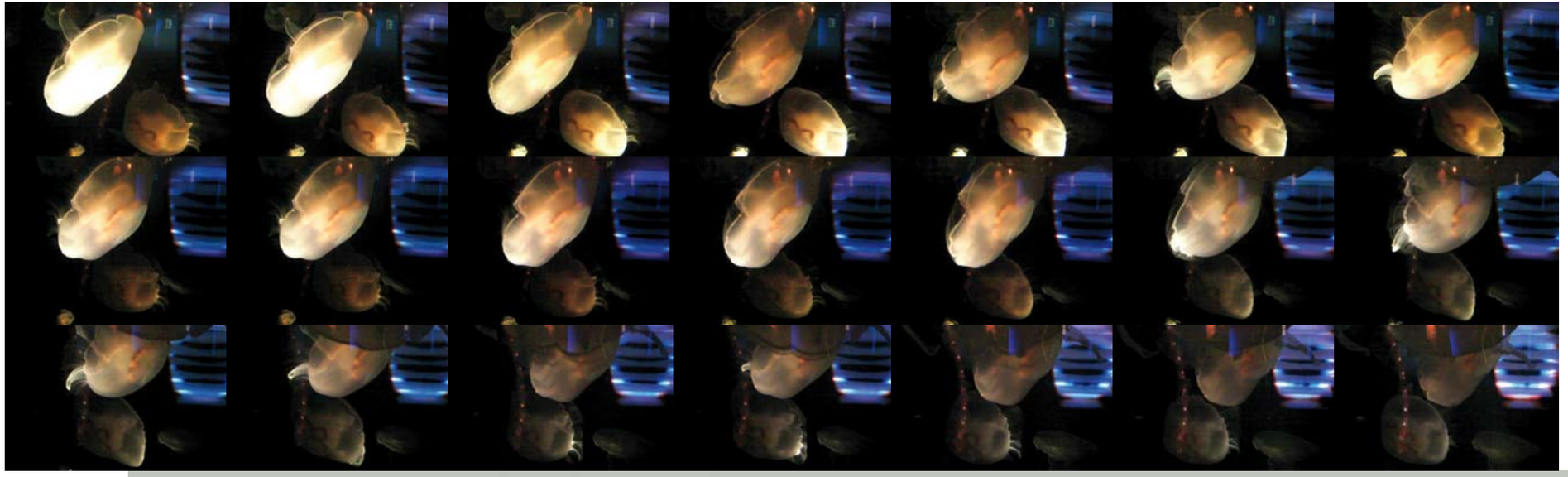
Think of bees swarming around a bed of flowers on a warm day. Their erratic motions become something I am aware of when I want to be. Their scale is below what I see unless I change my perception. I believe, in life and in interface, the way the motion is articulated determines what can integrate into an environment.

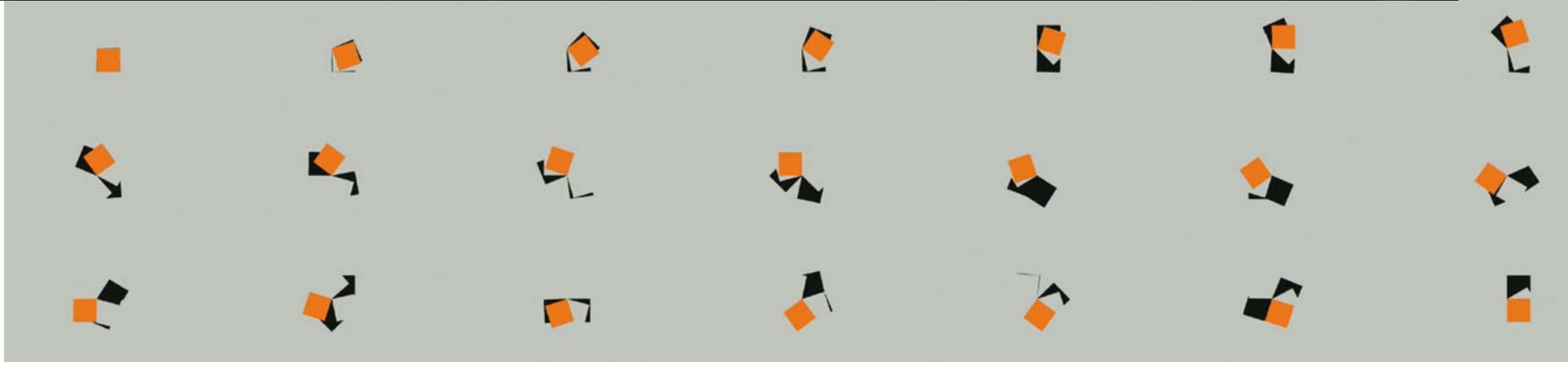
Motio, the motion lab

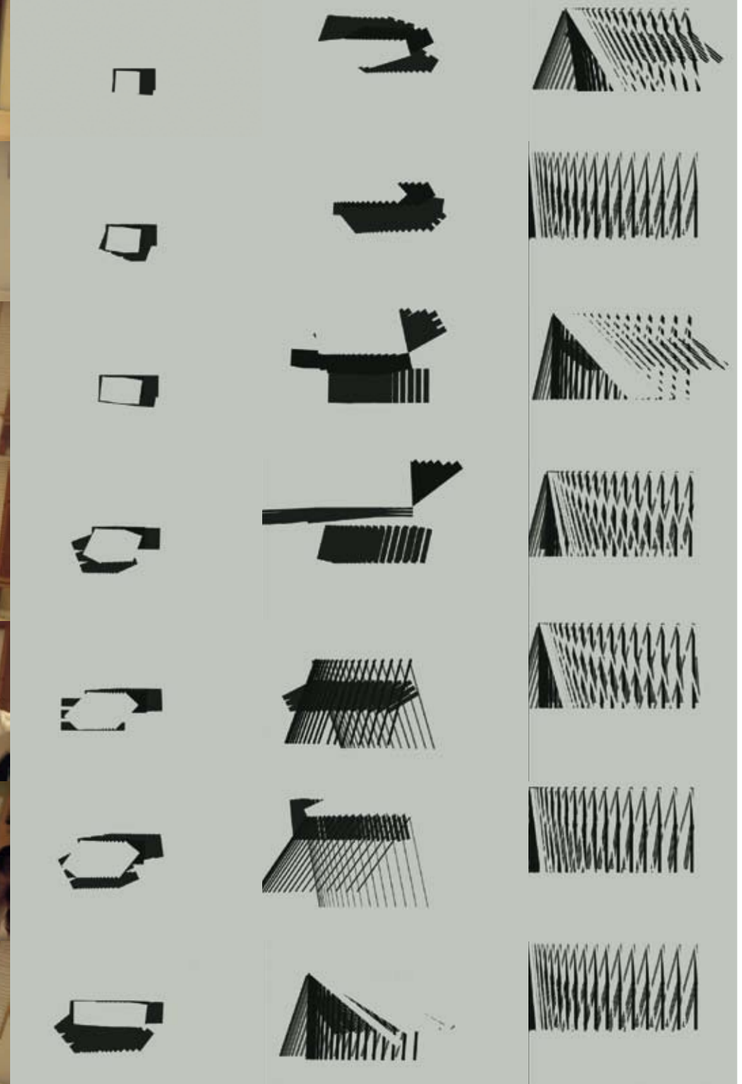
The use of motion can make an interface seem more natural. One day I watched some students clicking through a new version of *Extensis Suitcase Fusion 2* where the fonts move as they load themselves on the screen organically, growing down from the top of the display window rather than merely snapping into sight as they had on earlier versions. The students watched with delight, clicking through font family after font family to watch the motion repeat over and over again. They seemed comfortable with this movement and they were engaged by its novelty. An idea I had not previously considered as a goal for using motion in interface: make the experience of using software less jarring, more organic and integrated. As products change from being things we need to things we desire, we want that sexy interaction.

Motio was an experiment in creating motion using Actionscript transitions in Adobe Flash. The examples fall into two categories: those controlled with interactive buttons and those automatically animated by the program. They function as a way to translate gesture fragments taken from the video captures into programmed animations.

One of the frustrations I considered over and over in my thinking was the way motion is usually used in interfaces as cartoons of real motions; for example, the repetition of a piece of paper flying into a folder when copying a file in windows. That kind of literal translation appears to have limited value in complex visualizations. At least, my sense is that there must be a point where the language of motion can contain more depth. It's hard to think about using motion at a symbolic level beyond what we have seen as narrative storytelling in all sorts of animated media. I am sure that high levels of complexity will not be adopted until it becomes necessary, but that necessity appears to be near.







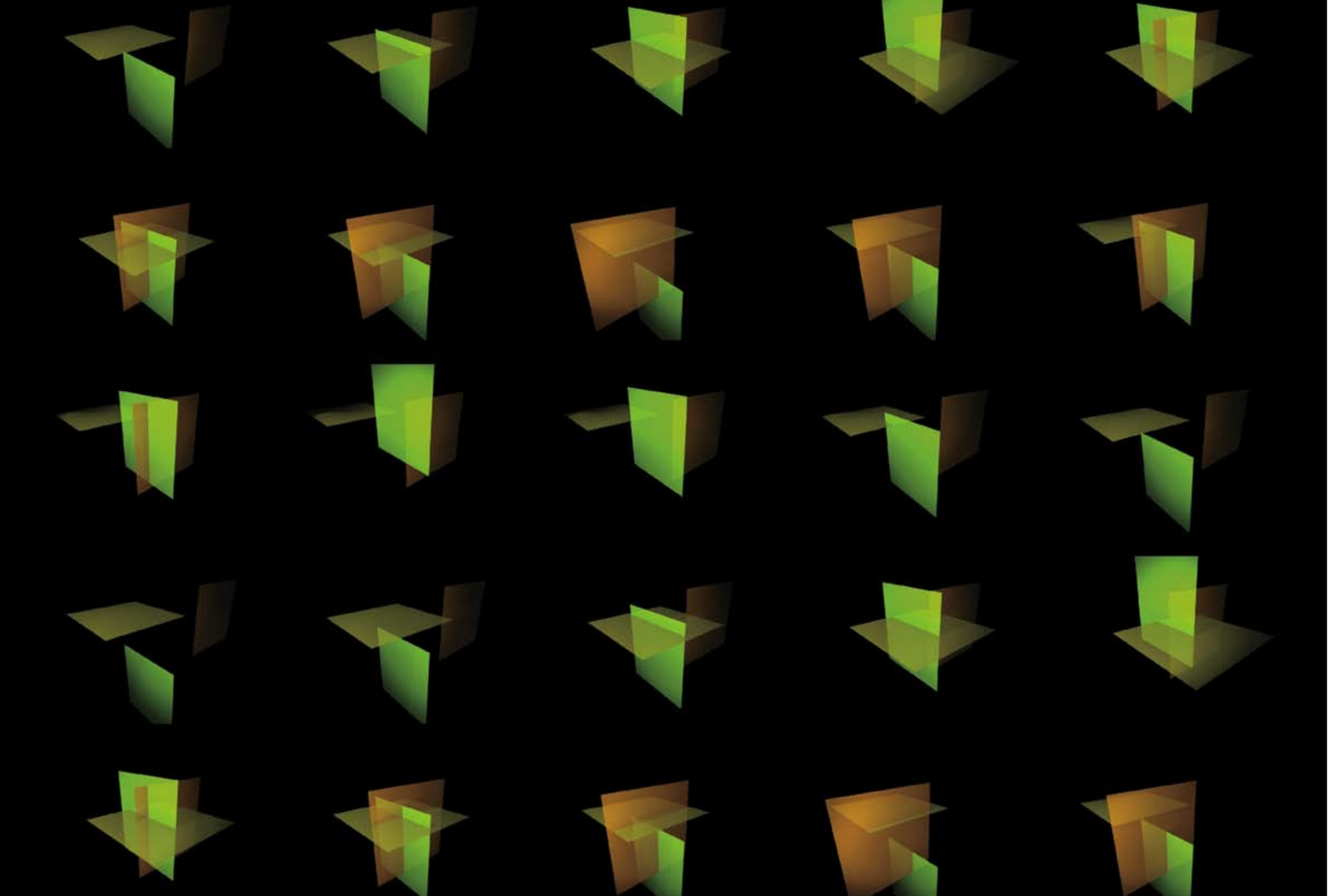
"the main characteristic of rhythm is the repetition of small groups with or without evident division."
(Klee, 269).

Paul Klee defines 'ethical' as "more according to the essence than according to the appearance, casually real, inward." (Klee, 444). The approach he took to some of his class assignments was to ask students to try to imbue a design with the essence of a thing, to embody its attitude. One assignment he gave was an "exercise in movement:" to interpret "the fountain; not the appearance of the fountain but its nature." (Klee, 401).

An animation attempting to replicate an object in motion is a cartoon. A translation of a motion into a sequence that draws the essence of that motion can function as a symbol. Paul Klee also thought about motions from the point of view of translation, wanting to capture the feeling of a certain motion rather than replicate it: "Representation according to essences, contrasted with representation according to appearance or with physical and spatial penetration." (Klee, 383).

The orange and black squares in the example on pages 82 and 83 were recorded from an interaction with the buttons on one of the interactive Motio studies. This project was created at the same time I was working with the motion video captures. As I worked with the programmed squares, I kept thinking of the moon jellyfish video. This iteration of the rotating squares seemed to have similar quality although the motions do not share obvious similarities. Only after creating the taxonomy have I been able to make the connections. The rotating squares share similarities of speed; that feeling of pulsing that comes with the slowing rotations then the speeding up of some of the squares, finishing with the change of direction of a square in the background. It would be beneficial to use an application like the motion lab to create motions and evaluate the qualities they share with motions captured from life in order to translate them into an interface. If organic motion is a natural attractor for human perception, if motion is used as a symbolic conveyor of meaning, then animating as a way of replicating the components of the motions as they are could present challenges that an interpretive method could overcome. An animated jellyfish on the screen would present a narrative about jellyfish but a pulsing motion on screen that shares the feeling of the jellyfish swimming style could better represent an idea of something resting, sighing, swaying, rising, or some other behavior that has meaning in the context of a particular interface.

In looking at motion in the videos, it's hard to separate content from form. The beluga whale turning in the water has a large, strong, smooth motion we can admire as much for its power as for its grace. Copying it to translate into an interface poses challenges because the context is part of the video. Translating the motion to communicate that idea of large, strong and smooth becomes a cleaner component that would be easier to use without the added information that this is a whale swimming.



timers

motion visualization for time

increment, point, medium

In order to explore relationships between motion and interface I created animations of what I called clocks or time pieces. Time is an increment, a definable point, a medium through which we move. (Caroll, Science Friday). My first study was a ten minute timer for midterm reviews. I made a simple timer that had a vertical format with a ball and a grid of horizontal lines marking every two minutes. I programmed the ball to move from the top to the bottom of the grid in ten minutes, the time allotment for my talk. The falling of the ball past the grid lines showed time passing. I projected this timer on the east wall of the presentation room. During my presentation I called attention to the clock when I talked about visualizing time as flowing data. Later I concentrated on the idea of creating visual interfaces for time. Our way of counting time evolved from a relationship to the rotation of our planet and its motion around the sun. Today we measure time by the rate of an atom. "Objective time is measured by cesium atom in an atomic clock, oscillating 9,192,631,770 times per second, it's accurate to within a second every 6 million years." (Zettl, 228). In the timer projects I looked at time as data flow by counting seconds, adding elements, combining intervals, or creating patterns of motion with significant sequences. I investigated time as a constantly flowing data set to visualize the flow of time like strings of "nows" using motion.

The mid-term timer was the first timer I made but the first timer I imagined was a timer made of blocks sliding from left to right on the screen, one block for each second. I imagined the blocks filling up the screen in a set period of time and then beginning again, in a different color, maybe filling a grid area or in a random pattern, the different methods visualizing time in different ways; highlighting different aspects of time, one more readable than the other. I made a series of clock experiments playing with the idea of blocks stretching to add up seconds.

While I was making the timer studies, I was also researching time as a concept. When the block idea started to lose interest for me, I asked myself how to visualize the perception of time. Sometimes the passage of time seems to speed up or slow down even though the actual rate of time is steady. I wondered if I could create a timer that shows perceived duration; "counting the degree of

involvement by how much we are aware of a certain duration in seconds, minutes, and hours…" (Zettl, 229). The next time study dropped numbers from one to sixty written as words from the top of the screen to the bottom edge in their respective number of seconds. The word "one" falls in one second, the word "sixty" falls in sixty seconds. In the first few seconds the rate feels quick and snappy. As the minute nears its end, the words fall more and more slowly. The perception of the time passing slows until it seems that the word sixty will never land. Then the next second starts, those first few seconds feeling even peppier.

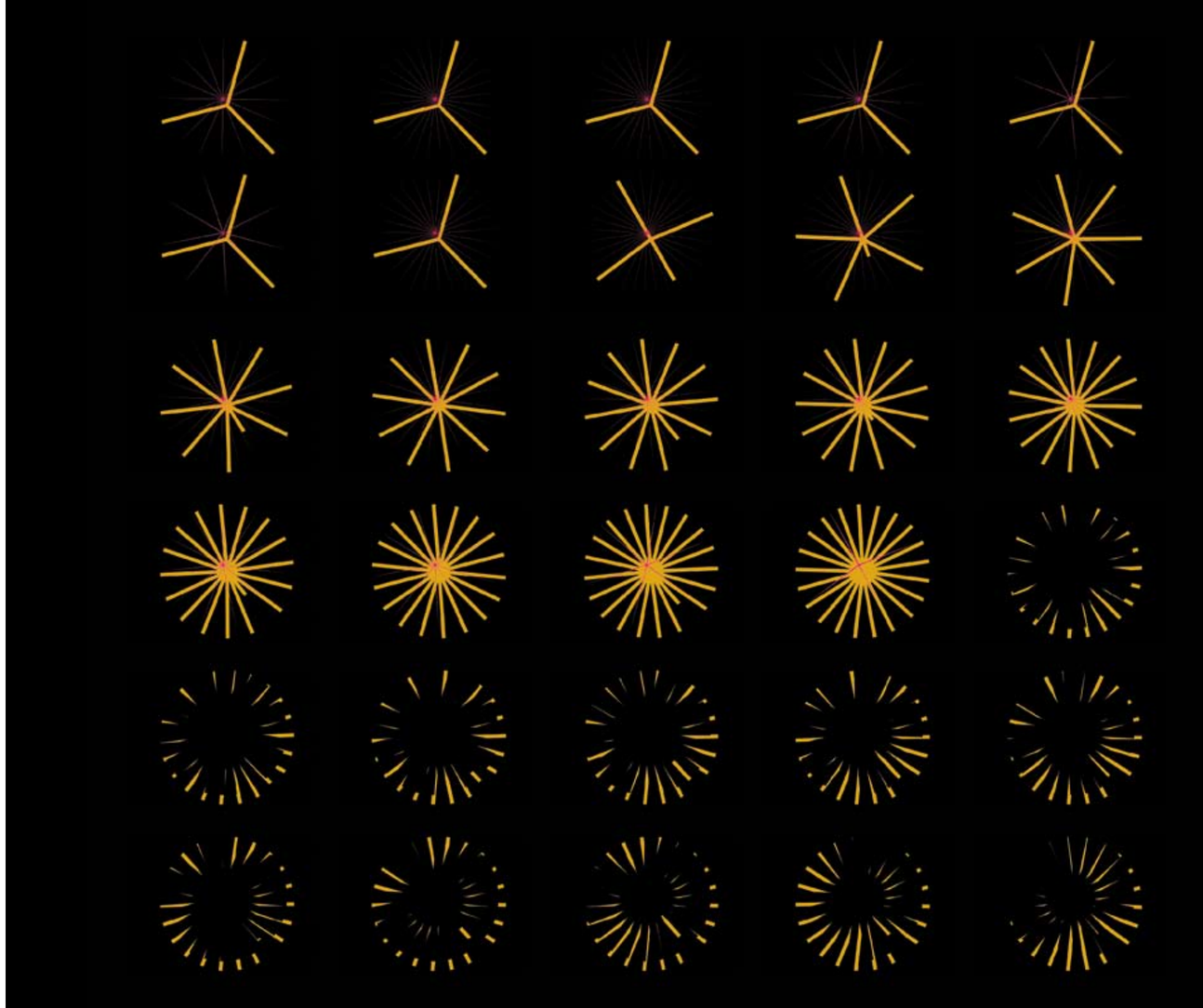
After trying to count every passing second, combining seconds into minutes and minutes into hours, I started thinking that system was an artificial construct superimposed over something more natural. At one point I had the idea to show time using groups of sounds playing at different intervals. Much as I wanted to work with the sound, I had to reluctantly accept the argument that sound created a conflict with the study of motion as a communication medium.

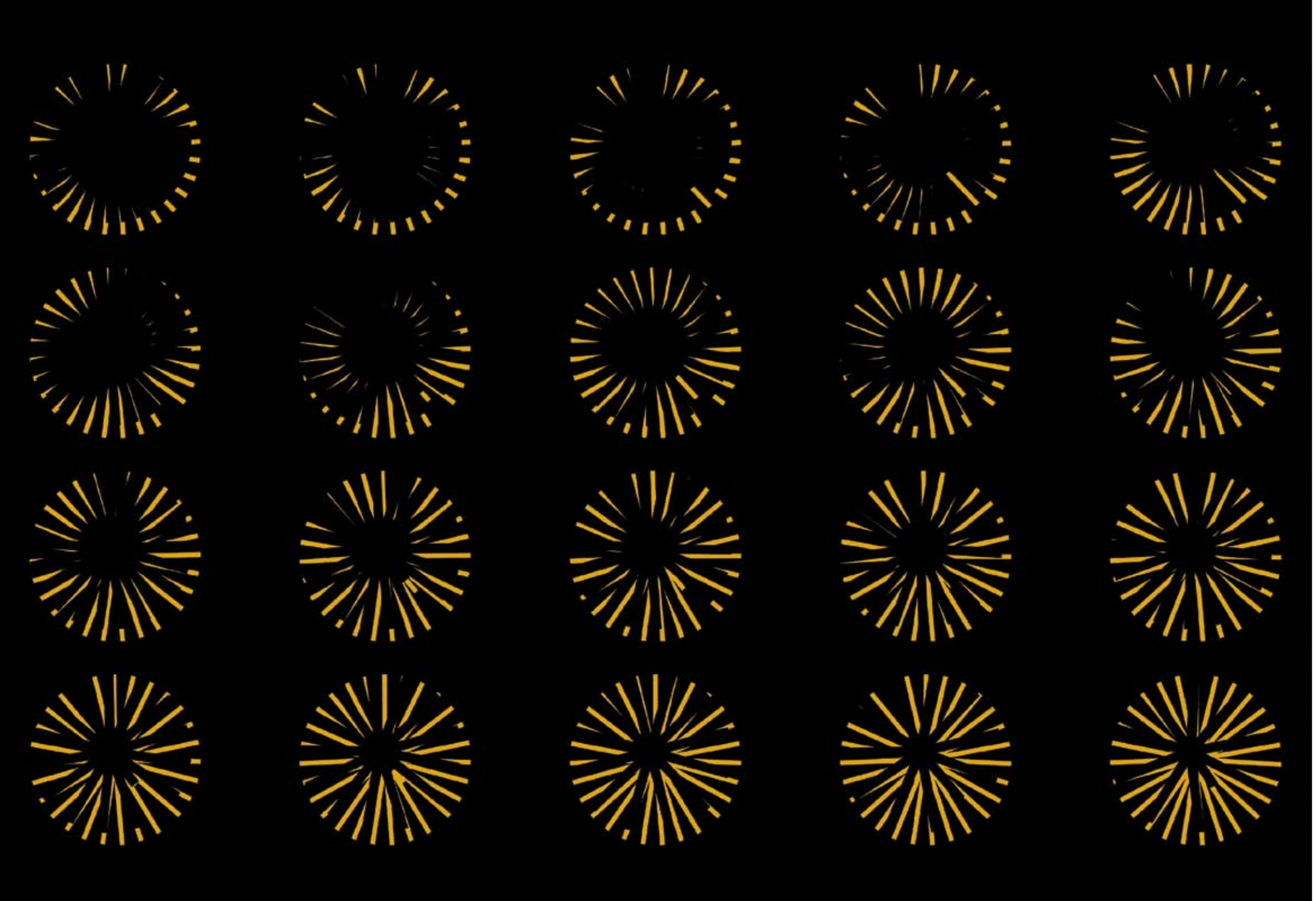
Instead, I translated the sound timer idea to showing inter-related intervals of motions, no longer trying to visualize every second but to create patterns of discrete groups of time segments into chords of movements. I made a series of sketches using planes. One with transparent intersecting planes moving against each other was easily visible.

The interval timers have a more relaxing aspect than the ones trying to count every second. It's hard to tell the time using them but pattern as a way visualizing data relates directly back to Alan Cooper's insistence that pattern is the "engine of unconscious recognition" in an interface.

Some general conclusions about motion from these studies are: Slow motions seem calming. Quick or fast motions attract attention. Synchronized motions also attract attention. Both can be used to create emphasis. There is an optimal speed zone, too fast or too slow and motion loses significance. More than one axis of measure can be helpful. Accumulating motions create complex messages. While complex messages are not bad, it can be challenging to make clear meaning. No motions are "wrong;" it's all about matching motion to message. The context matters, direction matters and a change in direction absolutely matters.

speed
rotate
grow
add on



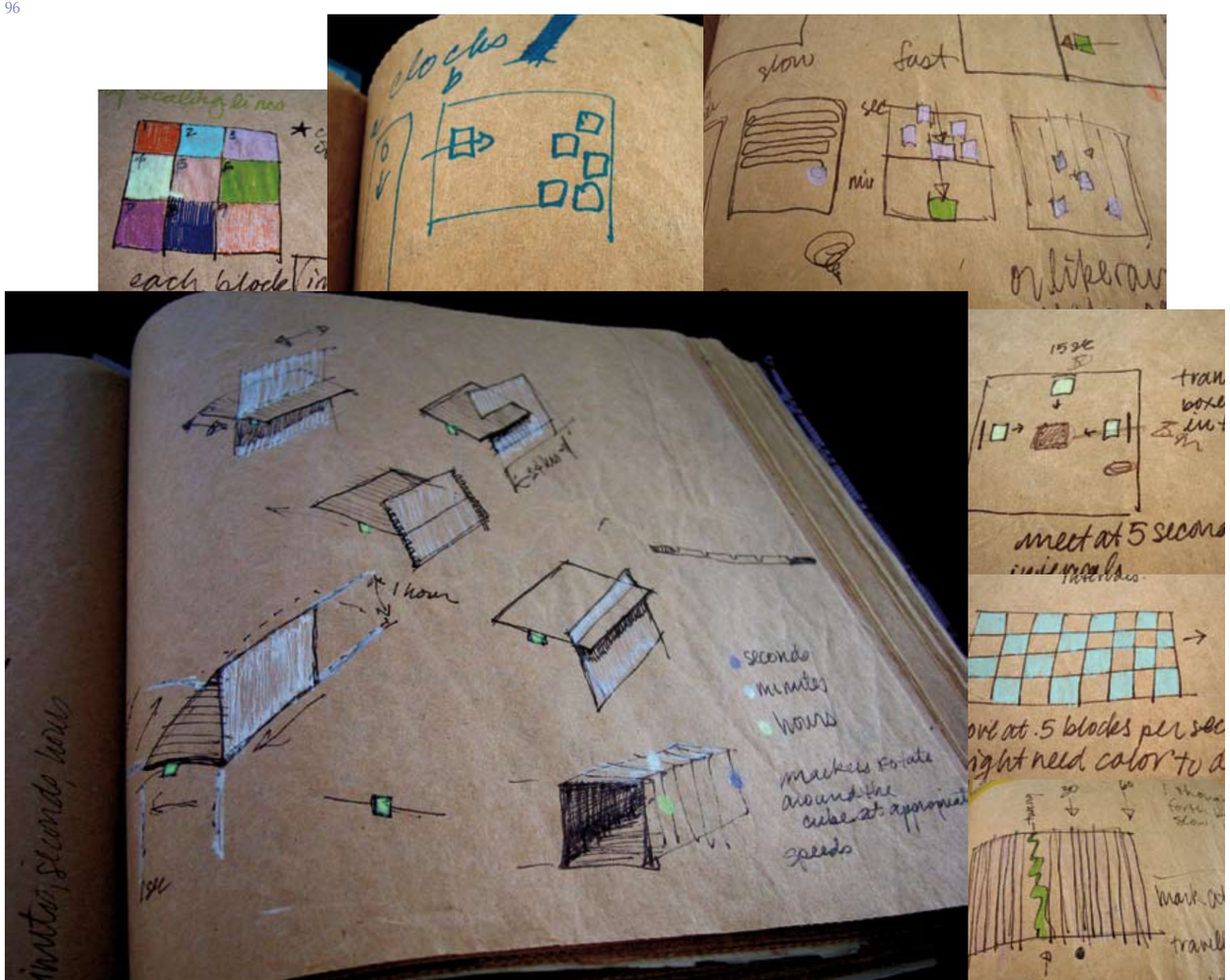


timer analysis

The timer project targeted a specific application for motion. It moved from the research-based projects into a phase of applied motion design. I felt that the motion studies I had done were left hanging without a project that applied my research to an actual interface. As I considered functional projects using motion in interface, the breadth of possibilities became paralyzing. In order to get traction, I decided to focus on a single project to solve visualization problems with motion. I decided if I was going to work on only one project, I had better choose carefully.

This project served to transform visual research into making research. It grew from the desire to use motion to show time as real-time data. Many ideas were considered. All of my more practical ideas for using motion in interface presented the problem of first creating a system. Each idea allowed limited opportunities for investigating the motion and significant challenges in working out the details of the system. The timer study was the most abstract of my ideas but also the most efficient one in allowing extensive opportunities for investigating motion as an interface for flowing data. All of my ideas are of interest to me. My consideration was practical and logical. My choice was entirely emotional. I liked the timer ideas the most.

My initial plan was to focus on the timer studies for half of a semester and then switch to a more applied interface problem for the second half. By the middle of the semester I was just starting to control the investigation. My earlier studies were rough, simplistic and had not yielded exciting visuals. By the middle of the semester, my ideas had begun to show progress that could result in completed sketches. I decided to continue making timer studies to see how far the topic would take me. When I made that decision, I had not yet realized how powerfully these studies paralleled the taxonomic overlay of structure that was brewing in my thinking for my motion video studies.



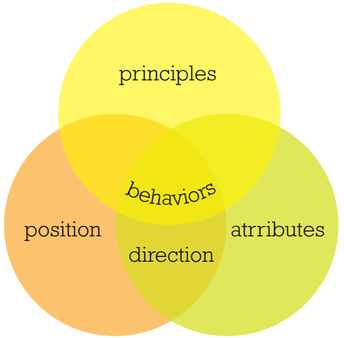
These are the ways I was looking at visualizing time in the timer projects. To the left are ideas from my sketchbook, many of which were advanced to animated studies. I used the types of transitions below to create the animations. These phrases describe the units of motion used to make the animations work.

Time:
transition duration
repetition rate
frequency tempo
cycle period
interval synchronization

Relative change:
shape morph
scale change
color change
transparency overlay

Cause and effect:
direction pull/push
surface disruption
spacial displacement
tension reaction
secondary response

Phase:
compositional sequence
linear sequence



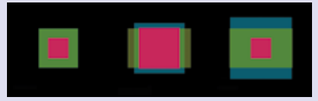
Behind that Pennsylvania barn, back where I grew up we had a little Beagle. People hunt for game out in those woods and a good hunting dog can be a real help. A Beagle's nose is thousands of times more sensitive than a human's. If you ever watch one chasing a rabbit you might see him running in circles as he follows the track the rabbit made as it spiraled through the brush. Humorously, the dog will run right past the rabbit several times as he follows the scent path the rabbit created because he believes his nose more than he believes his eyes. My search to understand motion for use in interface was a lot like that for me. I kept following a track that came close to the target but never quite hit it until the very end. When I started I was deeply confused. I didn't know how to begin to think about motion or how to apply it to an interface design. Today I see. I have a place to start thinking about motion and how it might apply to interface. This document is a stake in the sand. There is much more to be done to create a true methodology for using motion.

matrix for motion: mechanics

screen position

left, center, right		*whole screen*	
top, middle, bottom		*part of screen*	
z-axis		*center*	
circle		*edges*	
diagonal			

principles

rhythm		*sequence*	
texture		*synchronize*	
pattern		*pace or pacing*	
contrast		*transition*	
repetition		*order of events*	
continuity		*turn*	
sequence		*accumulation*	
interval		*reduction*	

multiple principles may be identified in a single gesture fragment and they may exist at different levels of intensity.

speed	slow			fast
noticeability	ambient			obvious
scale	away from			toward
depth	behind			in front of
distance	far			near
quantity	few			many
desnity	apart			 together

principles identified in example video

Multiple principles can apply to each gesture fragment. (Visual descriptions of principles on page 101.)

boys flip		*rhythm, pattern, synchronize, theme, turn, interval*
Motio rotation		*texture, repetition, continuity, contrast, theme*
lion fish wiggle		*rhythm, repetition, synchronize, interval*
beluga turns		*rhythm, continuity, contrast, transition , order of events*
anemone reaches		*rhythm, texture, pattern, continuity,*
ocean crashes		*rhythm, texture, pattern, repetition, continuity, sequence, interval, transition*

direction

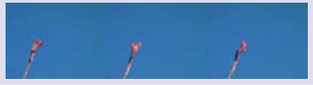
right

diagonal

left

toward

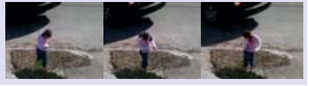
up



away from

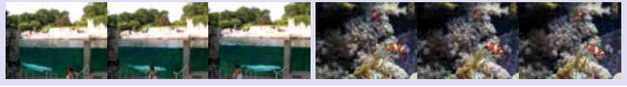
down

turn

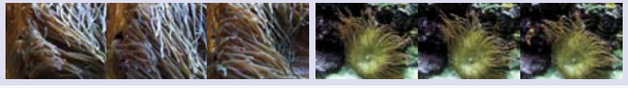


attributes

proximity: together, apart;

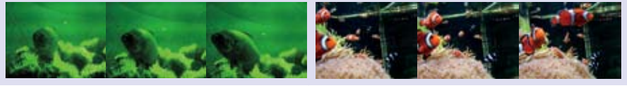


density: consolidated, dispersed;



distance: far away , near;

quantity: single object, multiple objects;



attributes

size: large elements; small elements move;

speed: fast, medium, slow;

scale: toward, away from;

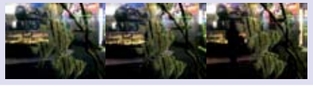
coincidence: before, during, after,

noticeability: obvious, subtle, ambient;

cause & effect;

change of focus.

depth: pass in front/behind.

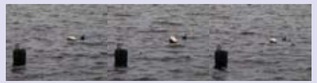


matrix for motion behaviors

examples of behaviors from matrix, page 74

sway

bob

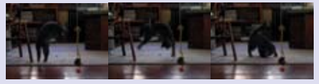


wave

crash

cross

jump



vibrate

pulse

ripple

pour

throw

worm

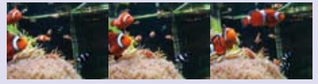
approach

pulse

flip

watch

cluster



hover

pounce

sigh

glide

slide

dump

wiggle

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