WHY WE DRAW

an exploration into how and why drawing works.

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Why We Draw
An Exploration Into How and Why Drawing Works

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This thesis is submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of Master of Science in Architecture.

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:: Abstract

Visual information allows us to experience concepts in a way that is analogous to the real world; an image represents the semantic meaning of a concept and does so without conforming to the structural or syntactic rules of standard language. Drawing is therefore an agile form of communication, able to maneuver around barriers that impede the exchange of ideas between one profession and another where the difference in cultural dialects gives rise to translation complications. This thesis argues that the value of visual information lies not in the final, finished images, but during the creation of those images, during the *action of drawing*. If drawings are generally considered a form of communication, then *drawing* is a form of *visual conversation*; much like spoken language, its message unfolds as it is performed, and we make meaning from that performance.

Following an exploration of the visual and cognitive systems integral to interpreting visual information, a discussion of language structure and sources of language conflict sets the stage for employing the act of drawing as a collaborative tool in cross-disciplinary settings. Proposed is a set of principles guiding this use of drawing which builds upon the research findings herein. These principles are structured to be usable by all professions, regardless of artistic background or traditional practice, and to encourage a reevaluation of drawing's role in the problem-solution process.

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:: Introduction

The use of drawings to communicate information is a long-standing practice, however it is my belief that it is in the actual *act of drawing* where the most information can be exchanged. At times, this exchange of information is internal to the one creating the drawing. Donald Schön, author of *The Reflective Practitioner*, speaks at length about the way a designer's understanding of a problem (and its many and far-reaching effects) and their proposed solutions co-evolve during an organic and fluid exchange between designer and concept. The drawings produced during this dialogue are a physical record of the thought process of the designer. This use of drawing highlights one of its most beneficial attributes: its ability to show us, even as we draw, new opportunities and solutions to the problem we are seeking to solve.

In other instances, drawing is employed as a means of communication; often overlooked however is its capability of transmitting more than merely visual data. Drawing is a *performative act*: its message unfolds in the moment much the same as spoken language, yet it is able to transmit meaning without adhering to the structural rules of established language. This informal flexibility pushes drawing away from the category of *communication* and toward that of *conversation*.

At the intersection of these two attributes of drawing, generation and conversation, we find an opportunity to move drawing beyond the professional territory of designers and artists. To do this, drawing must be presented as an easily accessible medium of collaboration that focuses not on artistic talent but rather on the communicative inherencies of the act itself. This requires investigation into three key areas: the relevancy of drawing to professional practice, the intrinsic values of the act of drawing as exploited by traditionally design-related fields, and how drawing can be elevated to a primary mode of communication.

This document is divided into three sections. The first, *Why Drawing Matters*, begins by tracing our interest in drawing from childhood through professional practice. It also includes analysis of responses to a survey of faculty across the Virginia Tech campus about the presence of drawing in their respective disciplines (excerpts of which can be found throughout this book). The second section, entitled *How Drawing Works*, traces the visual and cognitive pathways that are responsible for our abilities to interpret visual information as well as how we reverse that flow of information to *produce* drawings. In *Drawing As Conversation*, we explore the structure of language and its comparison to drawing, and potential sources of language conflicts (specifically within crossdisciplinary groups). In closing, we discuss a proposal for principles that might guide the use of drawing as a conversational tool aimed at overcoming these language barriers.

My personal perspective on this topic has been influenced by the works of Zenon Pylyshyn in the field of visual interpretation and mental imagining, the writings of Donald Schön on the reflective nature of drawing, and those of Don Norman and his persistent calling to make design meaningful to human beings. As such, this body of work serves as a compilation of the findings encountered while researching areas of science, design, and the collaborative environment as they relate to drawing. Though this book includes tangents through the realms of psychology, anatomy, television commercials, and board games, each can trace its origins back to the core question: *why do we draw?*

01.

WHY DRAWING MATTERS

Drawing is one of the most universal activities in which we as human beings participate from an early age. Drawing separates us from other species by its function of representing ideas without words — indeed even before we as individuals or a species learned to communicate with articulate sounds; some of the earliest known discernible marks made by human beings are pictorial in nature, representative of the world around them. Why then is drawing seen by many professions and disciplines as a sidenote, an asterisk to the greater methods of verbal and written communication? This view negates one of drawing's most valuable characteristics: its ability to show us, even as we draw, new solutions that we are incapable of reaching through mindpower alone.

:: Drawing Before Language

"The human mind is capable of amazing things, and to draw something we visualize in our head is unique to humans." - Survey #9

With children, drawing is an everyday occurrence, one that happens all around the globe and in all cultures. How common it is to see a child marking with crayon on a sheet of paper or on a more ambitious canvas such as a wall, creating images from which only they can deduce the true meaning. Children draw for fun, they draw to entertain themselves, they draw to share what is in their heads. The question is, what happened to that child-like fixation on drawing our thoughts? Why do doodles and sketches — for the majority of the working professions and academic disciplines — seem too elementary to be taken seriously? A closer look into how we learn to draw as children gives reasoning to this dismissal of drawing's relevance as we mature.

Can you remember the first time a writing instrument (a crayon, a marker, a pencil) was placed in your hand and you inadvertently pressed it against a hard surface, making a visible, physical mark? Though most likely you couldn't articulate it at the time, you saw the result of an action, one that created a permanent record of that action. What change did this cause in your brain? It gave you an avenue for impacting the world around you in a way that other (older) human beings could begin to understand. This first encounter may come earlier for some, but on average children learn to scribble at age two. At this age, the motor skills necessary to direct the scribbling motions are less than established, but quickly, only about a year later, they are capable of allowing a child to draw recognizable shapes such as triangles, squares, and the like (see fig. 2). Typically, around the age of four, children begin to draw their first representations (distinguishable by other people) of human beings. They usually follow a similar formula: a rounded, circular shape for the head, with dots inside the circle for eyes, with a line or oval for the mouth |Steinhart, 2004|. While a child might tell you that her drawing is one of "Grandma" or "Jimmy," it rarely bears a close resemblance to Grandma or Jimmy. Here lies a key point: children draw what they *know*, not what they *see*. To them, the circle with one eye bigger than the other is Grandma, not because one of Grandma's eyes is larger than the other, but because the child was thinking of Grandma while making the drawing. In another example, if you ask a child to draw two bananas (which in physical space are overlapping each other), typically the child will draw two bananas — one beside the other; they know that in their field of vision there are two bananas, so they represent them that way in the drawing |Steinhart, Undressed Art|.

"I did draw a lot as a child...I stopped drawing that way when I realized that I did not have the skill to truly capture what I saw and became frustrated." - Survey #41

As children age, their ability to represent what they see as a reproduction of their observations lags behind their grasp on language, and this gap in skill causes them to become increasingly critical of and frustrated by their drawings. The brain is beginning to lateralize, or specialize functions into left-brain and right-brain processes; the left hemisphere of the cerebral cortex is devoted to logic and analysis, categorization, naming, and symbols, while the right hemisphere is more intuitive, activated more by spatial relationships than quantities |Steinhart, 2004|.

> Not long after the age of ten, the switch to explaining and representing the outside world through spoken or written language is complete.

Typically by the age of ten, the two hemispheres are carrying on their own functions, reducing the ability to cross-over from one way of analyzing to the other when observing and representing the world around us. As this lateralization process is taking place, things that a child would have expressed through drawing are increasingly expressed through verbal language. Eventually, not long after the age of ten, the switch to explaining, describing, and representing the outside world (as well as internal thoughts) through spoken or written language is basically complete |Steinhart, 2004|.

The educational system also plays a significant role in this shift. When literature, mathematics, and science are the focus of educational curricula, drawing out ideas and thoughts is less encouraged — and often penalized. We see drawing as something that is less quantifiably evaluated, unable to compare it with standardized teaching and testing practices, and regard its immeasurable nature as a hindrance to academic progress.

"However, I am a horrible artist, so most of my drawings end up looking like a 5 year old's." - Survey #42

So what happens when a child stops drawing? Their drawing ability doesn't progress beyond the last time they drew. And if that child was to revisit drawing later in life, perhaps 30 years later, their ability to represent things around them will be almost exactly as it was when they were nine or ten. As mentioned before, a child draws what they know, rather than what they see. As Peter Steinhart describes in *The Undressed Art*, "Once a child has worked out a conventional person or house or kitten or dog, that child will go on drawing the same version over and over again...Once the brain lays down these connections, they may hold on to their franchise forever" |Steinhart, 2004|. It is no wonder then that adults who haven't drawn for years are often ashamed of even attempting to represent anything pictorially and instead continue to increase their fluency and usage of written and verbal language.

Where did the enjoyment and fascination with drawing go? It was replaced as we matured with the more conventional, learned, reliable structure of language. To be clear, a healthy grasp of language is of great importance, however it raises the question: do the long-lasting effects of this heavy emphasis on language and analytical thinking impact the way we view the validity of certain forms of communication later in life?

:: Questioning Drawing's Credibility

Throughout the design education program, we are presented with opportunities to work with students and faculty from varying disciplines, each with their accompanying approaches to problem-solving. As each project begins, hopes are high that the group dynamic will be open, inclusive and productive, but all too often the group falls victim to differing academic deadlines, varying priority on individual parts of

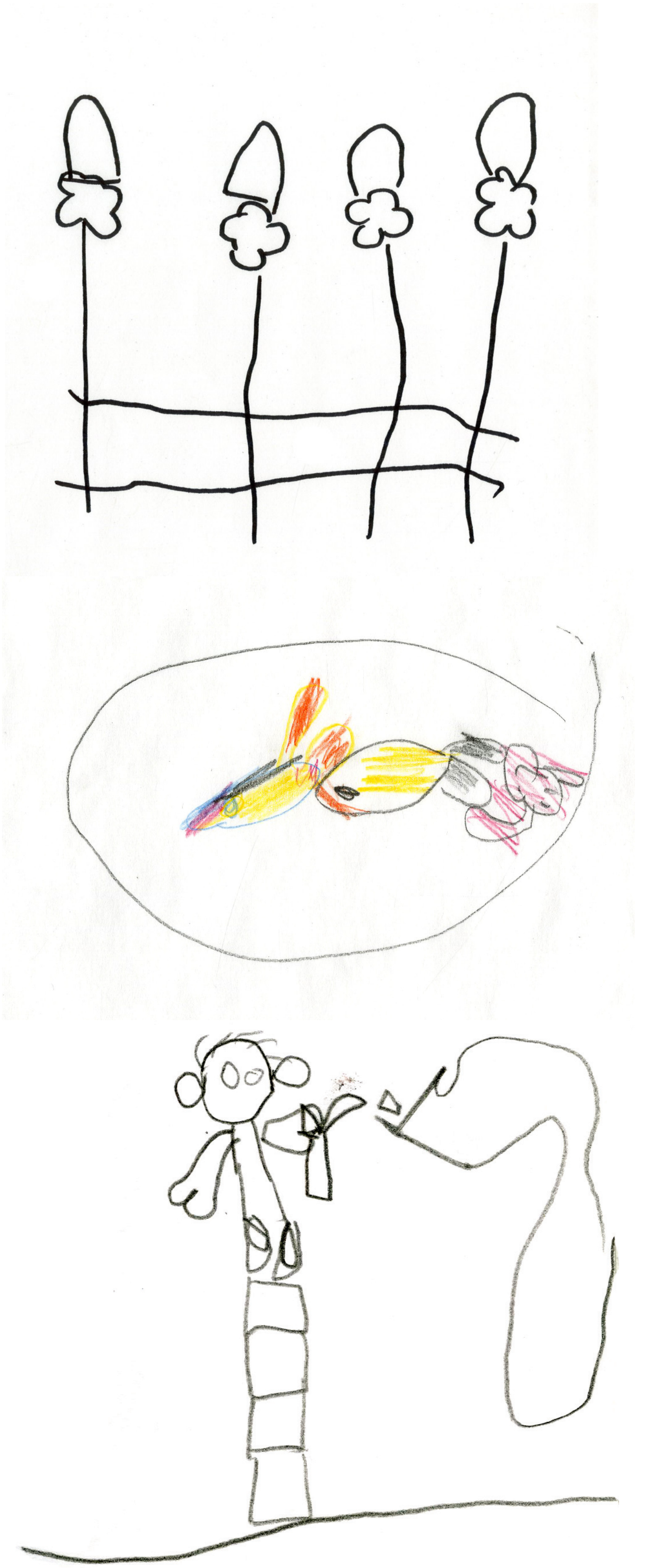


fig. 2. drawings from 4-year-olds: from top, "The flowers are getting the triangles but the triangles are up high. The flowers are bigger so they can hold the triangle and they are cut"; fish in a bowl; and "Man on a ladder with a hammer fixing an ice cream shop."

the problem-solving process, and, ultimately, an ill-informed view of the purpose of the project and the role of each participant in the group. In discussing the outcomes of these cross-disciplinary group projects with other design students, patterns emerge about the preconceptions of the use of visual imagery in group projects. The following are some of these issues surrounding designers and drawing:

First, many people assume the job of design is to make “pretty pictures” and that they lack a comprehensive (or professional) understanding of how the design will work or how their concepts could be implemented. For instance, in approaching a reputable professor of engineering, we presented a comprehensive document proposing not only a concept for a new transportation system, but an accompanying cost analysis and implication timeline. The idea was initially waved off as superficial and insubstantial: “All you have are pretty pictures; the ‘warm fuzzies’ of a feel good idea. Where’s the data?” What he failed to realize was that the data was in the document, the research was compiled, the plan was thought through and proposed on a reasonable time scale; but what he saw, what first caught his eye and commanded his attention, were the rendered images used to sell the idea — to designers. These photorealistic representations of the concept hijacked his ability to view the proposal objectively, and overshadowed the substance of the ideas contained within. Eventually, after much backtracking and rejustification of the need for such a system, we were able to begin proceeding with gathering together the necessary players to move forward on the realization of the total concept.

Second, drawing is not accepted as a quantifiable endeavor in the traditional sense, and as such is deemed to be less important in the formula-driven professions. It is true that the effectiveness of a drawing cannot be measured along a metric of requirements per se, but it is tacitly evident when a drawing is successful — when the audience, whether the group or an external body, *gets it*. This lack of classification causes a difference in prioritizing group efforts because the drawing stage is seen to be only useful at the front end of a project or, again at the end, when the group desires “pretty pictures” to sell an idea. One aim of the following research and discussion is to offer a different method of measuring the effectance of drawing as it relates to group ventures, one based on internal, cognitive dimensions.

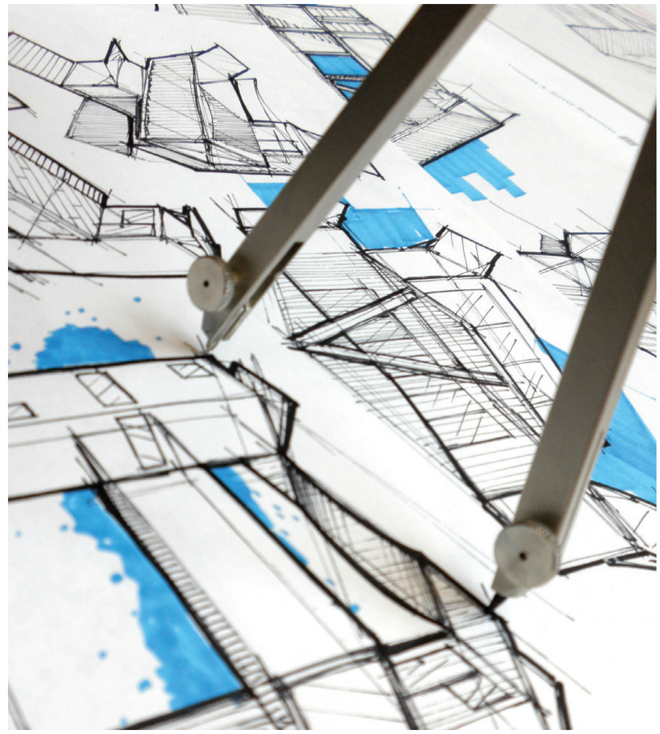


fig. 3. drawing’s lack of quantifiability is often the source of its criticism as a solution-generation tool.

Lastly, showing our best drawings prematurely (before the near-final or final stages of the problem-solving process) has a tendency to backfire; non-designers tend to believe that what we show them is our ultimate and final solution, regardless of the stage of design. In addition to rough sketches designers produce renderings, highly detailed images with the intent of creating a realistic interpretation of design concepts; however, these images are often taken as the culmination of the design process and interpreted by non-designers as being what we, the designers, are set on producing. Perhaps what is required here is a sensitivity on the part of designers to modulate the intensity of the drawings we share, not a “dumbing down” of drawing ability, but a stronger focus on accuracy and connection with our audience.

Susan Kemp and Sharon Sutton from the University of Washington (School of Social Work and School of Architecture and Design, respectively) summarize these concerns in a study weighing the advantages of the design approach in the realm of community-based design problems. They state that designers help by "generating beautiful, functional solutions to complex spatial problems. At the same time, they create visual representations that help people make sense of their spatial experiences and communicate with each other about possible spatial changes." However, "because designers co-evolve problem and solution, they appear to leap to conclusions, which may lead social scientists and community members alike to perceive them as unresponsive or self-indulgent," They also warn, and rightly so, that "their emphasis on artistic expression may also seem irrelevant to pressing community concerns" | Kemp&Sutton, 2006 |.

Perhaps what is required here is a sensitivity on the part of designers to modulate the intensity of the drawings we share, and a stronger connection with our audience.

These views, when taken together, suggest that a core competency of design-based professions — drawing — is seen by other professions as lacking credible substance when compared with the more concrete and analytical practices of non-design disciplines. In an attempt to determine if these perspectives were the same across the spectrum of academic disciplines, it was necessary to gather a larger body of opinions about the importance of drawing.

:: Why Do We Draw?

To gather this insight, a simple survey was conducted of faculty at Virginia Polytechnic Institute and State University (see IRB approval letter in appendices). The survey consisted of only one question: why do we draw? Participants (who were solicited through emails generated by participating university department offices and gave their consent to having their responses used in this thesis by responding) were asked to answer the question in any way they wished and to include in their response their area of expertise or discipline. While the total number of responses was small (only 45), they were submitted by disciplines as diverse as human development, agriculture, engineering, business, creative writing, economics, and molecular biology (see fig. 4). The responses ranged from quick and concise to thorough and detailed, and from personal to professional, and, perhaps because of the protective cover of anonymity, they were all quite candid (a full 20% of respondents cited "doodling" during meetings to prevent boredom). While the exact content of the responses varied, it was quickly evident that similarities exist in the way these differing disciplines utilize drawing. These similarities led to the organization of five categories of the uses of drawing: expression, comprehension, documentation, communication, and generation. The following comments are particularly telling of the type of drawing which they precede.

Expression:

"Drawing offers a vehicle for human expression, emotion, desire, deviance, and CATHARSIS. There you go, Drawing is cathartic." - Survey #1

"We draw to express immediate feelings or to reflect on feelings from the past or connections between the two." - Survey #14

"I think there is an impulse for creativity from a very early age that some of us engage in more than others." - Survey #38

"The inspirational reasons for drawing are to express myself in an artistic fashion." - Survey #42

Roughly one-quarter of the total responses (27%) mentioned that drawing was a means of expression, with those responses being split almost equally between emotional expression and creative expression (one response did not clarify). Some of the participants who cited drawing as a method of creative expression clarified that it was a way for children to be artistically expressive, while there was frequent mention of using drawing as emotional release for adults during therapy sessions.

Comprehension:

"I draw to simplify concepts." - Survey #3

"Sometimes I draw for myself — to help myself understand or process information." - Survey #18

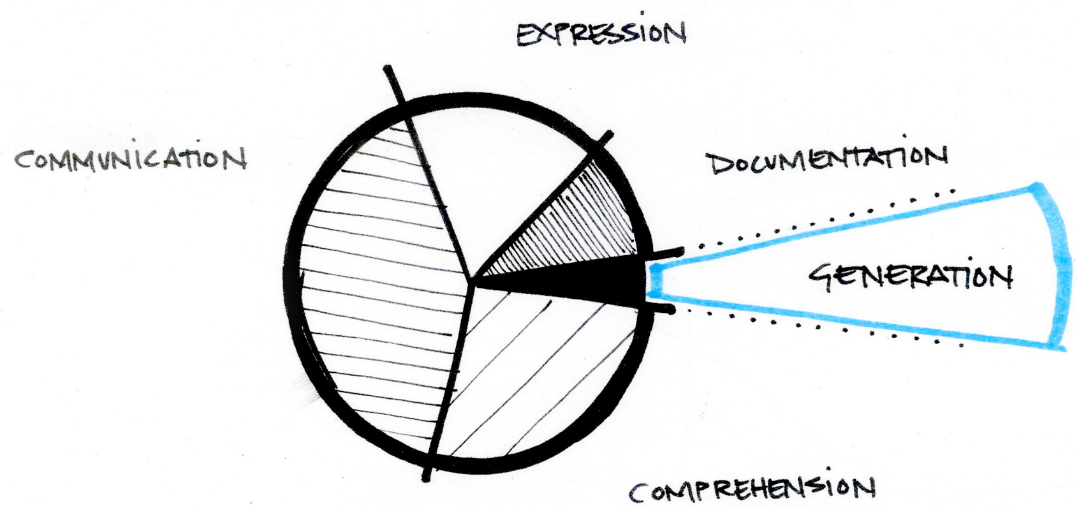


fig. 4. responses from non-design disciplines: comprehension (40%), communication (58%), expression (27%), documentation (20%), and generation (7%).

"Most people seem to perceive a graphic form better than text or numeric forms. I belong to those people." - Survey #24

For the purposes of categorization, the term "comprehension" is used to include drawing as a way of clarifying what is being heard or observed as well as to make abstract concepts more concrete and understandable; drawing as a tool for comprehension was the second-most frequent mode of drawing among the participants surveyed (40% of the total responses). In this mode, drawing becomes a tool for interpreting and storing information — for *internalizing* information.

Documentation:
"To save a copy of something when I need to remember size, shape, function and interaction." - Survey #34

"In my discipline (plant pathology) I primarily draw to record structures of microbes, their measurements, shape, etc." - Survey #27

"Other times it was completely functional, such as building plans for my tree house." - Survey #41

Drawing is also an effective means of recording observations, and making notes of specific, detailed information for the purposes of consulting those drawings again later to recall that information; 20% of all responses mentioned that they draw in order to document something about their profession.

Communication:
"To communicate or express ideas or information." - Survey #32

"Also, I often want a drawing to convey a message to a broad audience or an audience who has limited time to receive my message." - Survey #35

"In my field, scientists draw mainly to share the information or facts or research findings to other colleagues." - Survey #23

The use of drawing for communicating was identified by the majority of survey participants (58%). Often, responses stated that drawings were used when demonstrating something to others (like when illustrating *how* to do something), or in place of words when either the correct words cannot be recalled or when, as one respondent described, "our descriptive techniques are inadequate."

Generation:
"To better conceptualize and develop concepts." - Survey #22

In clarifying survey results, the term "generation" is used to describe a mode of drawing in which the actual act of drawing is integral to the discovery and development of new ideas. One of the clearest statements of using drawing as a generative tool came from a molecular biologist: "Many times it helps us think of new connections and synthesize new ideas." This type of drawing received the lowest number of responses (7%).

These survey results lead to the conclusion that drawing is common across disciplines but the modes in which we draw — and therefore our reliance on drawing in our problem-solving process — are weighted differently. Many professions that draw do so with the intention of either internalizing information individually, or documenting information so that it can be transferred (communicated) to others. Expressive drawing, however, involves the act of getting ideas and emotions *out*, but is seldom utilized in non-art-related disciplines (with exceptions such as therapy and child development). What then of generative drawing? Perhaps it could be said that generative drawing is the synthesis of all four, comprehension and expression, documentation and communication, and has the ability to lead to each of the other modes when the need arises. Figure 5 displays these five different types of drawing uses arranged along two dimensions of measurement: internal-external and abstract-concrete. The internal-external axis compares whether the end product of the drawing mode is for the individual creating the drawing or for others outside of the artist, while the abstract-concrete axis is used to qualify the content of the drawings. If generative drawing contains elements of the other drawing modes, then it belongs at the intersection of these modes as represented in the chart (fig. 5).

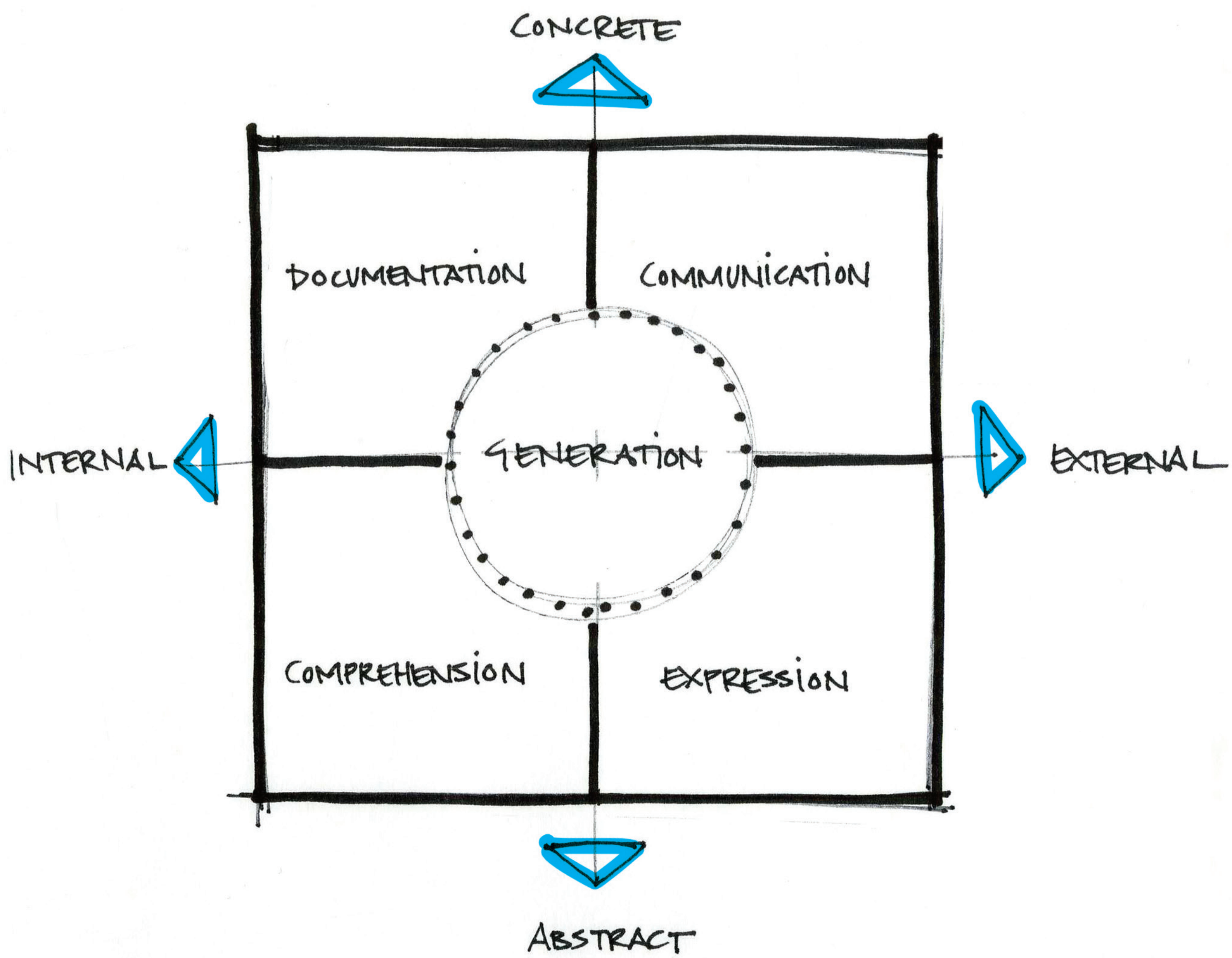


fig. 5. chart comparing drawing modes on internal-external and abstract-concrete. Generation is superimposed on the intersection showing that it leads to the other modes.

The basic premise of this thesis is that drawing is one of the most simple and yet most effective means of communicating and developing abstract ideas. In this world of ever-increasing reliance on technological solutions to issues, it would be unwise to overlook the efficiency of simple, expedient, analog modes of explanation. This essay is not an argument against the importance or necessity of digital technologies or methods, but rather a chance to explain the difference between the increasingly precise, digital world that we are creating and our relative, context-reliant, analog human nature. In *The Invisible Computer*, Don Norman states:

> "It is perfectly proper and reasonable for machines to use digital encodings for their internal workings. Machines do better with digital encoding. The problem comes about in the form of interaction between people and machines. People do best with signals and information that fit the way they perceive and think, which is analogous to the real world. Machines do best with signals and information that are suited for the way they function, which means digital, rigid, precise" |Norman, 1999|.

Our most sophisticated systems, created by humans, behave quite unlike human beings. This is understandable, as humans are unable of being precise down to thousandths of an inch or accurately measuring parts-per-million, however these systems are based on computing and mathematics where precision is the rule. And therein lies the fault with these rigid, standardized processes when dealing with abstract concepts: they are mathematic attempts at replicating the actual world around us.

A digital camera, for example, will never be as true to human vision as one that uses film because the image that it produces has been compiled by turning analog signals (light) into digital representations of those signals (pixels) and aggregating them into a patchwork picture. In the best conditions this translation is quite effective and therefore unnoticeable, but as light conditions worsen, the digital "brain" of the camera uses intense algorithms to deduce what color pixel to place in the areas that it can't quite make out -- leading to "noise" in the final photograph. Film photography, on the other hand, needs no translation stage -- the shutter opens and the available light and color (as reflected by the objects at which the camera is pointed) creates an imprint on the light-sensitive film. We will not discuss the merits of compressing and storing digital files versus photo film, but as a means of "capturing" the real world around us, the analog minimizes the possibility for visual information to be lost during the translation from world-to-film.

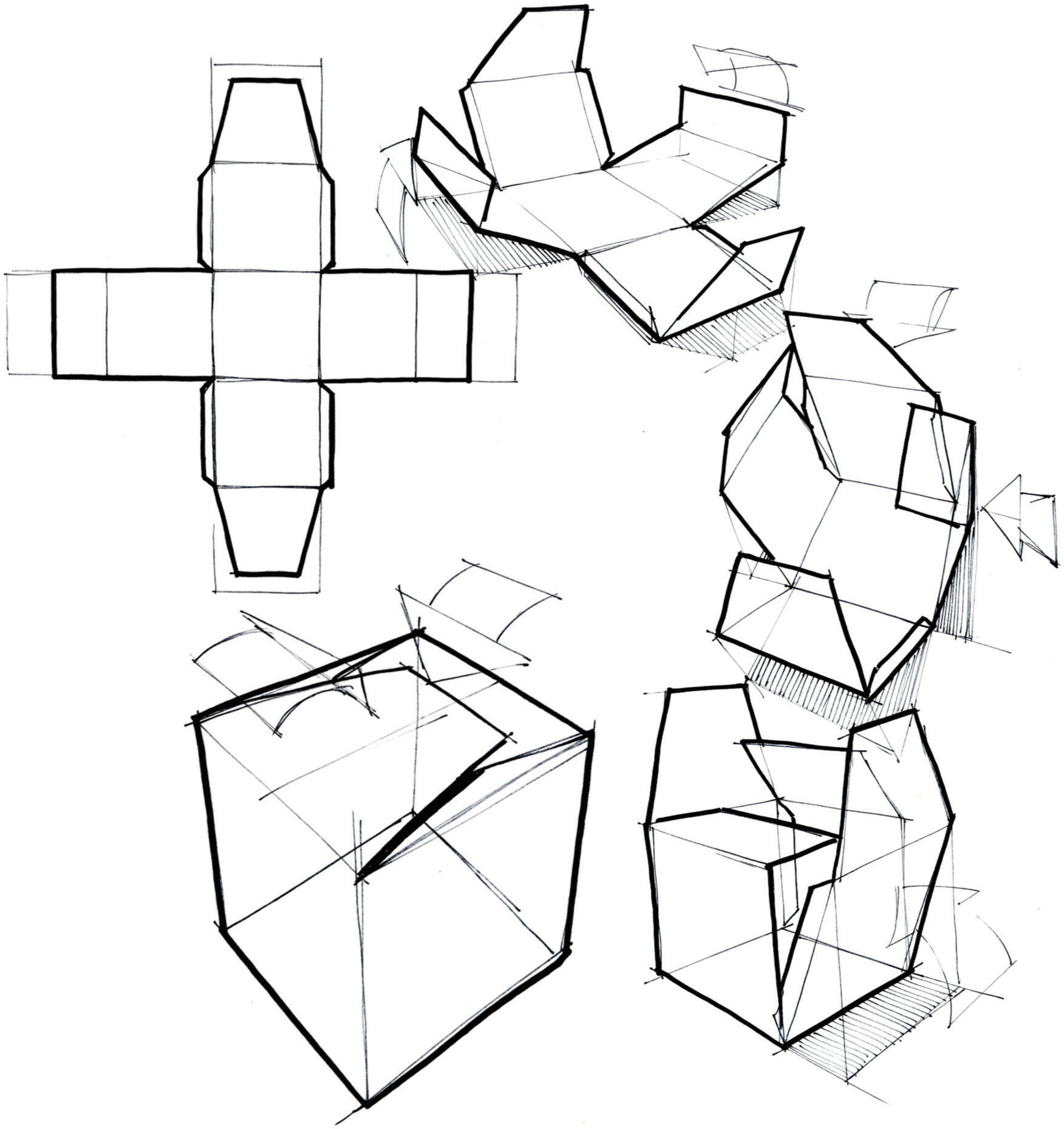
Drawing is one of the most natural methods of exchanging ideas because it is representative of how we actually interact with the world.

When dealing with abstract concepts (such as time, size, mood, etc.), digital representations lack relativity, or context, to the broader scope of whatever is being discussed or determined. In his book, *Information Graphics*, Wilbur Burke expresses his appreciation for representing time with an analog clock. He notes that "we relate the present moment to the larger framework of before or after noon, to the context of the present hour and, finally, to a particular five-minute span." He continues by positing that this sense of context "accords with the way in which we normally sense and observe things, relating the particular to the general, whether consciously or unconsciously" |Burke, 1998|. If an analog clock presents time along with context, it can be argued that a digital clock is absolute: it tells the truth, and nothing but the truth, but perhaps not the *whole truth* . A typical digital clock delivers what we want to know (the time) down to the most accurate measurement (tenths or even hundredths of a second), but not much else. If we wish to know how long ago something happened, we must perform a mathematic (digital) operation, whereas with an analog clock we can visually confirm how far the minute or hour hand has moved since that specific occurrence. Imagine, for a moment, that you have never before seen a clock. If you were to encounter a digital clock, what would you make of it? A series of numbers, constantly changing one at a time until suddenly two or three of the numbers change at once! Contrast this with encountering an analog clock; after 60 seconds it becomes clear that this cyclic motion resembles an increment of a larger system. Visually, the clock face depicts the scale of what's being measured and how to place the immediate bits of information on that scale.

As a final comparison of analog (relative) and digital (precise), we will look briefly at the history of the London Underground map. This ubiquitous map, with its definitive graphic layout and far-reaching influence on subway maps around the world, is a wonderful example of choosing representation over resemblance in an attempt to make absolute information graspable by commuters on the "Tube". Since its inception in the 1860s, maps accompanying the London Underground were largely geographical maps overlaid with the routes of the separate lines, becoming increasingly complex as new lines were added or extended. In 1933 Henry Beck, an electrical draftsman, applied his knowledge of electrical diagrams and created the first schematically-based map of the Tube. According to John Walker in *Communicating Design: Essays in Visual Communication*, "Beck realized that clarity and geographical truth were antithetical to one another and that geographical accuracy had to be abandoned in favor of clarity. In other words, Beck's choice of diagram rather than map was the result of an evaluation of different modes of representation in relation to the needs of the traveling public" |Triggs, 1995|. Making a break from the geographically-based maps which preceded his own required Beck to distill out the most important information that one traveling on the London Underground might wish to know: he gave priority to easily identifying what was next or before, or how many stops until the desired one, rather than cardinal direction or curvature of the subway tunnel or the exact distance between stops. He chose relativity (analog) over precision (digital), and his approach made the London Underground map one of the most lasting, usable, and recognizable tools for public navigation in history.

Here I wish to set the foundation for why drawing matters to human beings and why, with all the great advances in precise, digital technologies, something as simple and elementary as drawing will remain relevant and utilized on a world-wide scale. We are analog creatures; we operate by comparing and contrasting one option against another, giving preference to experience rather than logic, and rely heavily on our perception of the way the world works around us rather than explicit descriptions of every minute detail. We are able to assemble the parts into a whole without being consciously aware that we are doing so, and in the process we are able to overlook or compensate for gaps in information. When we attempt to exchange ideas or abstract concepts, drawing is one of the most natural methods of doing so because it is representative of the way we actually interact with the world around us, and it creates the experience of those interactions. This notion of human-as-analog will resurface later as we discuss ways that might maximize drawing's ability to create an environment of conversation when exchanging ideas.

02.



HOW DRAWING WORKS

To make the case that drawing is a productive means of solution-finding, it is imperative to investigate the two systems which allow us to see objects in our surroundings and to interpret those signals and assign them meaning. This requires an explanation of our visual mechanisms as well as what we know from cognitive psychology about our brain's inner workings.

While the process by which our brains receive visual inputs seems fairly straightforward, the process that allows us to internalize and create meaning from that information is much less so. This process is called cognition, and it is described as the mental process of knowing, which includes aspects such as awareness, perception, reasoning, and judgement. Psychology, very generally, studies and posits theories about how our brain does what it does and the behaviors that result from those processes. Cognitive psychology, more specifically, focuses on the mental happenings that allow us to understand abstract concepts; to learn and gather experiences and apply them to subsequent situations of similar or dissimilar nature, and so on. The following sections, will examine several perspectives on how our *visual abilities* relate to our *cognitive abilties* and how drawing, in turn, is the catalyst for activating them both simultaneously.

:: How Vision Works

The science of how our eyes gather visual information is well documented and generally agreed upon by those studying human anatomy. As light is reflected from an object in our field of view it passes through the cornea, then through the lens, and is projected upside down (a result of light rays crossing while passing through the lens) onto the retina. At the back of the retina is a thin layer of cells comprised of photoreceptors called rods (responsible for detecting changes in light) and cones (capable of determining color) which gather the light and color information, turn it into electrical signals, and pass those signals through the optic nerve to the visual cortex at the back of the brain. (fig. 7)

This part of the process can be compared to that of a package delivery service. Let's say that you've ordered a set of glass shelves from a company far away from your location and are having them delivered to your home. This particular set of shelves includes hardware from one supplier, special fittings from another, a brushed metal frame from another, and the actual glass shelves from yet another supplier. Each component is packaged at its respective location (the outside world in our analogy) and shipped to a delivery hub. It is there at the hub (our retina) that the packages are sorted and organized (by our rods and cones), and gathered together for shipment to your address. The delivery truck takes the place of our optic nerve; it is responsible solely for getting the packages to the final destination. Once delivered, it is your job to unpackage each box and assemble the shelves correctly; you are left with the task of making sense of what you've received. (see fig. 7)

Once this visual package has been opened, each bit of information is then sent by the occipital lobe to other parts of the brain (up to 30 different areas). For example, information about the identity of an object (what the object is) activates the ventral stream of the temporal lobe, while an object's location in space (where an object is) activates the dorsal stream, found in the parietal lobe (just above the visual cortex). Other information, such as emotional response to visual stimuli, excites the limbic system which is buried deep in our inner brain |Wujec, 2009|. Tom Wujec, an information designer and Fellow at Autodesk, explains

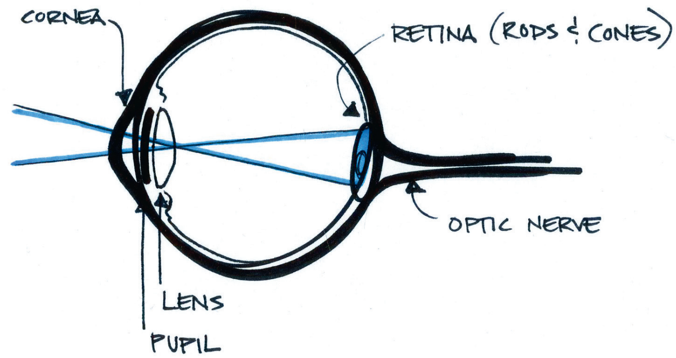


fig. 7. simplified diagram of the human eye showing that light passes through the cornea, focused by the lens, and projected onto the retina.

The brain doesn't see the world as it is, but instead creates mental models through a collection of "aha!" moments.

how this mechanical acquisition of visual information begins to be interpreted by our brain, allowing us to recognize and understand what exactly we are looking at: "The brain doesn't actually see the world as it is, but instead creates a series of mental models through a collection of 'aha!' moments, or moments of discovery through various processes" |Wujec, 2009|. He proposes that our eyes visually interrogate our surroundings, constantly acquiring individual aspects which the brain compiles into a unified mental model that represents what we see. In short, the way we make meaning is by covertly "knowing" what we are seeing rather than by overtly identifying everything in sight.

:: Gestalt Perception Effects

This ability to make sense of the visual world around us by creating a map of *what things are* rather than *what they look like* can be described through the theories of Gestalt psychology. This particular psychological perspective stems from the now-familiar idea that "the whole is greater than the sum of its parts." In fact, the German word "Gestalten" can be translated to mean "configuration," and it follows that Gestalt theorists believe that our perceptive abilities are based not on the individual elements in our surroundings but

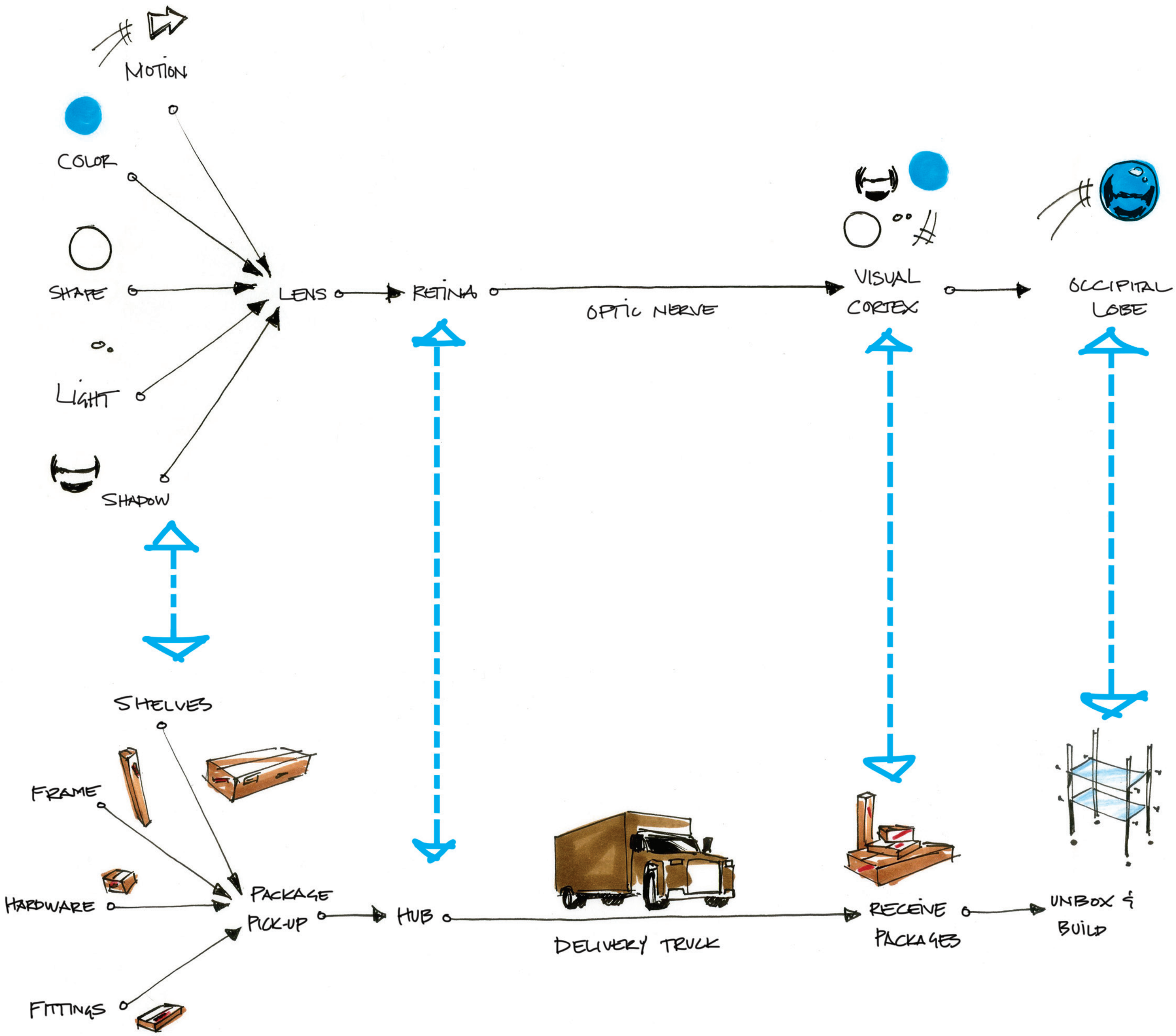


fig. 8. comparison of visual pathway to package delivery service: individual pieces of visual information [shelving components] are picked up by the lens and passed to the retina [hub]. The optic nerve [delivery truck] then carries the information to the visual cortex [package reception] where it is reassembled by the occipital lobe so that we can know [use] what we have seen.

on the way they are arranged and how they interact |Walker, 1966|. For instance, if there was a tall fence in our field of view and just above that fence was the head of our neighbor, moving from left to right, we would likely interpret it to be our neighbor walking across his lawn rather than our neighbor's head mysteriously floating around. But why? We cannot see all of our neighbor's body and thus cannot be sure that he is "all there," however we make the connection that heads do not usually float around on their own and should therefore be attached to a body that causes the movement. In short, we do not need all of the visual information about an object to know what that object is if that object creates the same *experience* as that of something that we have encountered before. A simpler example can be seen in the following image, where six unconnected lines are arranged in an open contour. What do you see?

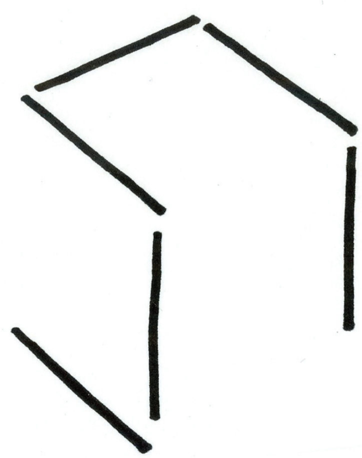


fig. 9. example of the Gestalt principle of *closure.*

Did you see a cube? Why? There is no cube in that figure except the one that your mind *assumes* exists because the lines describe what could be interpreted as the edges of such a cube. Gestalt perceptual theory provides principles of how our visual and cognitive systems work in conjunction to make meaning of the visual world, most of which relate most directly to two-dimensional images (i.e. drawings). The line-cube figure above is an example of *closure*, in which our minds complete or "fill in" an incomplete image to make it have meaning. Other principles include *good continuation, similarity,* and *apparent motion* |Walker, 1966|. Figures 10, 11, and 12 include examples and explanations of these principles.

These principles could be considered as subcategories of the Gestalt Law of Prägnanz; this "law" is predicated on the belief that we organize our perception of our environment so that it becomes as simple and orderly as possible (i.e. so that it "makes sense"). Typically shortened to an understanding that "good figures" — those that are simple, symmetric, and balanced — aid in determining this organization. Figure 13 presents a situation in which a pair of intersecting lines create closed contours. Do you see the overlapping of a circle and a square (b)? Or three closely-nestled irregular shapes (c)? At first glance we perceive the image as two simple geometric shapes overlapping — our minds make this assumption almost immediately; to see the three irregular shapes, we must make a conscious effort to *intentionally focus our attention* to the area of overlap to determine if, in fact, three shapes exist in the image.

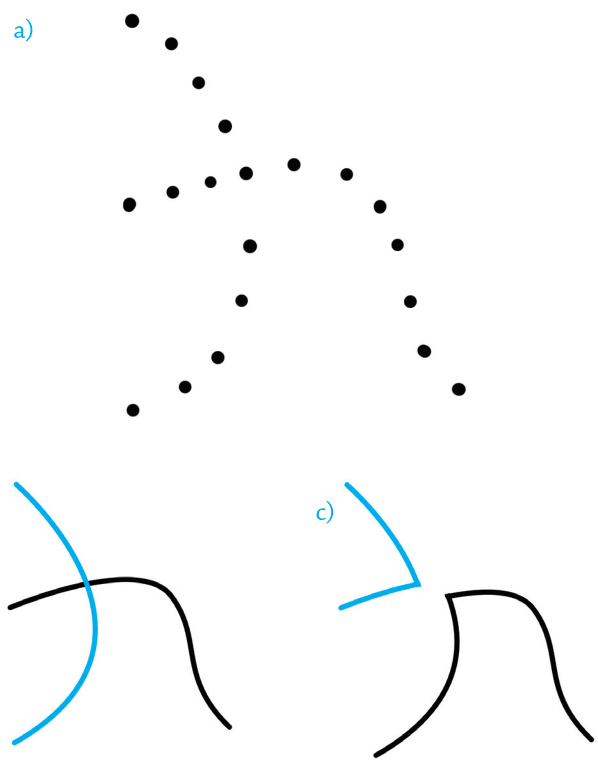


fig. 10. example of the Gestalt principle of *good continuation.* when looking at a), do you see two lines crossing — as in b), or two lines such as in c)? Image b) represents the typically assumed paths of the series of dots, encouraging good continuation.

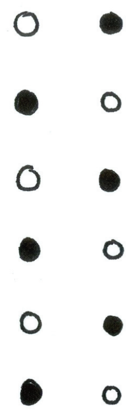


fig. 11. example of the Gestalt principle of *apparent motion.* in this particular array of dots, do the like-colored dots visually produce a zig-zag or back-and-forth motion? This example is similar to the effect of a traffic light warning sign with lights on either side of the sign that flash in sequence; the lights themselves do not move, however the visible light moves back and forth from one side to the other.

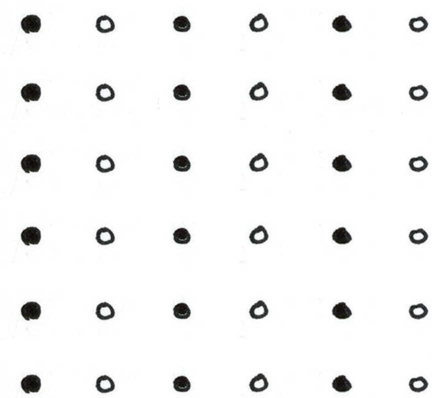


fig. 12. example of the Gestalt principle of *similarity.* do you see rows or columns of like-colored dots? We tend to group like items together even if other possible ordering systems are visually available.

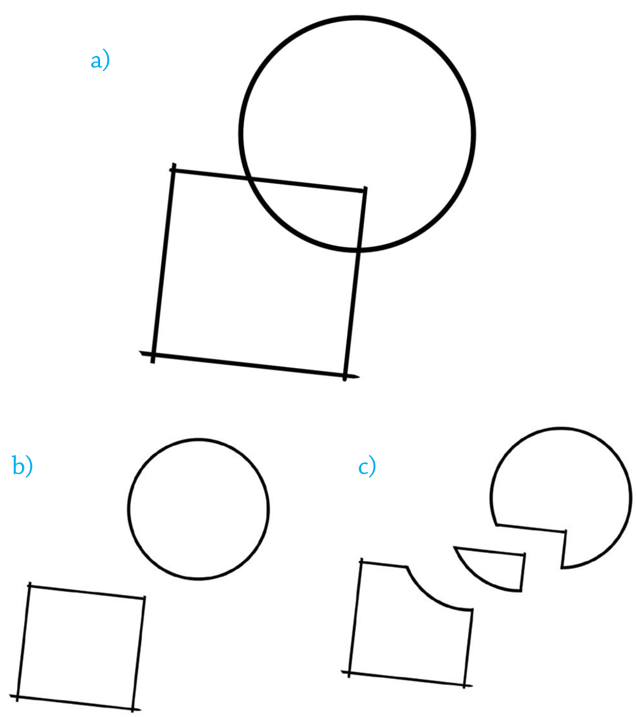


fig. 13. example of the *Law of Prägnanz.* when looking at a), do you see the intersection of two shapes — as in b), or three nestled shapes such as in c)?

:: Dynamic Information and Visual Attention

Another key component in the stimulation of our visual system that directly impacts our attention span and supports the view that drawing (the action) has significant effect on our understanding of visual information is the presence of "dynamic information," or movement. Dr. Pawan Sinha, head of the Sinha Laboratory for Vision Research at MIT, conducts humanitarian missions to restore sight to blind children in some of the most underserved areas of India. His work with Project Prakash (the humanitarian outreach of his research work) focuses not only on performing the surgery to correct congenital anomalies, but on observing and aiding in the recovery process as well. It is here that he has made a significant finding about the way in which our vision matures; by studying the sight recovery process in hundreds of children (and many adults) who are old enough to explain their experiences but are only just beginning to understand what it means to see, he has determined that motion is absolutely essential for our visual system to be able to create meaning from the stimuli acting on our eyes. "The one thing the visual system needs in order to begin parsing the world is dynamic information," he said during a TED talk as he shared video of an adult male faced with two visual displays on a computer screen. Though unable to correctly determine how many shapes are present in the display if those shapes are fixed, when the shapes are moving across the screen this man is immediately able to identify the square as a square, and the circle as a circle |Sinha, 2010|. His continuing research shows that this holds true for almost all patients of Project Prakash. Dr. Sinha goes on to explain that the scientific inference from these observations is that motion is what allows us to separate different kinds of shapes and colors and luminosities from the visual world, which leads to visual integration, leading ultimately to object recognition.

To place Dr. Sinha's research in the context of drawing, this means that the motion required to create drawings — the movements of arm, hand, and utensil all serve to reinforce the eye's ability to detect visual information. The importance of motion on the acquisition of sight when patients are "learning" to see finds a direct correlation in the dynamic nature of the action of drawing. It is the difference between *seeing* a drawing, and *watching* a drawing come to life.

:: The Percept/Image Conflict

"So drawing is a way of seeing. A vision of how we interact with the world." - Survey #10

Recent experiments using brain scanning technologies have revealed that the way our brains produce mental images activates the same mechanisms, and subsequently the same parts, of the brain as actually seeing real objects in the outside world (which will be referred to as "percepts").

A leading figure in the field of cognitive psychology and mental imagery, Stephen Kosslyn has made advances in determining the exact areas of the brain that are involved in the vision and visualizing processes. In an article on the cognitive processes required for drawing, Chris Frith (from the Institute of Neurology in London) and John Law (of Bath College of Higher Education) allude to this research: "[Kosslyn] used functional brain imaging to confirm that visual imagery activates the same areas of the visual cortex as those that are activated when stimuli are actually present" |Frith, 1995|. Kosslyn proposes that this duality in function of visual processes is part of a brain economy strategy — that instead of having separate areas of the brain responsible for incoming and outgoing visual information, the brain simply reverses the direction of the flow of that information. While this leaves more room in the brain for controlling other bodily and sensorial functions, it does have a negative effect on our visual system: our visual imaginings must compete with the steady stream of incoming visual stimuli from the physical, visual world around us. Imagine, if you will, that the incoming visual percepts passing through our visual system are traveling along a one-way highway from our eyes to our brain; traffic on this highway is thick and moving at break-neck speed. Now imagine that our mental images are trying to traverse this highway in the wrong direction, dodging the oncoming traffic, trying to avoid a collision which might cause it to become lost in the throng of incoming visual stimuli.

Our visual imaginings must compete with the steady stream of incoming visual stimuli from the world around us.

There is an inherent upside to the percept/image conflict, however: it is possible for real images to become the "underlay" to our imagined ideas. This superimposition of ideas onto reality often happens without conscious awareness and typically leads to the remembrance of a memory that is similar to the visual percept, and can be as simple as seeing a balloon and thinking of how it resembles a lollipop. We intentionally make use of layering our mental images onto percepts as well. If you were to wonder about repainting the exterior of your home, you could sit inside and imagine the shape and form of the house and the application of the new color, but this requires you to construct the mental image of the house, the roofline, the shutters, the yard, the trees around back, the cracks in the driveway — wait, where were we? You could instead walk outside and look at your house, this percept becoming the framework (or "underlay") for imagining the new exterior color.

When we are trying to recall the way something looks, many people close their eyes to shut out the visual

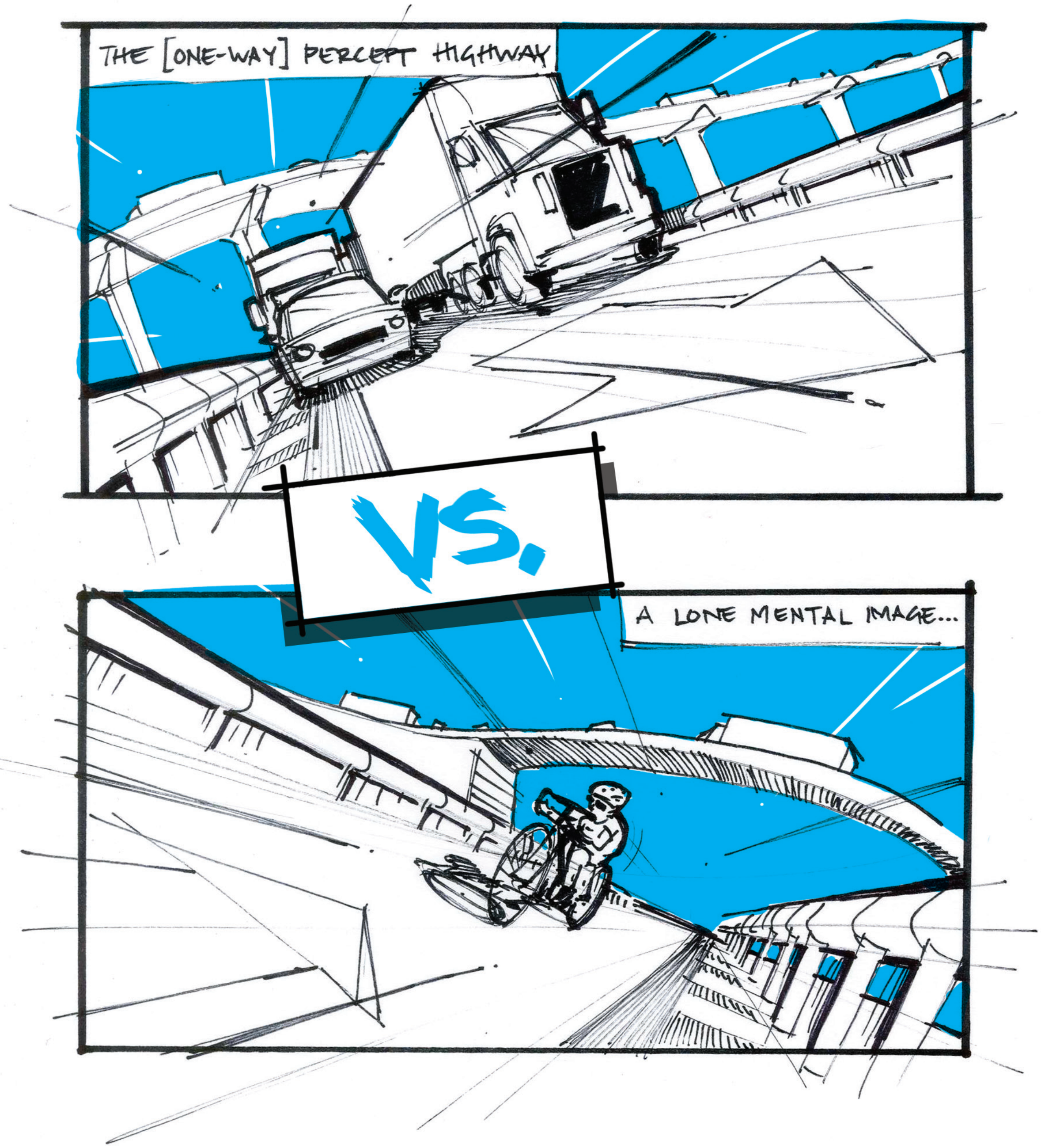


fig. 14. the percept/image conflict

distractions assaulting their eyes. This is one way of "quieting the noise" — stopping traffic on that one-way, high-speed visual highway — momentarily to allow our brain an opportunity to produce its own, internal images. One way of resolving this percept/image conflict is to transform our mental images into external visual stimuli, and one way of doing this (perhaps the most expedient) is to draw them. Turning our ideas into drawings allows our visual system to assimilate our images into the steady stream of percepts, therefore allowing other visual processes such as spatial relationship detection and pattern recognition to take place subconsciously.

:: Mental Manipulation Limitations

"I draw to clarify things to others and in my mind. So I can see the relationships between things." - Survey #26

In his 2003 book, *Seeing and Visualizing: It's Not What You Think*, cognitive scientist Zenon Pylyshyn discusses this and other limitations of our mental capacities in imagining visual information and proposes arguments for why the use of drawing is essential for understanding our own mental images as well as overcoming these limitations. "It is widely held that one of the purposes of mental images is to allow us to discover new visual properties or see new visual interpretations or reconstruals in imaginally presented information," he states. Pylyshyn goes on to point out that this theory is valid only to a certain degree, that once we begin to manipulate the images in our head our ability to maintain the "whole picture" diminishes. He warns:

> "Our mental image also does not have the benefit of being a rigid surface, so it does not have the stability and invariance of properties that a physical picture has when various operations are applied to it. For example, unlike a physical diagram, a mental image does not automatically retain its rigid shape when we transform it say, by rotating it, moving its parts around, folding it over, or adding new elements to it. This is because there is no inner drawing surface to give a mental image its rigidity and enduring shape and because there is no credible evidence for visually 'noticing' new patterns or new construals in an image" |Pylyshyn, 2003|.

This notion may be disagreeable to those who believe their mental capacities to be quite advanced, but these observations are not intended as an attack on personal intelligence; this viewpoint reflects the large body of research focused on how our cognitive systems work, and it has been shown that our abilities to manipulate mental images are not nearly as powerful as we would assume them to be. Jonathan Fish and Stephen Scrivener, of the University of Technology in Leicestershire, U.K., agree that mental images can be manipulated with more speed and flexibility than visual percepts, but their evidence shows that our working memory and attention have low spatial capacity and short duration |Fish, 1990|.

> Turning our ideas into drawings allows other visual processes such as spatial relationship detection and pattern recognition to take place subconsciously.

The following is a quick, two part test. In the first part we are only allowed to use mental images to solve the puzzle: imagine a cube (you may determine the size); if you were to hold that cube so that the index finger of each hand was in contact with opposing corners of the cube, how many corners are left untouched? Now let's cut that cube in half (for the purposes of this exercise, there is no gravity to cause the cube to fall to the floor) — how many new corners have we just created? And suppose we take one half of the cube and cut it in half again? How many corners are there in total for the entire cube? Now, for the second part of the test, use a piece of paper and a writing tool to retake the test. Were your answers the same for both methods? Was your answer 22? (see fig. 8 on the following page as an example)

What we learn from this simple test forms one of the strongest arguments for using drawing to solve problems: there is a point at which we reach the limitations of our mental manipulation capacities and we must rely on the inherent abilities of our visual system to reveal opportunities for reaching solutions.

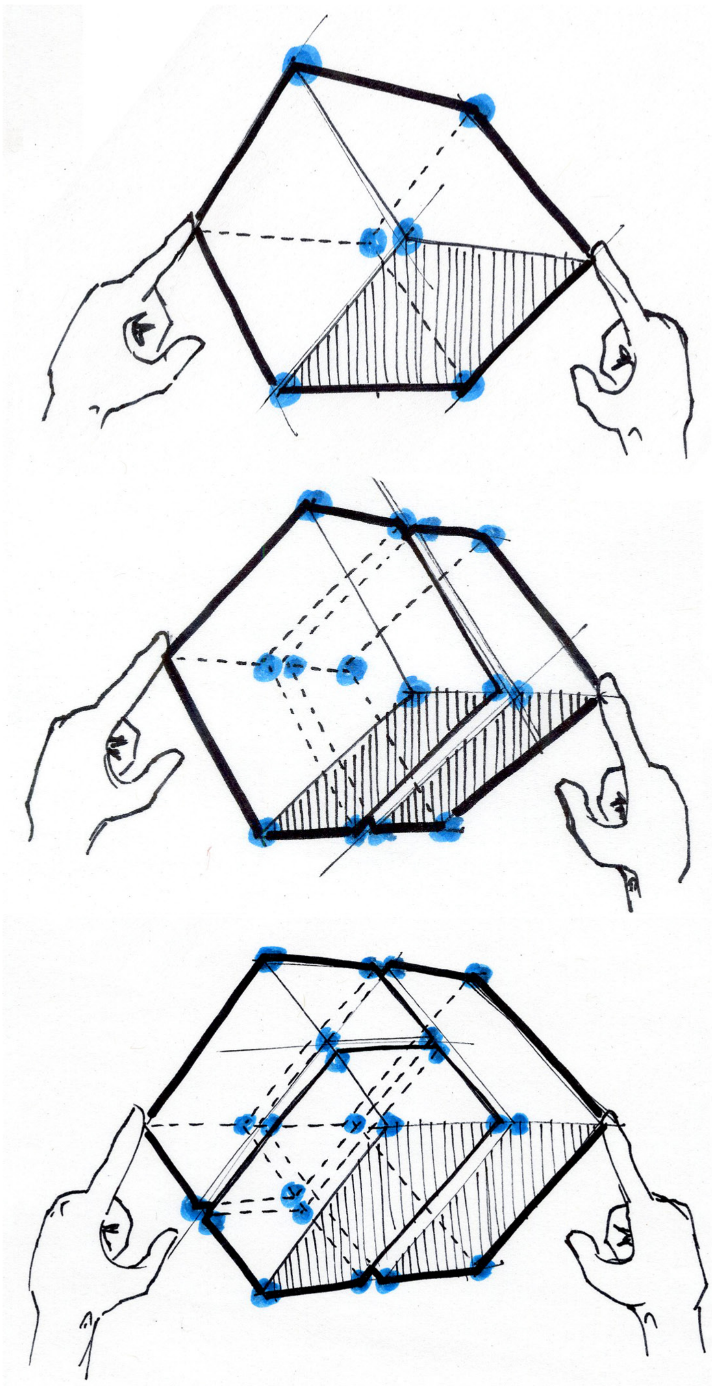


fig. 15. a visual representation of the cube-slicing test. With the visual representation, we are able to hold the "big picture" as well as each new modification of the cube.

:: Vision Over Space and Time

Have you ever tried to remember where your missing keys are by retracing your steps through the house, performing the same actions you did when you last saw your keys? Or closed your eyes while trying to recall an old house? These actions of attempting to recreate what you saw while viewing a particular scene or participating in a particular activity allow us to *re-experience* the original experience.

Here is another example. When using a touch-screen Automated Teller Machine (ATM) for the first time, each new input by pressing a finger against the screen prompts a new series of active areas, with buttons appearing in various places across the display depending on the string of decisions that we make about whether to deposit or withdraw money, access our savings or checking accounts, or to print out a statement or terminate the transaction. This first encounter often results in an attentive, deliberate approach to surveying all available options at each phase of the transaction process; we are particularly aware of the way each new screen presents a new set of alternatives and we take our time in selecting the appropriate function — after all, it is *our* money. After several uses of the ATM, however, we begin to familiarize ourselves with how we are to behave in order to get what we want out of the machine, knowing that first we have to input our Personal Identification Number, waiting until the system verifies that we are allowed access to the account associated with the card we've inserted into the machine. Next we express that we want to deposit money, then specify that the money should go into our savings account. We enter the amount to be deposited, then follow the prompts to place the money-filled envelope into the deposit intake, and wait until the screen asks us whether we'd like to perform any other transactions today. As our familiarity with this process matures, many of us have found ourselves hovering a finger over the area where the button we want to press will appear in the next screen. We've memorized not only where the button is, but when it will appear — how?

Jennifer Ryan and Christina Villate of the Rotman Research Institute in Ontario, Canada, offer an explanation that focuses on the role that vision plays in recalling where things are located and when they appear in those locations. According to their research, the way we move our eyes when observing a scene may be the conduit by which information is integrated into lasting memory representation, and subsequently how present information is compared to what is stored in our memory |Ryan, 2009|. Their studies used eye-tracking equipment and a computer-screen-based display to monitor how our eyes looked at the placement of a series of objects (spatial relationships) and the order in which those objects appeared (temporal relationships). The tests were structured as follows: participants viewed a computer screen that displayed one object (object A) then that object disappeared. Moments later a second object (object B) appeared in another location on the screen. Again, object B disappeared and a third object (object C) was displayed on the screen. After a pause, all three objects were displayed at once and the participant was tasked with determining if the final image displayed all objects (A, B, and C) in their same locations relative to the others. In some trials, the spatial relationships were maintained (ex: A is above B, which is to the left of C) while in others the arrangement was changed (ex: A is now below B, which is still to the left of C).

While the results showed that participants were very successful at determining whether the final image had been manipulated or not, the eye-tracking data revealed the most interesting results. At each stage of the display sequence (ex: when object B was displayed), participants directed visual attention to the new object *as well as* the area where the previous object was located. According to Ryan and Villate, "Transitions to an already sampled region may serve to recall that information from memory, or at least maintain it in an active state, so that it may be bound together with the target of the subequent fixation"|Ryan, 2009|. In addition, when the final image was of a manipulated spatial arrangement of the three objects, viewing to the empty regions which should have contained objects — had the relative relations been maintained — increased. Ryan and Villate attribute this spatial re-checking to a disruption of eye movement re-enactments of temporal order, meaning that the way a participant scanned the final, manipulated image did not match the way they had experienced the locations of the three individual objects |Ryan,2009|.

Where is the refrigerator in your home? Where can you find the bread at your local grocery store? How do you get from the post office to the park, and then back home? While thinking about the answers to these questions did you mentally visualize their specific locations? Perhaps you retraced the paths you take (either on foot or by vehicle) to get to each of those destinations — if so, you've just proven what Ryan and Villate proposed in their research:

> "Eye movement patterns elicited during imagery of a previously studied (but now absent) array largely resembled the eye movement pattern observed during viewing when the array was present, suggesting that eye movements serve to activate portions of the remembered scene and arrange those activated portions into their proper location with the (imagined) scene" |Ryan, 2009|.

When recalling visual information, we tend to mentally recreate the experience of seeing that thing we wish to remember and in doing so, our cognitive systems are working in conjunction with our visual system to piece together that memory.

:: Drawing and Mental Control

When visual signals enter our eye, they begin their trip to any one of a multitude of final destinations. As you will recall from the work of Wujec and others, information about an object's identity is stored in the temporal lobe while information pertaining to an object's location activates the parietal lobe. Chris Frith and John Law go on to explain that the act of drawing excites the same regions of the brain needed to see, and that drawing requires the brain to pull the fragmented bits of information from these areas (about color, shape, size) into a whole, employing the prefrontal cortex to accomplish this recombination of scattered information. This region of the brain then directs motor movements to translate the recombined images into drawings which reside in the real world. They state that "in order to draw, we have to map inner representations of scenes onto inner representations of movements." Once that mapping has taken place, "the time taken to initiate a movement depends upon its complexity. This result suggests that a program

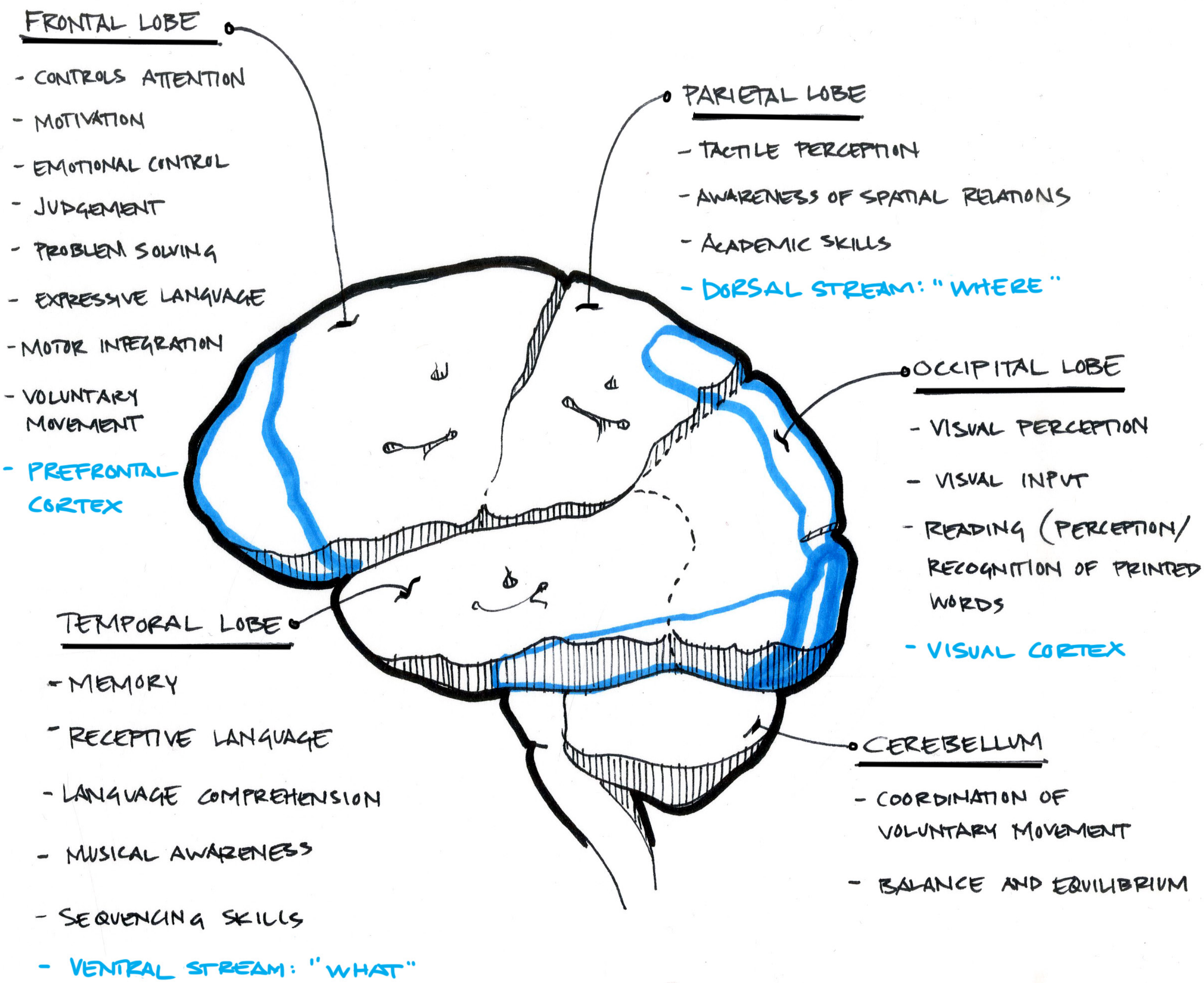


fig. 16. map of brain regions and their associated functions. Although the human brain is much more complex, this simplified map shows the main responsibilities of five major regions of the brain; overlaid in blue are the regions most associated with vision (with the prefrontal cortex responsible for orchestrating the efforts of other brain areas when we are drawing).

for controlling the whole movement sequence is assembled before the movement is initiated" | Frith, 1995 |. Here, Frith and Law describe the first steps in visually turning thoughts into action.

In related research, Aaron Kozbelt from the Department of Psychology at the University of Chicago, used drawing and perception tasks as a medium for examining how artists (described by Kozbelt as individuals that "spend large amounts of time engaged in drawing, painting, or manipulating other media to produce visual representations") differ from non-artists on cognitive abilities. He assumed that artists would outperform non-artists on the tasks requiring drawing, but was most interested in how artists would compare in the purely perceptive tasks; if their visual systems were heightened in any way that would offer them an advantage over non-artists in *perceiving* what they *saw*. His testing resulted in conclusive evidence that artists are more skilled not only in representing or recreating visual imagery, but also in interpreting visual stimuli | Kozbelt, 2006 |. He attributed this higher proficiency on visual tasks to artists' ability to develop, over time, special categories of knowledge such as perspective systems, anatomy and structures of commonly drawn objects, as well as having a more active prefrontal cortex.

While his findings do little in the way of encouraging non-artists to engage in drawing, they do point out another key relationship between drawing and cognition: they are directly proportional, and the rate at which they are employed has a clear impact on our perceptual and recognition abilities. If drawing relies heavily on the brain's ability to aggregate information from numerous internal areas, then individuals who participate in drawing on a regular basis — thereby maintaining the brain networks which connect these areas — possess stronger cognitive skills for evaluating novel perceptual scenarios. Kozbelt suggests that "flexible, proceduralized knowledge may be important for proficient performance in open [disciplines]" | Kozbelt, 2006 |. In short, those who utilize drawing on a regular basis are more adept at engaging a broader range of areas of the brain, leading to a more complete understanding of issues and solutions. This ability relies heavily on a procedural component, or understanding of a process, as opposed to applying a memorized formula to solving analytical problems (*how* to approach a situation rather than *what* is present).

This understanding and familiarity with *process*, with being able to establish the relevancy and priority of the elements of a problem and how they are connected, is a focal point of design-related professions and disciplines. Dan Soltzberg, a member of the design consulting firm Portigal Consulting, reiterates this when describing the role his company plays in helping clients: "It seems like what we are able to identify isn't a specific equation but a set of factors that influence how situations are constructed and get responded to" | Core77, 2010 |. Soltzberg is referring to a way of visually representing the breadth and scope of the problems his clients face, a method that is responsive to the individual nature of the situation at hand.

Those who utilize drawing on a regular basis are more adept at engaging a broader range of areas of the brain.

:: *Design Drawing Modes*

"The necessity to sketch arises from the need to foresee the results of the synthesis or manipulation of objects without actually executing such operations" | Fish, Mind's Eye |.

The application of drawing takes many forms in the design disciplines, from purely gestural to the most precise and controlled drawings used for manufacturing and building purposes. Designers often shift between drawing modes at various points throughout the design process, as and when required by the demands of the problem that is being considered. What then are these modes? An extensive explanation comes from the following excerpt taken from the introduction to Erik Olofsson and Klara Sjölén's *Design Sketching*, a book focused on drawing in design:

> "In professional design practice, sketching has proven to have multitude of purposes [sic] which can be summarized under four headlines — investigation, exploration, explanation and persuasion:

fig. 17. Expression [Persuasion] sketch. This sketch screams “fast” and “powerful”; the liberal use of red, the dynamic background element, and strong contrast all add to the experience of speed in this concept. (courtesy Dino Tsiopanos)

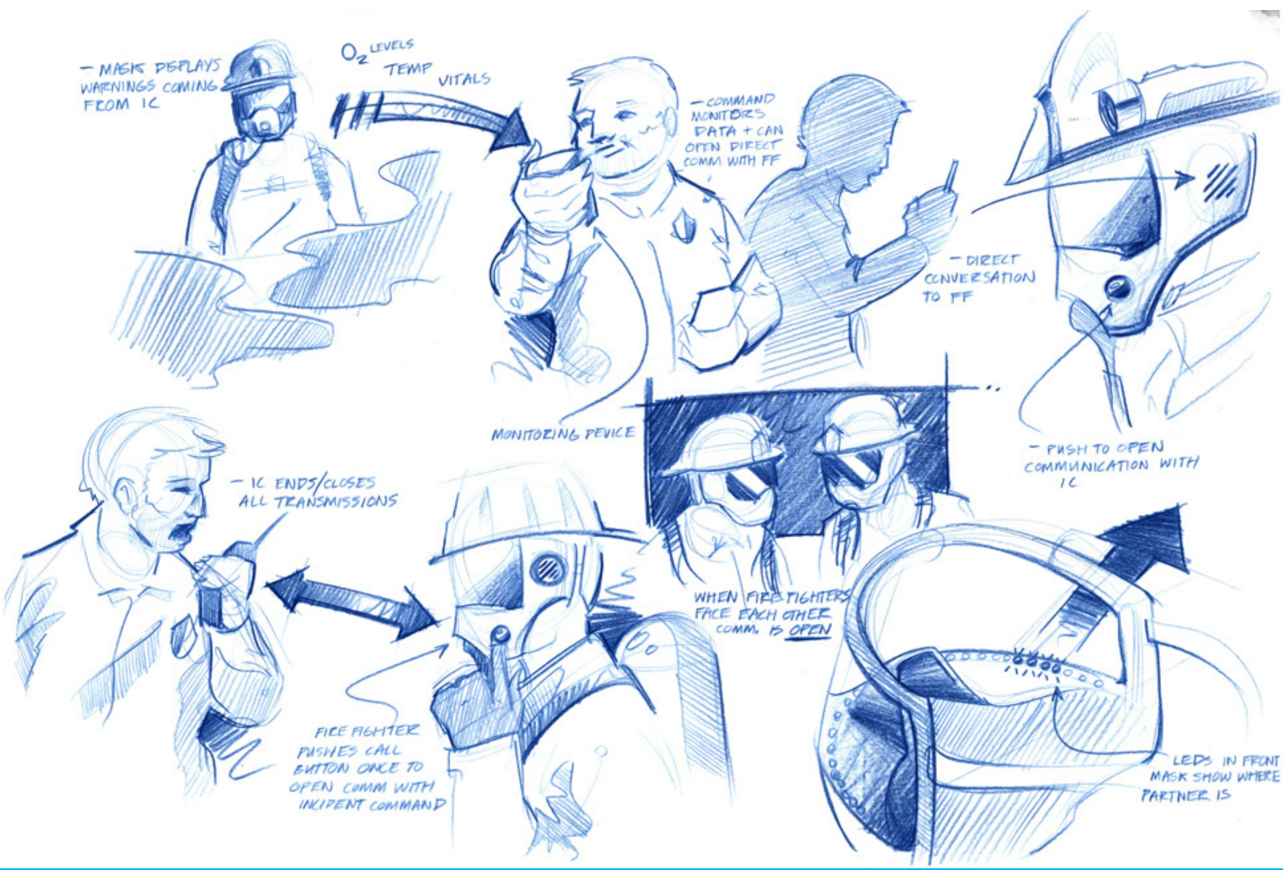


fig. 18. Comprehension [Investigation] sketch. Before proposing new concepts for fire protection systems, these sketches were produced to fully understand the existing methods of communication between firefighters. (courtesy Chris Grill)

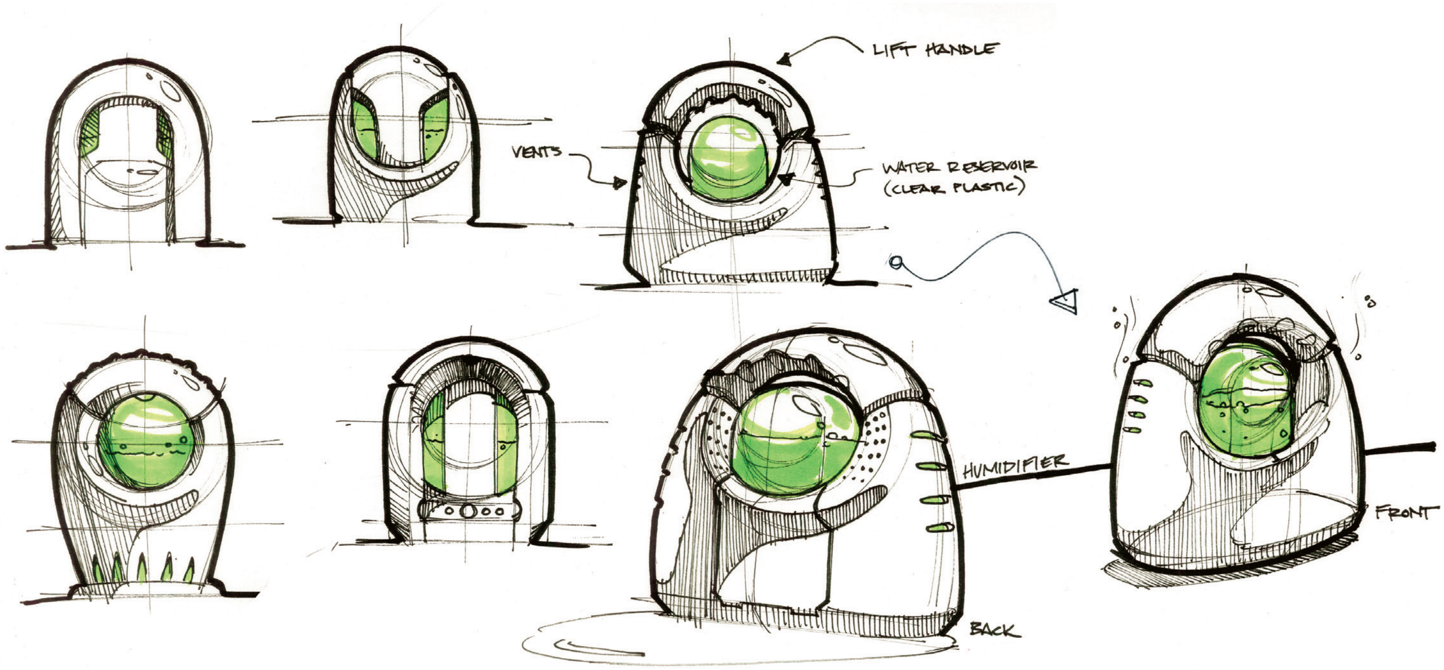


fig. 19. Generation [Exploration] sketch. By putting designs on paper, the designer is able to make modificiations to the initial idea, creating a series of "iterations" until a concept with the desired qualities to solve the problem are discovered.

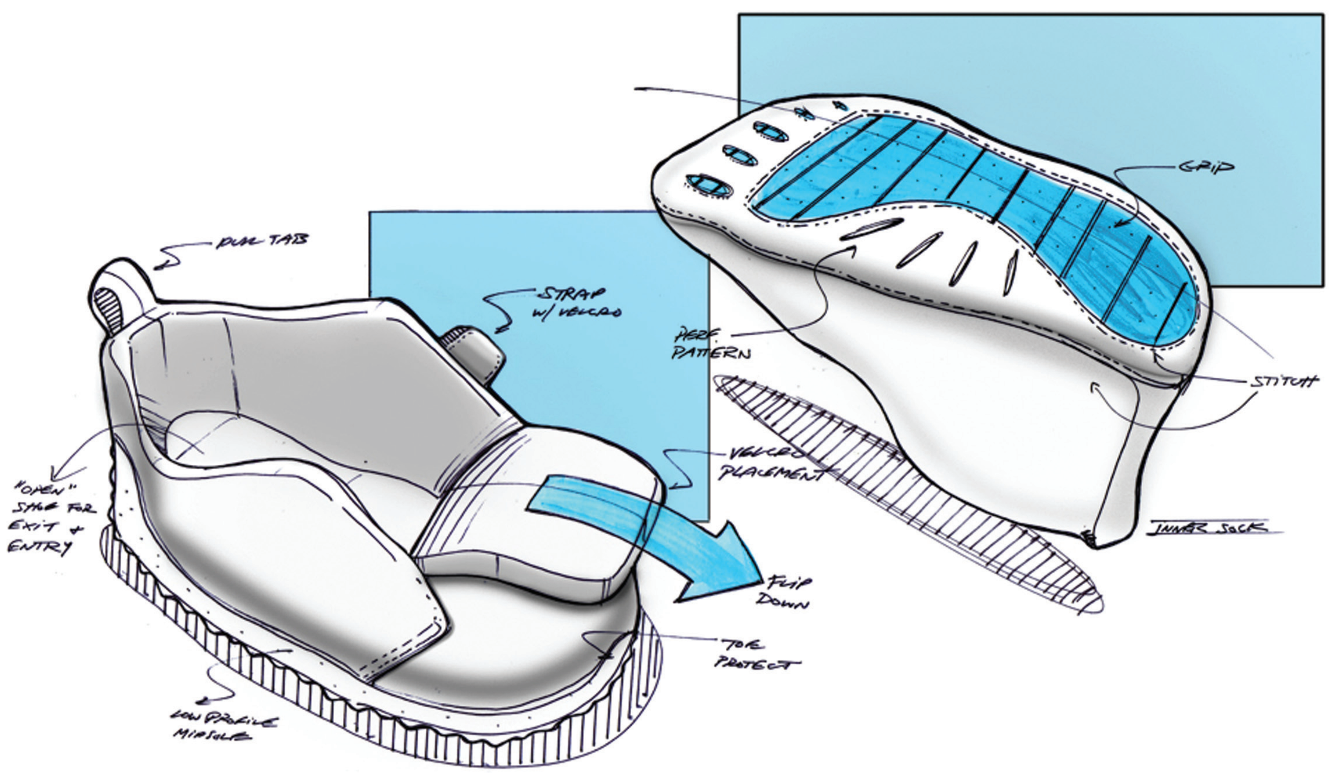


fig. 20. Documentation/Communication [Explanation] sketch. Drawings can be used to communicate details and describe "how" something works or is to be used; often shared with others in place of verbal dialogue. (courtesy Chris Padilla)

> Often, the *investigative* function of sketching is tightly connected to the early research phase of a design project. The designer is examining the problem space, and sketching helps analysing the context while the problem and its components are emerging. *Explorative* sketching is often used when proposals of design solutions are generated and evaluated. These sketches are produced in large numbers, are often very rough and do seldom make much sense for others than the people directly involved in the design process. *Explanatory* sketches have to communicate a clear message to others than the designer and the team, in contrast to the explorative sketches mentioned above. These sketches describe and illustrate proposed concepts in a neutral and straight-forward manner, and are often created in the later phases of a project, to get valuable feedback from users, clients and external experts. *Persuasive* sketches are the most artistically impressive type of images, often called renderings and takes [sic] much more time to finish than the other types. The main purpose with these drawings is to 'sell' the proposed design concept to influential stakeholders, such as CEOs or Design Managers" |Olofsson, 2005|.

Reflecting back on the results of the "Why Do We Draw?" survey reveals similarities between how non-designers and designers utilize drawing in their profession. These patterns become surprisingly clear as we compare the four "design" modes to the categories of responses:

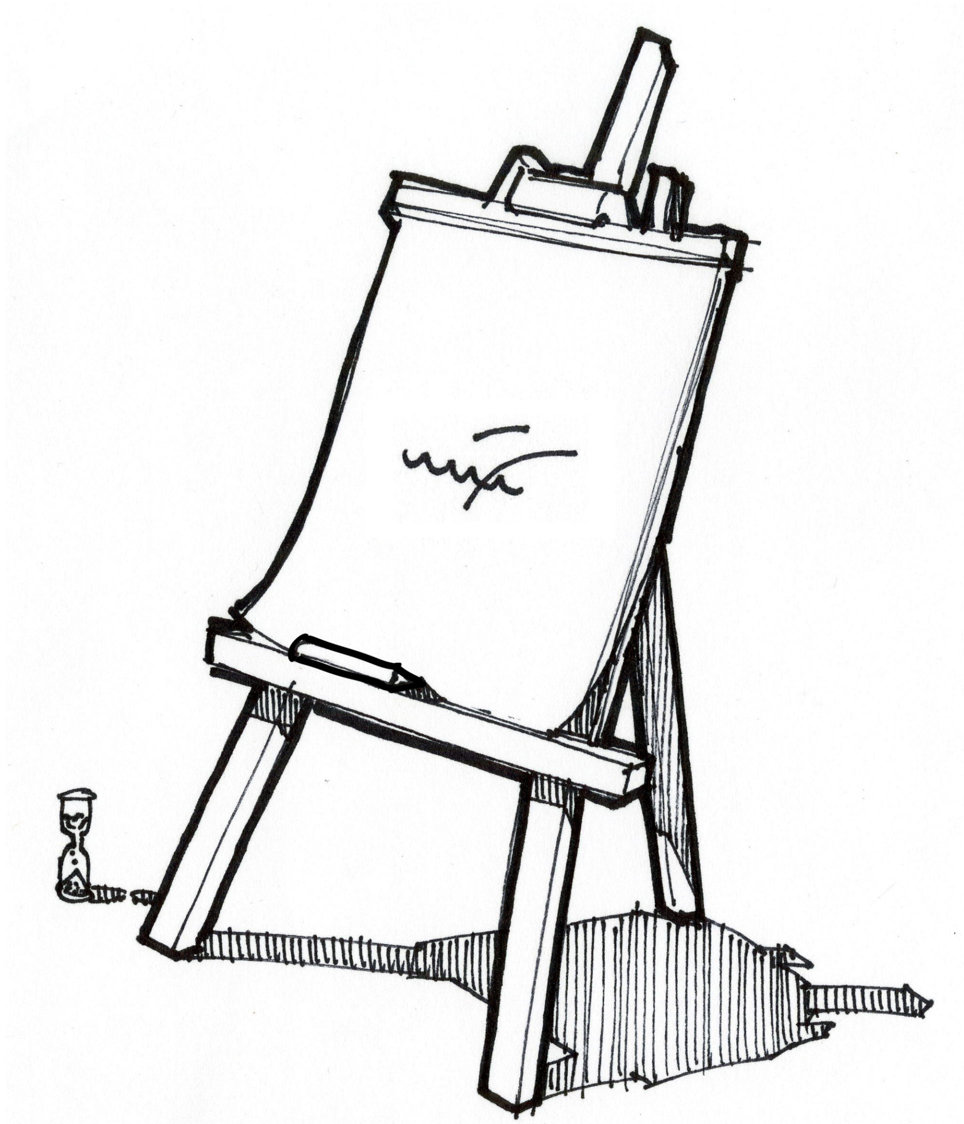
Expression [Persuasion]: utilizing a more artistic set of elements, drawing allows us a means to "tap into" the emotional qualities of our audience in an attempt to shift their point of view to our own.

Comprehension [Investigation]: as a primary tool for *understanding*, drawing has the ability to help us make sense of complex issues and elements of problems, whether design-related or not.
Documentation and Communication [Explanation]: drawing to document is about making a *physical record* of something experienced or thought which then in turn can be shared with others. With its ability to bridge language barriers, both ethnic and cultural, drawing therefore acts as the interface between one individual and another (or one profession and another).

Generation [Exploration]: rooted in the psychological benefits previously discussed, drawing is the product of — and fuel for — the development and refinement of new solutions to problems; it is a means to discovery, and the drawings produced become the roadmap to that discovery.

Perhaps the only thing that separates designers from non-designers in the use of drawing is their proficiency and use of all of these modes (see examples, fig. 10-13, on the preceeding pages), or perhaps it is a conscious awareness of these different modes and when to employ each for greatest effect. This ability to shift perspectives, to better understand the problem in its many forms and therefore provide a broad range of possible solution directions, refers us back to the findings of Frith, Law and Kozbelt that reveal the connection between visual tasks, bodily motion control, and the role of the prefrontal cortex in orchestrating the recombination of vastly dispersed pieces of information within the brain. The drawing efforts of non-design professions typically revolve around a single style or mode of drawing determined to be necessary for that discipline — recording the shape of bacteria under a microscope or representing the chemical bonds between elements in a molecule. The proficiency displayed by designers in utilizing many different modes of drawing can be a major source of intimidation for non-designers, and this effect can be traced even farther back to the effects of language and drawing skill progression during childhood. The effects of this non-engagement of drawing are not purely artistic however; by not engaging all of these modes of drawing (and the brain regions associated with each), non-design professions are limiting their abilities to explore novel solutions to problems. The next section proposes a way to reconcile these and other differences on the professional application of drawing in a way that invites those without a traditional design background to cross into and explore drawing with the purpose of engaging their visual and cognitive processes to maximize their work efforts.

03.



DRAWING AS CONVERSATION

We know that drawing is manifested in different ways for different disciplines, and that is has the ability to engage our visual and cognitive systems simultaneously; what then can we do with drawing that pushes its usefulness beyond mere representation and comprehension? It has been said that drawing is itself a language, however we usually refer to this form of language as being the effect that the final images have in communicating our ideas. Drawing then is like written language — it is static, unmoving. If we take one step back in the drawing-creation process to the actual *action* of drawing, to the motions and movements of the designer or artist, could this then be said to compare to spoken language — done *ex tempore*, unfolding in the same way that a spoken story unfolds? In this final chapter, we will discuss the structure of language and areas where language structures collide, typically located at the intersection of differing disciplines when trying to share information or knowledge. We will also explain how mixed-discipline groups approach the collaborative process. In closing, we will propose a series of principles or considerations that might help infuse the collaborative process with the language-barrier-breaking advantages of drawing during the formative stages of multi-disciplinary work groups.

:: Conversation, Not Communication

When we have a learned grasp on the basics of language, we know how to manipulate our words to express our thoughts — we talk, and we do this to communicate. But how often do we view talking as *communicating*? Yes, technically when we speak we are communicating; but do we recount instances of sharing ideas with friends by saying, "I was communicating with Hank just yesterday..."? Certainly not often, if at all; instead, we view our vocal exchanges with others as organic, unfolding, reflexive activities. We have conversations. So it can be when we apply this to the exchange of visual information.

While it is understood that drawings are an effective method of communication, it is necessary to now make a distinction about how to classify the *activity* of drawing; to propose that drawing is analogous to "conversation" requires an exploration of the semantic meanings of communication and conversation. To communicate, as defined by the American Heritage College Dictionary (Fourth Edition), is "to convey information about; make known; impart," and communication is rightly defined as "the act of communicating," or "the art and technique of using words effectively in imparting one's ideas". This definition frames communication as a one-way process, a monologue wherein there is no interaction by the audience listening to the vocalization of information. To converse, on the other hand, is "to engage in a spoken exchange of thoughts, ideas, or feelings" and conversation is "an informal discussion of a matter by representatives of governments, institutions, or organizations." Immediately we are confronted with two key terms that separate communication from conversation: conversation involves an *exchange* of ideas, and it is considered more *informal* when compared to communication. This exchange of ideas is a two-way process, a dialogue between the parties involved, and allows for the back-and-forth swing of information transferral. The informality of conversation inherently creates an environment that eases the tensions associated with diverse working groups (governments, academic disciplines, etc.), and sets the stage for exchanging ideas through non-standardized means.

This distinction of terms, however minute, is necessary so that we might approach the activity of drawing as we would the activity of casually conversing with our peers, neighbors, or colleagues. Exchanging visual information can be encountered as a casual, fluid action that needs no formal training.

:: The Structure of Language

"Human language serves as a good example of the evolution of a robust, redundant, and relatively noise-insensitive means of social communication. Errors are corrected so effortlessly that often neither party is aware of the error or the correction...The result is a marvelously complex structure for social interaction and communication." - Don Norman, The Invisible Computer

To accurately discuss how language is used to communicate, we first start with what comprises the structure of *language*. It will help if we look at language as an onion, and we will peel away layers to reveal the smaller, more basic layers beneath until we reach the core of the onion. With that in mind, let's begin: A language's *lexicon* is the vocabulary of a language, the set of all words belonging to that language, and that lexicon is the entire inventory of that language's *lexemes*. Lexemes are, in short, words; they are categorized into sets of all forms taken by a single word (e.g. run, ran, runs, etc.) and are used to express *sememes*. Sememes, in turn, are a unit

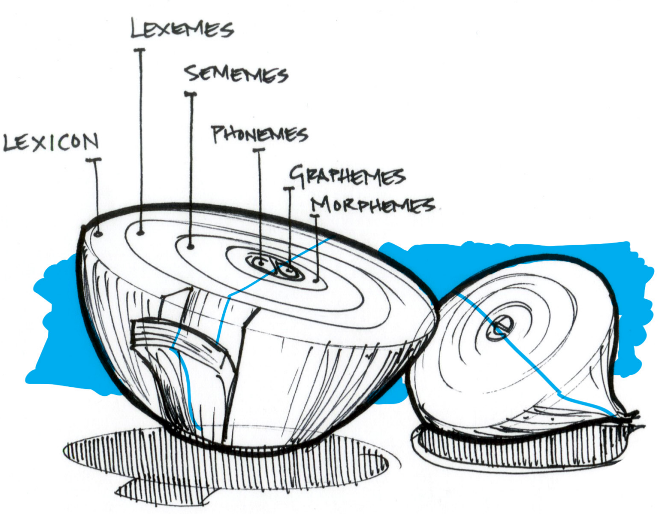


fig. 22. the "lexicography taxonomy onion".

of the transmitted or intended meaning of a word (for example, "go," "run," and "skate" all share the semantic meaning of action). Sememes can be further deconstructed into *morphemes*, which are the smallest linguistic units that have semantic meaning. Tricky? It is here that we discover that our lexical onion has two cores, for we have both verbal and written language: *phonemes* are the smallest linguistically (i.e. audibly) distinctive units of sound, thus used to describe spoken language, and *graphemes* are the most fundamental unit in written language. As this structure can be complicated, here is an example: Think of a word. Any word. Is that word "cough"? Good. If we were to write "cough", we would use the letters c, o, u, g, and h. The written word "cough" is comprised of five graphemes (the individual letters), however it contains only three phonemes, as "ou" together make only one identifiable sound, as do "gh". Our word "cough" is a morpheme (composed of phonemes), and could be used to express the sememes "sick" or "diseased." Other forms of the word "cough" (such as "coughing," or "coughed") are part of the same lexeme. And as "cough" is used in English, we can say that "cough" is part of the English language lexicon. This study of lexicography is quite complex, however it raises questions about language, and in turn about the various forms of language — verbal, written, and *visual*. What could we say are the graphemes of visual information? Or perhaps more importantly, what are the sememes of visual information? What is it in language that helps us visualize? What types of combinations of phonemes, sememes, and lexemes allow us to get a clear picture of what someone is telling us?

One clear aspect of spoken and written language that helps us convey our message is *syntax*, or the systematic order in which we place the words that we speak or write. It is not enough to merely know the parts of speech; we must also know how to successfully arrange them into an order that transmits our ideas — but how much of that order is culture-specific? Eva Belke, of the School of Life and Health Sciences at Aston University in Birmingham, UK, conducted a series of studies involving a *referential communication task*. This particular type of task requires participants to describe a target object in such a way that a listener could correctly pick out the same target object from a display of multiple objects. She prefaces these studies as such:

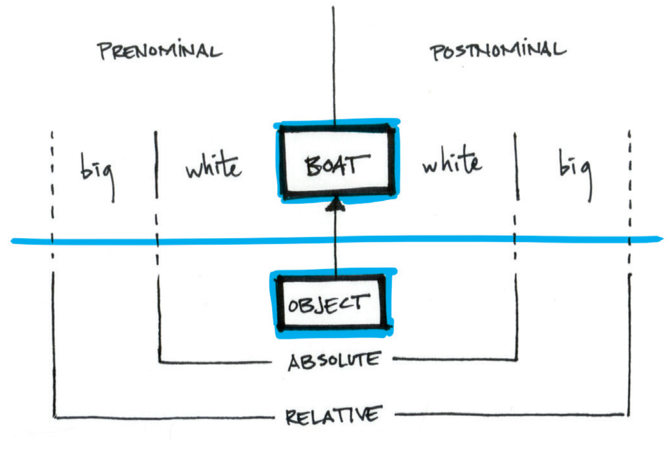


fig. 23. comparison of prenominal and postnominal languages shows how each would describe the "big white boat" (prenominal) or the "boat white big" (postnominal). In both cases, the most absolute characteristics are placed closest to the subject of the statement.

> "Making verbal reference to objects in the outside world is one of the fundamental functions of language. Depending on the complexity of the situation, referring expressions may differ with regard to their degree of elaboration. For instance, when speakers refer to an object in the context of several similar objects, they often have to specify it by means of a set of features that clearly distinguish it from the other objects" |Belke, 2006|.

But what of the way in which speakers vocalize these specific features?

One would assume that the dimensions of objects that are immediately visually available (e.g. color) would be described before something relative (e.g. size). However the results of her studies revealed something intriguing about language syntax and cultural influence: the specificity of our descriptions are organized by proximity to the object we are describing. This holds true for prenominal languages (languages such as German and English where adjectives come before the noun they are describing) and postnominal languages (languages such as Spanish where descriptors follow the utterance of the noun). As Belke concludes: "The dimensions that are easiest to detect (e.g. absolute dimensions) are commonly placed closer to the noun than other dimensions (e.g. relative dimensions). This stands in stark contrast to the assumption that language production is an incremental process" |Belke, 2006|. In her trials, participants typically included the visual dimensions of shape, color, and size when verbalizing descriptions of the target object on a computer screen display. These target objects where located in a field of other similar (though not the same) objects on the screen, meaning that participants had to differentiate — to a degree which they believed to be sufficient — the target object from its neighboring objects (see fig.__ for an example display). In daily speech, these findings mean that if someone were attempting to describe a blue boat that was large, the prenominal-language speaker would describe it as the "large, blue boat" while a postnominal speaker would describe it as the "boat blue large." A seemingly small syntactic rearrangement, but the implications of these two descriptive techniques lie in their respective advantages in a communication scenario; prenominal descriptions create an advantage for the listener, while postnominal descriptions do so for the speaker.

Listener-Advantage: by hearing a description that begins with relative information first (information that is reliant upon one object's comparison with other objects), the listener is allowed more time to filter out visually matching possibilities before hearing the name of the object being described. This convergent system of narrowing down possible objects that match the increasingly specific description of the target object allows the listener to essentially "zero in" on the correct object.

Speaker-Advantage: describing the characteristics of an object first that are more clearly defined (absolute dimensions) allows the speaker to embellish the target object description, creating a more complete and detailed account of that object. This postnominal system is divergent in nature and allows the speaker to "layer on" information to further describe the object.

Essentially Belke describes the existence of a certain verbal spatial relationship, that of object-to-attribute, where we can tell the level of certainty of those descriptors by how they are arranged, in this case by how close to the intended object they are. This understanding only helps us to an extent — we are aware of it, but if we still do not know the correct verbal language, what are we to do? This is one distinct example of how verbal language can translate into visual language; utilizing spatial relationships, even forcing them in some cases, is one way of visually presenting the semantic connections between various elements of an idea, a design, or a system.

This focus on the exchange of semantic meaning as a purpose of communication prompts the question, how do we process semantic meaning when we are listening to someone speak to us? Gerry Altmann from the University of York, UK, and Faulk Heuttig of Ghent University in Belgium, offer some insight on this question and how their answer blends with the effects of language on visual attention. Altmann and Heuttig performed a series of experiments wherein participants were asked to view an array of four unrelated images and listen to a speaker read a sentence aloud. Using eye-tracking technology, they recorded the eye movements of the participants during the trials, from which they observed two interesting phenomena. The first is that as a spoken word unfolds (i.e. spoken), visual attention can be directed immediately toward the image in the array that is conceptually related to the spoken word. For instance, let's say the array included pictures of a tree, a balloon, a sheep, and a car (fig. 24). If the spoken sentence was, "A man looked in the field, and there was a sheep," then upon hearing the word "sheep" participants would look at the goat in the visual array. As they explain, "Participants could orient their gaze toward an object's spatial location because its structural representation matches the visual representation of the concept activated by the phonetic input" |Altmann, 2007|. This means that when we hear the word "sheep" we imagine what a sheep looks like, and we direct our eyes toward an available image of a sheep; indeed all of this happens quickly, even as we are hearing the word.

This finding is amusing but not extraordinary, however Altmann and Heuttig also found that if the sentence was structured in such a way as to prime the participants toward a particular target image, then participants would direct their attention toward the target object even before hearing the target word. To use the sheep image example again, if the sentence were changed to become "The shepard looked in the field, and there was a sheep," the mere mention of a shepard would prime participants to direct their attention toward the

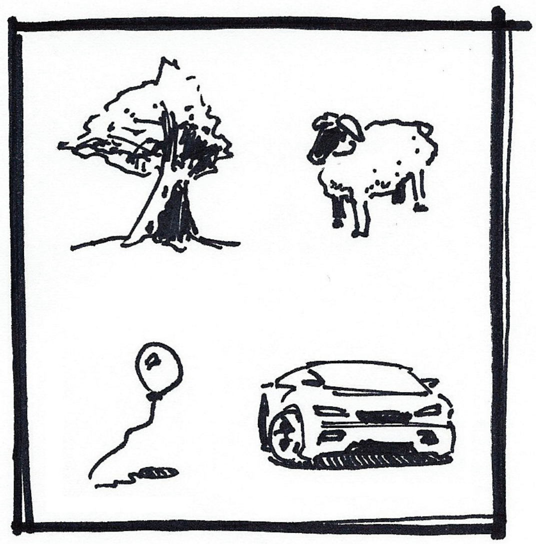


fig. 24. an example of a typical four-quadrant visual array used in Altmann and Huettig's semantic priming trials to accompany the statements, "A man looked in the field, and there was a sheep," and "The shepard looked in the field, and there was a sheep."

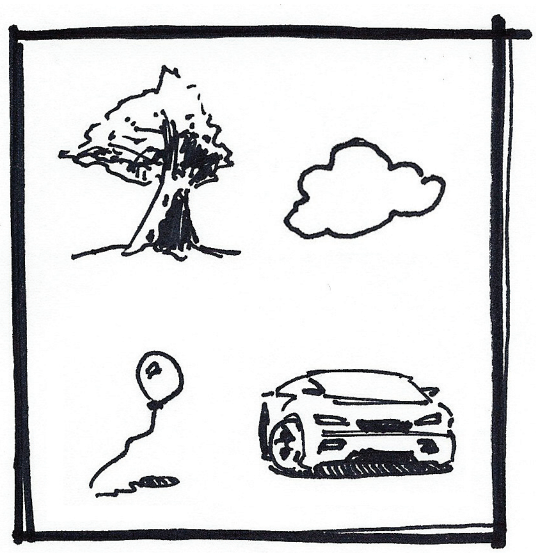


fig. 25. an example of a conceptually mismatched four-quadrant visual array used in Altmann and Huettig's semantic priming trials to accompany the statement, "The shepard looked in the field, and there was a sheep."

image of the sheep because "sheep" and "shepard" are semantically related (quite closely).

To examine how far these semantic similarities could be stretched, they included more trials wherein the array did not include an image of the target word, but an image that shared visual characteristics with what an image of the target word would look like. In the sheep example, the image of a sheep in the four-image display would be changed to something visually similar, perhaps a fluffy cloud (fig. 25). Altmann and Heuttig's findings revealed that upon hearing the sentence, "The shepard looked in the field, and there was a sheep," participants, when viewing an array of four pictures (of a tree, a balloon, a cloud, and a car), would direct more attention to the cloud than to the other non-"shepard"-related images. This indicates that "shifts in overt visual attention occur towards items related to words in the language when there is some featural match between the target specification accessed by the spoken word and the properties of the objects in the visual display" | Altmann, 2007 |.

What Altmann and Huettig's work reveals is that as we receive audible inputs (in the form of spoken, verbal language), we are creating in our minds a conceptual representation of that information, and that we involuntarily tend to shift our visual attention to stimuli in our field of view that match our conceptual representation, either *visually* or *semantically*. As author of "Design, Communication and the Functional Aesthetic", David Rowsell's words seem appropriate here:

> "When communicating, it is more than useful to have some idea of the state of mind of your audience. What beliefs, preconceptions and predilections does your audience have? Our words may be misunderstood, meanings can go astray. Mistakes of meaning can be avoided only if we put in some work on preparing our audience for what is to be said. Aesthetics is one such means of preparation at the disposal of designers" | Triggs, 1995 |.

Rowsell touches on some of the same topics as the studies of Altmann and Heuttig: by understanding who our audience is and how they think, we can overcome language mismatches by visually connecting our message with the conceptual representations that lie in the minds of our audience.

:: Sources of Language Conflicts

At some point, it happens to us all: we've got something to say, something to contribute to the conversation at hand, and we voice our opinion — and no one understands. So we try again. And we try and try until finally we give up and the discussion moves on just as it would without our input. Why? Everyone in the group speaks the same national language, but in many cases they speak different cultural dialects; their backgrounds are different, their experiences are different, and the way those elements come together frames their point of view, just as we do with ours.

When the stakes are higher than just a soundbite in a conversation, those cultural dialect variations are magnified. For example, if a design team comprised of product designers, marketers, and engineers are working together to create a handheld computer for general contractors and the marketing agent says that the device has to be tough, what does that mean? To the engineer, perhaps that means the housing must be made of a rigid composite material that can withstand the crushing force of a work truck but to the product designer it means that the form language of the device has to visually communicate its durability and reliability in harsh conditions. Both characteristics are relevant, but how can we be sure that the designers understand the engineers and vice versa?

Let's take this example a bit further: suppose the marketer is based in London, the designers are in New York, and the engineers are in Germany. On top of this, the manufacturing plant is in Thailand. Obviously there is a need for the exchange of information, and there are numerous ways to do this — document sharing through email, conference calls, video sessions, etc. Each has its place, but there still exist gaps in the dialogue between parties that forces each member of the team to interpolate, or fill in, the missing information. And the way they do so is surely driven by their own take on the scenario. If the manufacturing plant is unable to mold the proper radius on a corner of the general contractor's computer device and tells the engineering team about it, the engineer may correct the issue by increasing the radius. This small change, however, could be enough of a difference to cause the device to lose its *toughness* quality, as interpreted by the designers or marketers and, ultimately, the consumer. Certainly the aim of the engineer in this scenario was not to redirect the overall feel and selling point of the device, but to correct a logistical issue with a clearly-defined problem-solving approach.

This differentiation of problem-solving approaches is part and parcel of collaborative teams comprised of members of varying backgrounds and experiences, and is further exasperated by differences in cultural dialect. John Gooch, who teaches technical and scientific communication at the University of Texas, explains this scenario:

> "Conflict, consensus, and resolution are inextricably intertwined in collaboration, and how these elements emerge can tell us much about the formation of a particular group. When experts communicate, they communicate using a language specific to their discipline...other individuals from outside the person's disciplinary community cannot readily understand this language because they do not possess the vocabulary or the sophisticated theoretical understanding of a person who has received this specialized training" | Gooch, 2005 |.

If those involved in the problem-solving process are still in the process of learning their own cultural (professional) dialect such as in the academic setting, another layer of difficulty is placed on the team. This division of specialty and language can be better understood by addressing the traditional — and emerging — forms of collaborative efforts.

:: Working Group Approaches

There are three fundamentally different ways of dealing with the organization of a cross-disciplinary, collaborative effort, each characterized by its treatment of the knowledge areas of the parties involved; these include multidisciplinary, interdisciplinary, and transdisciplinary. Barbara Mirel, a research scientist at the University of Michigan, describes these three

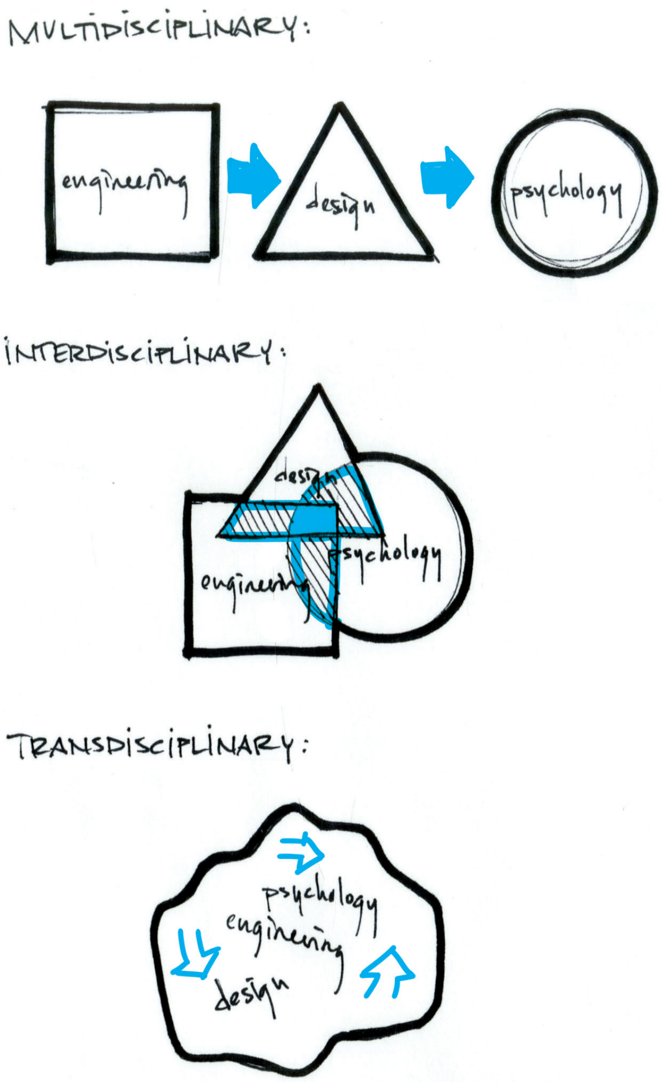


fig. 26. a visual comparison of the three collaborative approaches: the multidisciplinary assembly line, the crossover of knowledge in interdisciplinary swap-meet, and the shared working space of the transdisciplinary "symphony."

approaches as *assembly line, swap meet,* and *symphony*, respectively.

The first, multidisciplinary, is the most common form of collaboration found in academic and professional groups alike. In this model, each discipline, profession, or knowledge area (henceforth referred to as "discipline") is bound by the limits of its standard functions and responsibilities. Very much like an assembly line, a multidisciplinary team operates in a sequential manner; as one discipline finishes its contribution, the project is passed on to the next discipline, and so on. From the outset this model relates its perceived efficiency to an undeniable sense of direction and process. In practice, the marketers start the process by telling the designers what the customer wants, the designers create the product concept, then the engineers turn the concept into reality. Precise and rigid, but is it efficiency at its best? Not so when problems arise, or when one member of the team is unclear about the ideas or notes passed down by the discipline before them. The multidisciplinary, assembly-line approach leaves no room for a glitch in the works, no way of ensuring that all players are on the same page from the start, headed toward the same goal. Nor does it allow for one discipline to share in the responsibilities of — or give criticism of — another because of the perceived lack of knowledge and understanding of what each specific discipline does. The advantage of the multidisciplinary model of collaboration can be found in its methodical, formulaic treatment of the production process, however its lack of maneuverability and reflexivity to outside pressures seriously undermines its benefits.

The prefix "inter-" is borrowed from Latin, where it meant "between" or "among". As its name would suggest, then, interdisciplinary collaboration deals with what happens between the different disciplines involved in a joint venture. Taken literally, this would imply that something occurs within the physical space between, say, a marketer and an engineer, but figuratively this means focusing on the interactions that take place when that marketer and engineer discuss their respective viewpoints. In interdisciplinary teams, the tasks performed are usually still held as being particular to each discipline, with the marketers still providing the big idea and selling points of a product, the designers interpreting the identified consumer needs and embedding those functional requirements within the form of the product, and the engineers translating the proposed concept into working documents and finally a real, physical object. But this model differs from multidisciplinary collaboration in that each stage of the process is reviewed by all members of the team, creating a system of oversight of and from the individual disciplines.

The interdisciplinary approach also differs by creating an environment where team members are able to communicate with any other discipline at any time, instead of through a chain-of-command-type protocol. This overlapping of input from the various disciplines within the team is this model's greatest benefit, however with each discipline still wholly responsible for producing its own contributions, the pervading sense of proprietary material still exists.

The third model for collaborative efforts is based on the core idea that members from each discipline, while still the experts in their particular field of knowledge, move beyond their individualized responsibilites and participate at all levels in the contributions of the other disciplines within the group. Daniel Stokols, from the School of Social Ecology at the University of California describes transdisciplinarity:

> "A process by which [collaborators] work together to develop a shared conceptual framework that integrates and extends discipline-based concepts, theories, and methods to address a common topic. Transdisciplinary [collaborations] are intendend to achieve the highest levels of intellectual integration across multiple fields and yield shared conceptual formulations that move beyond the disciplinary perspectives represented by team members" |Stokols, 2006|.

This explanation may seem rather esoteric, however it points to the main features of the model: developing from the very beginning a shared perspective for framing all decisions made by the group, and to rise above — or transcend — the feeling of ownership of any particular process or expertise by members of the collaborative group. If multidisciplinarity has the attitude "I do this first, then you do that," and interdisciplinarity has an attitude of "We'll get together at these three times," then transdisciplinary collaboration fosters a feeling of "We're all in this together."

Cross-disciplinary work groups exist both in the corporate world and in the academic setting, the former as a means of maximizing success for the brand and the latter as a means of preparing the soon-to-be careerist for their role in that brand-success process. Once in the industrial setting, any training or education required by the employee is largely directed by the desires of the company for which they work. This re-education of employees is rarely free, however.

:: Corporate Collaboration Costs

There was a time when it was enough to have good collaboration within an individual company, so long as coworkers were able to successfully share files and information that might help in achieving the goals of the business. In an increasingly global marketplace however, the value of collaborating (or "working with") reaches beyond the walls of each business and across oceans, time zones, and cultures. So how do we prepare our employees to respond to this expanded view of "collaboration?" International Business Machines (IBM) is one of the world's most global companies with offices in the US, Japan, India, China, Israel, and Switzerland. On average, IBM spends $600 million each year on worker education programs |Lohr, 2007|. To put that in perspective: if everyone in America worked for IBM, the company would be paying almost $2 per person per year just on training.

John Bersin, President of Bersin & Associates (a research and advisory firm whose work focuses on enterprise learning and talent management) points out that current economic stresses had an impact on corporate spending on training their employees: "In the last few years, corporations have moved to coaching and informal learning methods, focusing on collaborative activities and other less costly training schemes. From 2007 to 2008, total spending on corporate training programs dropped from $58.5 billion to $56.2 billion, an average change from $1202 per employee to $1075." He believes this money-saving trend will continue even as companies begin to recover from the economic downturn. Bersin states that "Today's business world demands a combination of formal and informal learning with an emphasis on collaboration, knowledge sharing, social networking, coaching, and mentoring...Business, HR, and learning leaders must think differently about corporate training and focus on those informal and collaborative strategies that will save money" |Breitbart, 2009|. This leads us to the question: for what purpose do companies spend money on training? The simplest answer is to increase employee productivity (i.e. their problem-solving skills). In his book titled *Design Thinking*, Peter Rowe breaks down problem-solving behavior into three subclasses of activity:

> "The first, the representation of the problem through structuring and restructuring the problem space, is known as the 'problem representation problem'. The second, the generation of solutions, is termed the 'solution generation problem'. The third, the evaluation of candidate solutions, is known as the 'solution evaluation problem'. Those who study problem-solving behavior generally make comparisons among problem solvers according to differences in their methods of problem representation, solution generation, and solution evaluation. Clearly these three subclasses of activity are interdependent. The choice of solution generation strategy may markedly affect the manner in which a problem is represented and the manner in which solutions are evaluated. It is generally in terms of solution generation strategy that problem-solving procedures are described" | Rowe, 1987 |.

To summarize, to remain competitive at the ever-increasing global scale of business, corporations continually expend large sums of money on employee training. The modes by which employees are trained are becoming much more informal, often focusing on collaboration techniques, but the goal of that training is still to increase employee productivity (problem-solving skills). Drawing (visual thinking and conversation) has a direct application to the first two stages of the problem-solving process as described by Rowe (problem representation and solution generation). Drawing as a means of solution generation is most heavily employed in design-related disciplines, so where can designers most readily share their techniques with other disciplines? Corporate collaboration typically follows the multi-disciplinary model; each profession has its own job to do, so long as the assembly line keeps moving. It is because of this drive for efficiency that the corporate world leaves little room for shifting to a less clearly defined method of problem-solving — the numbers can't instantly prove that such a shift would equal success. Academia, on the other hand, offers an environment of inquisition and experimentation and serves as the testbed for potential success-building strategies that can be carried into the corporate world by new generations of employees.

fig. 27. student design discussion accompanied by sketching.

:: An Academic Focus

If we focus our efforts toward the academic setting — and interdisciplinary work groups in particular — drawing becomes the language of collaboration that students can carry forward into the collaboration-heavy commercial market and arrive well-equipped to handle the ambiguity of complex, real-world problems. Perhaps even so much as to reduce the need for additional company-sponsored training on the need for and application of collaborative problem-solving techniques.

Academia makes an attractive host for this new approach to collaboration for several reasons. The university setting is a unique collection of a broad range of knowledge areas, all contained in one clear location; close proximity between the varied disciplines increases the possibility of interaction among dissimilar areas of expertise, a kind of academic "cross-pollination". Secondly, in this pre-professional environment students from each discipline are still learning the language of their respective area — the cultural dialect of their discipline. Presenting them with an active, engaging means to reach beyond their own cultural dialect and converse with students versed in another dialects would create "professionally multilingual" students. Additionally, students in a university setting are typically between the ages of 18 and 24. These ages could frame a window of opportunity to reintroduce drawing as a productive activity before personal views are solidified, where drawing concretely becomes the domain of trained artists and the emergence of the phrase "I haven't drawn since I was a kid" becomes the de facto excuse to be excluded from drawing-based activities. Lastly, the academic setting has long been the incubator of non-traditional methods of research, learning, and teaching; centers of higher-education are more open to new collaboration techniques without the high costs associated with implementing such approaches in the corporate setting.

:: Principles of Visual Dialogue

Until now we have discussed at some length how vision works, how drawing can be used to expose new ideas, and how language is structured as well as stifled. How do these three broad concepts relate when applied to the academic environment? Is it possible to combine what we know about visual stimuli, the use of drawing as more than a representational tool, and the elements and syntax of language to encourage more fruitful cross-disciplinary interaction in a place so ripe with profession-oriented knowledge? The following is an attempt to do just that: propose principles that could guide the activity of drawing in a collaborative setting that would maximize its effectiveness on group cohesion and group solution-generation. These principles are predicated on drawing's inherent qualities of accessibility, expediency, and communication.

i | Balancing expediency against completion.

Time, as they say, is "of the essence" in collaborative working groups; often these cross-disciplinary ventures are done in addition to or outside of regular individual responsibilities. This necessitates a use of drawing that can be executed quickly, and one way of doing so is to employ the Gestalt principle of completion (discussed in Chapter 2) wherein we rely on the mind's ability to fill in the missing information in a visual display of information. This form of visual sparsity is exactly the basis for the drawing game *Pictionary*. A successful Pictionary team — often made up of members of diverse backgrounds — is one that can extract meaning from the least number of visible marks on the drawing board (see Essay: The Pictionary Phenomenon).

ii | Balancing resemblance against representation.

Based on the work of Pylyshyn, Fish, Steinhart, and others, it is clear that our visual systems are able to make meaning out of percepts that are not exact copies of the objects that they represent. Of this, Pylyshyn says:

> "Resemblance is neither necessary nor sufficient for something to have a particular reference: images may resemble what they do not refer to or what they depict (e.g., an image of John's twin brother does not depict John) and they may depict what they do not resemble (an image of John taken through a distorting lens depicts John in the sense that it is an image of John, even though it does not resemble him)" | Pylyshyn, 2003 |.

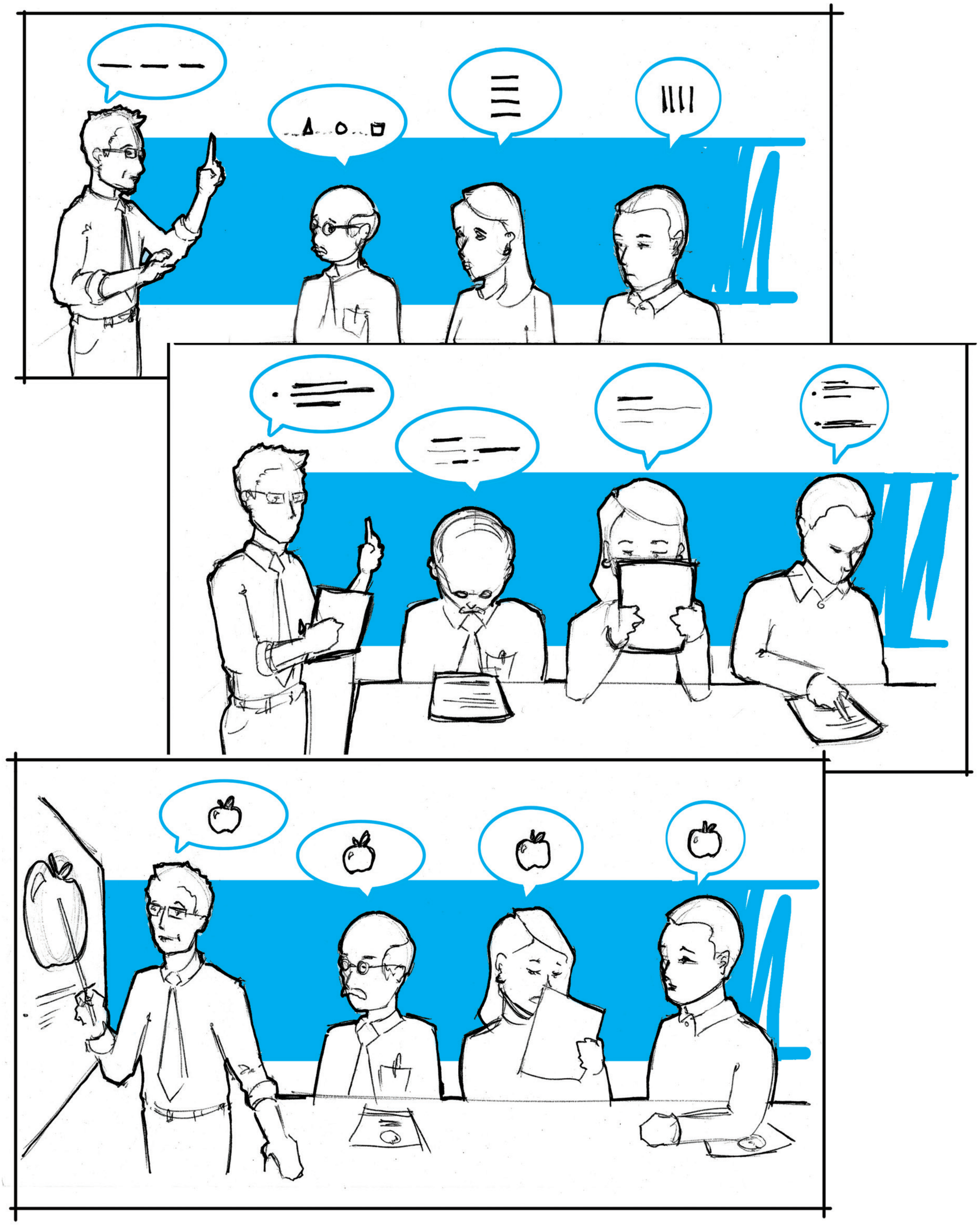


fig. 28. comparison of verbal, written, and visual information exchange. the ambiguity of collaboration decreases as information becomes more tangible and reflective of the way we experience the world.

This raises the question of how much our drawings need to actually resemble the ideas they are trying to represent. In a collaborative group setting where the goal is to advance the directives of the project, we do not want to spend copious amounts of time creating amazing works of art; rather, we should focus on creating images that connect with our audience's understanding of the concepts being discussed.

iii | Drawing what needs to be *known*, not always what must be *seen*.

Directly related to the preceeding principle, this principle recalls our natural tendencies in drawing as children as well as the basis for Gestalt visual theory (principle 1). As children, our grasp on accurately recreating what we see is limited, therefore we draw images that more closely resemble the mental models of which Wujec speaks in Chapter I that allow us to make meaning from the world around us. Perhaps by employing this style of drawing we are able to connect the concept that we wish to share with the way our viewer would naturally deconstruct the image. As for the Gestalt relation, again it is not always necessary to complete an image before our audience is able to extrapolate meaning from it; in addition, we can utilize other Gestalt principles to superimpose meaning and relationships on an image that does not exactly represent those relationships. [grouping, proximity, similarity, good continuation, etc.] In the words of Leonardo da Vinci, "confused things rouse the mind to new inventions" |Fish, 1990|. We are able to jump-start the creative problem-solving process by feeding the work group visual indeterminacies that lead them to synthesize relationships and therefore possible solutions.

iv | Sememe-Grapheme drawing.

The notion of drawing what must be known forces us to dig deeper into the material or concepts that we are trying to exchange amongst members of the group. It is imperitive that each member of the team have the same understanding of the concept being discussed, and one way we can increase the possibility of a shared understanding is to focus on the *semantic* qualities of the concept. If we look back to Altmann's studies, it is possible to influence our audience's receptiveness and responses to concepts by priming them ahead of time with semantically-heavy information. As discussed earlier, sememes of written language can be broken down into their graphemes, (the basic units of written language) so how does this translate to drawing? We could propose that there are, in fact, graphemes of a visual language; the danger here is that we begin to think of symbols as those elements that combine to represent meaning, and it is largely argued that symbols, in most professions, are arbitrarily assigned (such as π or Δ in mathematics) and lack clear connection to the concept they represent. Another drawback to symbols is that they have the tendency to oversimplify a discussion in a way that makes it difficult to recall the finer details at a later date. As Dan Roam suggests: "The real goal of visual thinking is to make the complex understandable by making it visible -- not by making it simple. Whether that goal demands a simple picture, an elaborate one, or an intentionally complex one is almost always determined by the audience and its familiarity with the subject being addressed" |Roam, 2008|

What then are the visual elements that combine to create meaning? One is speed: the rate at which we draw has the ability to transmit qualities of the thing being drawn. For example, if we wished to share forceful, strong ideas, it could be suggested that broad, quick strokes translate determination and assuredness. On the other hand slow, calculated curves could convey delicacy or softness. These are the graphemics of drawing which can be employed during the representation of a concept that could further enhance the semantic meaning of that concept.

v | Drawing globally, thinking locally.

One way of building a consistent understanding of a concept is to layer on information in such a way that the team can grasp the concept in increments. Edward Tufte, a prominent figure in graphically representing statistical data, mentions a similar idea in his book Envisioning Information: "Among the most powerful devices for reducing noise and enriching the content of displays is the technique of layering and separation, visually stratifying various aspects of the data" |Tufte, 1990|. We can take this to mean that if we gradually increase the number of visible elements, our audience (the group) can digest each new layer sequentially and in the proper order. We can employ the findings of Belke to determine this "proper order"; in response to whether our audience is predisposed to prenominal or postnominal modes of description, we could either start with the most vague dimensions first (for the former) or with the most absolute dimensions (for the latter).

Dan Soltzberg's comment about defining the factors of a problem rather than the exact formula seems appropriate again here: "It seems like what we are able to identify isn't a specific equation but a set of factors..." |Core77, 2010|. In the process of identifying these elements, and subsequently their possible relationships and arrangements, we are able to approach problem definition in an "outside-in" manner, i.e. we identify the global structure first, then gradually localize our focus until we have pinpointed the basis of the problem, from which we can begin to work outward again in scales of possible solutions.

Perhaps these principles are the basis for breaking down the convention that drawings must be prepared and then explained, that no one should see our work until it is finalized, or that our process drawings are somehow *less* when compared to our refined, final images. Perhaps this is the positing of a new discipline or practice, that of *visual conversationalism*. A way of using what we know about the visual and cognitive processes, along with our understanding of the limitations of our eyes and our mind's eye, to create an approach to drawing that not only communicates and allows for, but even fosters active conversation.

:: Conclusion

Globalization is a force that continues to drive world social and economic decisions and the interactions between nations, governments, corporations, and institutes of higher learning. A key component of the globalization engine is the need for collaboration in all professions, from business to science, from engineering to marketing, and from transportation to psychology, to name only a few. This spanning across professions arises from the need to resolve problems that, once able to be solved at the local level, now reach far beyond national boundaries and require an increasingly integrated approach.

As this professional-integration trend shows no sign of abating, the struggle to overcome barriers to collaboration will continue to exist in our social and economic ventures. Not the least of these obstacles — and perhaps the most prevalent — is the persistent conflict between discipline-specific languages. Each professional cultural dialect is the product of its own environment, employing a rhetoric that can be difficult to decipher by those of a different profession. The term "tolerance," for example, is not used by the structural engineer to describe the abilities of two entities to "put up with" each other or to "get along" (as it may be used in human psychology), but to express the absolute minimum distance between two components in an assembly. The vernacular of a structural engineer may utilize words that are also present in the human psychology discipline, however the semantic meaning of those words may be quite different. It is this difference of semantics that so often poses a problem to group cohesion by disrupting the exchange of knowledge between parties. When collaborative groups are formed, it is essential that each participant fully understands the goal of the project and not just their respective role in the group.

As we have seen, the *action* of drawing is able to do more than transfer visual pictures. Embodied in the motions and movements of the act of drawing is the ability to visually transfer semantic properties of ideas and concepts without the explicit use of a particular ethnic or cultural language. Some may believe that drawing is the territory of artists and designers alone, or that their limited use of the tool is merely for non-creative purposes. The principles discussed in this book can be applied to all professions, regardless of artistic background.

To the "non-artist": Drawing is an informal activity when compared to other professional solution-generation tools, a characteristic which can encourage members of all disciplines to join in without the fear of embarrassment associated with mis-translating across languages. If those of non-design professions tend to have the same skill level in visually representing information or ideas as a 10-year-old child, then everyone should be on a level field when drawing. And if 10-year-olds draw what they *know* instead of what they *see*, is it not more important that all members of a group understand the meaning of what is being drawn, rather than how accurately the image resembles its subject matter? Drawing is the visual correlation of exchanging the semantic value of an idea rather than translating the description of that idea from one ethnic or cultural language to another.

To the "artist": Design has a growing presence in the world's economies, appearing in a wide array of markets and professions. Often seen as the "value-added" piece of the industry puzzle, how can design share more than novel or clever design ideas? Internally, the design professions are well-versed in the use of several modes of drawing, and we shift between them to engage various perspectives on the issue at hand; this fluency in, and ability to shift between, these drawing modes is representative of the holistic approach that is inherent in good design practice. Can we share our own visual language — one based on the in-the-moment cognitive processes that occur while drawing — as a way of overcoming professional culture-specific language conflicts? Can we encourage a deeper sensitivity to the backgrounds of collaborative-group members by adjusting the mode in which we draw and encourage others to draw?

The argument has been made in this manuscript that there is more to drawing than what we often assume; its application to problem-solving ventures is made possible by its inherent abilities to reveal new solutions that could otherwise remain concealed from us. While the practices of many professions are structured to reduce or eliminate any form of ambiguity, it could be said that the act of drawing relies to a large degree on that ambiguity to allow our cognitive systems to take the lead in identifying possible solutions. This aspect of drawing forms the basis for its role in the design process (by its nature a visual profession); while attempting to visually resemble an internal mental image, a designer often stumbles upon a new direction, an unintended consequence of putting ideas out in the visual environment to be re-interpreted by our visual system. But to say that this phenomenon is the sole property of design-related fields is to negate the entirety of this body of work. Drawing connects with all human beings that possess the ability of sight. It is analogous to the way we experience the world: it relies on our brain's natural tendency to build mental models of the information that we see, and does so without the need for complex sets of symbols that therefore require extensive translation. We have discussed the juxtaposition of symbols and precision-oriented practices against our very own human nature. And if we are analog creatures, then ambiguity is the necessary counterpoint to the certainty and specificity that we strive for in generating appropriate solutions to problems. Drawing actively implants the two within our visual stream; the clear, intentional strokes that we make consciously giving rise to areas of visual uncertainty that we are therefore forced to resolve.

This book has been written with the intention of presenting drawing to an audience that would otherwise dismiss its usefulness in traditionally analytical disciplines. That presentation has relied not on extolling the need for accuracy or skill in creating pictures that resemble their subjects, but instead on how the simple act of drawing — and often low-skill, representational drawing — connects with human beings regardless of language backgrounds (ethnic or professional). The principles that have been proposed are intended to provide a loose framework within which the act of drawing can be seen as having structure and purpose as a tool that does more than impress us visually. By considering the visual phenomena, the language-based relations, and the conversational drawing principles discussed in this book, we see that the *activity* of drawing can be a catalyst for the effective exchange of knowledge between disciplines in collaborative groups.

Introduced in the mid-1980s, Pictionary was called the "game of quick draw" — and for good reason. The basic premise of the game was to read the clue on a game card, then draw out pictures that would allow your team to guess that clue. Each player's turn was timed, therefore encouraging the drawer to move quickly, especially when the clue had more than one part. There is a high probability that we've each played this game or one similar to it, but what can it teach us about collaboration?

While the game centers around rapidly drawing pictures of clues to be guessed, digging deeper we find that it also amplifies what we've discussed about group dynamics, team cohesion, and common language.

In the game, having a talented artist on your team is seen as an advantage, however it is not a necessity. In fact, this overload of talent could be detrimental to the success of the team if the artist gets caught up in resembling rather than representing the clue and time runs out. What is necessary for group success is a drawer that understands how to connect with all members of the team. If the group members' backgrounds are diverse for example, the artist must utilize a low-context form of drawing and make all her moves explicit; if all members of the group are familiar with each other and are from similar backgrounds, the artist's approach may become high-context and rely more on metaphorical representations that require little supplemental explanation. What is most advantageous is not merely a talented artist, but an artist that can empathize with her team and create drawings that speak the appropriate language that corresponds with the makeup of the group.

As for group dynamics and team cohesion, in a simple game of Pictionary the goal is clear: guess the word. Having this unambiguous understanding allows members to focus on the task at hand rather than on their specific role in the group. In the excitement of playing a round in Pictionary, we are more consumed with shouting guesses, watching the reaction of the artist, and remaining attentive to the corrections or additions to the drawing on the board than we are at speculating whether or not the artist is fully qualified to be using a marker to draw a picture of "spilling" or "circus monkeys." In addition, as the game progresses teams begin to become more integrated, growing accustomed to the way each team member tends to interpret the game drawings and how they themselves approach their responsibilities as "drawer." If the game lasts long enough, it is possible to see the emergence of an exclusive, inner-group language (be it as drawn images or spoken guesses).

Pictionary is also a prime example of the impact of dynamic visual information on visual attention. We are captivated by watching what the drawing will become and our attention is targeted toward each mark in an attempt to gather ever bit of information to form a guess. This same anticipation can be found in an example of television advertising: for a time, UPS built upon the Pictionary formula in a series of advertisements wherein the main character of the commercial stood before a white board and, while explaining exactly how UPS services worked, drew images on the board. These images typically began as a recognizable object or scene (a delivery truck, perhaps) and through a series of manipulations were transformed into another, different object representing the benefits of shipping with UPS. In an article discussing the effectiveness of creative television advertising, Set Stevenson explains the attraction of these commercials: "But more than the eye-catching set design or those killer whiteboard chops, I think it's the power of narrative that holds us entranced. There's something primal in our urge to listen when someone stands before us and tells us a story. This isn't the tensionless narrative of a lame testimonial ad...where we know precisely how the story will end. There's an element of uncertainty here. We know the initial drawing will turn into something new -- but we're not sure what this end product will be, or how the marker guy will pull it off. And...we can't pull ourselves away until we reach a resolution." |Stevenson, 2007|

Let us recreate this example, taken from a recent game of Pictionary:

(squiggly line)
"Water! Ocean!"
This last utterance was met with frantic pointing; so it *was* "ocean"...

(line curving down into "ocean" line)

"Shore! Beach! Sand!"
More excited pointing and smiling.

(curved line coming from "ocean" to "sand")
"Beached Whale!"
Bingo.

One of the beauties of Pictionary is its inherent roughness, its time-crunched importance that forceably distills abstract concepts down to their most basic representations. As M.C. Escher, author of mindbending hand-drawn images, once said of trying to depict our imaginations, "A mental image is something completely different from a visual image, and however much one exerts oneself, one can never manage to capture the fullness of that perfection which hovers in the mind and which one thinks of, quite falsely, as something that is 'seen'." |Pylyshyn, 2003| Escher makes the point that one could spend an infinite amount of time and attention to making a drawing resemble a mental image, but Pictionary forces us to perform visual triage; with only 60 seconds to score a point for our team, we have no choice but to "cut to the chase" and get the job done — prettiness be damned.

APPENDICES

a | Institutional Review Board online survey exemption
b | Why Do We Draw? Survey solicitation email
c | Why Do We Draw? Survey results
d | Parental Permission Forms (for child drawings)
e | Glossary of Terms
f | Works Consulted

Office of Research Compliance
Carmen T. Green, IRB Administrator
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24061
540/231-4358 Fax 540/231-0959
e-mail ctgreen@vt.edu
www.irb.vt.edu
FWA00000572(expires 1/20/2010)
IRB # is IRB00000667

DATE: October 15, 2009

MEMORANDUM

TO: Edward A. Dorsa
Jonathan Mills

FROM: Carmen Green

SUBJECT: **IRB Exempt Approval:** "Drawing as Communication" , IRB # 09-865

I have reviewed your request to the IRB for exemption for the above referenced project. The research falls within the exempt status, CFR 46.101(b) category(ies) 2.

Approval is granted effective as of October 15, 2009.

As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in the research protocol. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.

2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

cc: File

Invent the Future

VIRGINIA POLYTECHNIC INSTITUTE UNIVERSITY AND STATE UNIVERSITY

An equal opportunity, affirmative action institution

fig. 29. IRB survey exemption confirmation.

:: Why Do We Draw? Solicitation Email

Dear Faculty,

I am an Industrial Design graduate student in the School of Architecture and I am probing varying disciplines across the campus for answers to a simple question:

Why do we draw?

This question is open to interpretation; why do we as humans draw? why do we as (enter profession) draw? why do I draw? why do you draw? etc. The specific way in which you interpret the question is up to you, so please take that freedom and answer as you wish.

As per IRB requirements, responses shall be collected using an online survey to protect your anonymity. The survey can be found at the following address:

https://survey.vt.edu/survey/entry.jsp?id=1255534266287

My intentions are to compile the responses and see how they impact my thesis, which focuses on the act of drawing and its applications across disciplines. As such, if you feel compelled to share this email with your colleagues, please do so; the more responses, the greater the importance of your participation. I am asking that you send your reply no later than 5 p.m. on October 30.

Please take note that your responses will remain anonymous -- I am concerned with the substance of your reply and the discipline in which you teach, not your name specifically. If you care to be informed of when/how your response is used in my research, please make a note to that effect in your reply.

Again, I thank you for your time and willingness to respond and I am awaiting your replies.

Sincerely,

Jonathan Mills

:: Why Do We Draw? Survey Results

The following are responses to a survey conducted of faculty at Virginia Polytechnic Institute and State University. The survey consisted of one question: why do we draw? Participants (who gave their consent to having their responses used in this thesis by responding) were asked to answer the question in any way they wished, and to include their area of expertise or discipline.

1. | For me, and for others, this is what I assume:
It is a method of emotional release. Drawing offers a vehicle for human expression, emotion, desire, deviance, and CATHARSIS. There you go, Drawing is cathartic. I have nothing else to say regarding this matter. Thank you.
- Sociology, Religion and Aesthetics

2. | We draw to convey a message that words alone cannot send. In my profession I draw to illustrate concepts, to show where and how lesions occur, to follow the flow of blood from one chamber of the heart to another, to show how a lesion in one segment of the spinal cord affects areas upstream and downstream from the lesion. We draw to demonstrate what a specimen looked like before we trimmed it into cassettes. We draw to show where sections of the tissue came from.
We draw because our descriptive techniques are inadequate. My son draws because he can tell a story better through pictures than words.
- Veterinary Pathology

3. | I draw to simplify concepts.
I teach pharmacology and use line drawings to explain quantitative dose-response, dose-response using qualitative values, potency, efficacy, drug interactions, time for removal of drug from the body by zero order and first order kinetics, single and multi-compartment models of drug distribution, why different routes of administration or different pharmaceutical preparations of the same drug can cause different effects, the autonomic nervous system receptors and transmitters, etc.
- Pharmacology

4. | pleasure, esthetics, visualization, presentation, representation, ideas, doodling, to inform, to teach, to explain, to show ...
- Veterinary Medicine

5. | Why do we as humans draw: expression, to capture what we see, to help explain to others what we see
Why do we as microbiologists draw: to help explain to others what we see under the microscope; to help explain complex biological phenomenon related to how things work
Why do I draw: see all of the above
- Microbiology/Veterinary Medicine/Human Medicine

6. | Humans are visual animals. Our vision is better than almost any other species, certainly better than any non-primate species, except perhaps some birds. Our brains have extensive capabilities for image processing and recording. We draw because when we make a visual representation of an object we are internalizing it into our visual imaging "data bank" and abstracting from the reality of the object those salient features that are "important" to us in fixing the image in memory. Pattern recognition and visual memory are crucial skills for survival: a poisonous plant may look like an edible one, and it's obviously important to know what predators and prey look like; with whom to mate and with whom to fight. The one thing about humans that makes them human, as much so as opposable thumbs, is the huge amount of brain power devoted to visual recognition and visual processing. We have lousy noses and not such good hearing, but our sight is the most sensitive tool we have for exploring the environment and reacting to it.
I teach histology, a VERY visual discipline, and tell my students that they're developing their pattern recognition skills more than anything else. I have developed my entire course curriculum around this concept, and am constantly stressing it. I tell them they need to draw what they see because in doing so they internalize and idealize the real and create that image memory they must have for studying pathology and medicine. Drawing is the fastest and most efficient way to do this because it integrates the sense of vision with that of touch; and because a student who copies a picture or a microscope slide is thinking about what he sees, and translating it into symbolic representations that will aid in recall and recognition when it is next encountered. I can't stress too much the importance of visual recognition in my field and the value of drawing to enhance that skill.

7. | I draw to focus on something that I like - to "feel" it. I draw to capture my feelings. I draw to understand things. I draw to work out ideas that are bouncing round in my head. I take great pleasure in creating an image of something real or imaginary. It may be for no one, it may be for me, it may be a way to present an idea.
I draw with pencils, pen, paint, thread, fabric and plants. My gardens are my three dimensional drawings. I love to absorb the colors, the textures, the smells, the changing appearance during the day, and day to day.
If I had the talent, I would be in the visual arts.
- Veterinary Clinical Pathology

8. | As a veterinary ophthalmologist, I constantly draw figures for clients and students to illustrate points concerning how the eye works, what kind of pathology is present, and what surgery to correct a condition involves.
I am an extremely "visual" person. Give me a map and

compass, you can have your GPS units. Give me an illustrated set of instructions (or just an exploded image of something), and I will conquer the world.
A bit old fashioned, I still like my KodaChrome ASA 64 slides, not the grainy fake looking digital Power Point images that students "demand" of teachers.
I could live deaf, but blind, I would be in a real mess.
- Veterinary Ophthalmology

9. | I am a veterinarian who works on companion animals (cats & dogs mainly).
I use drawings to help explain or demonstrate a process. Sometimes it is a useful way to present something that replaces in a quick way what hundreds of words would be needed to do. I am a firm believer in the adage "A Picture is worth 1000 words".
I think as a child, I did it to express my imagination, and it was great entertainment. The human mind is capable of amazing things, and to draw something we visualize in our head is unique to humans.

10. | I think we draw because we want to visually represent or capture the world--to make it less abstract. I also think that drawing is a way of knowing something deeply. You have to study the human body, its underlying muscle and skeletal structure, to understand the ripples of skin. You have to know the life cycle of a peony to illustrate its full bloom. So drawing is a way of seeing. A vision of how we interact with the world.
MFA nonfiction--creative writing

11. | Boredom during meetings.
Professor and economist.

12. | I draw in order to teach or demonstrate a concept to others. Drawing is not a primary activity in my teaching. I am an instructor and I teach nutrition to upper level nutrition students and facilitate learning through arranging practical internship experiences. I am also a registered dietitian.

13. | My area of expertise is molecular biology, plant biotechnology
Professionally
1. In the classroom, I use drawing as a method to illustrate concepts. Complex concepts, mechanisms and scientific material are most often more clearly transmitted through the use of visualization rather than words.
Personally
2. I draw (doodle) when I am bored sitting in meetings, usually geometric shapes just to past the time. I have no artistic ability what-so-ever and consequently don't draw for any aesthetic reasons.
3. When my kids were little I would draw with them just for entertainment, but drawing is also a valuable learning tool in that setting.

14. | We draw to express immediate feelings or to reflect on feelings from the past or connections between the two.
We draw to document...our thinking, our process, our actions, our beliefs, our culture or heritage, our connections to other living and non-living things.
We draw to share who we are with someone we care about.
We draw to share a topic for which we have passion to another or groups of others.
We draw for fun, for liberation, for expression and to share beauty, noticings, or metaphors of life.
We draw to communicate.
We draw to make a statement.
We draw to leave a mark of our existence.
It's therapuetic :)

15. | I work in agricultural research. Many times I need to draw to communicate to someone else the design of a system to be installed, or what a piece of equipment looks like that I do not know the name of (or can't remember the name). So I would say I draw primarily for communication. Secondly, I draw when I am on telephone conference calls or during meetings as a way to keep my brain engaged and to prevent boredom from meetings that seem to have no end.

16. | To more clearly illustrate points in teaching.

17. | In science we draw models in an attempt to find relationships and/or visualize how different, sometimes abstract, pieces fit together. Many times it helps us think of new connections and synthesize new ideas.
Profession = molecular biologist

18. | I draw for a number of reasons. Sometimes I draw to relax (usually doodling) or while I am thinking deeply about something. Sometimes I draw as an aid in conversation with someone, often to show my preceptions of the relationships between things or people or both, but also to show my understanding of what someone might be telling me. Sometimes I draw for myself--to help myself understand or process information. Sometimes I draw just for a creative outlet, but this is fairly rare---once or twice a year.
I work for Virignia Cooperative Extension -- my expertise is in nutrition and health. My primary role is to develop educational programs that teach Virginians health eating and physical activity habits.

19. | to express ourselves, or a concept, in a visual way
Agricultural and Applied Economics

20. | I draw to convey ideas to students and clients. Visualizations of molecules, compounds, as well as data such as plant growth responses to nutrients can (many times) be

more easily comprehended through a drawing. Also, the drawing does not have to very good, and in fact, many times people appreciate that one is willing to try to draw in order to get an idea across.
Good luck with your survey. I am certain that it will be interesting.
Plant nutrition and crop management (Agronomy)

21. | As a person I draw because it allows for an escape. I can draw a place I have been or a place I have only imagined. I can draw to take me away from the boredom of a meeting or I can draw to explain a point.

22. | To better conceptualize and develop concepts.
To record observations.
To transfer knowledge.
Cause I'm bored at meetings.
Biological Systems Engineering

23. | I think it is part of the brain process. Our brain thinks, acts, synthesizes, and produces information or materials. It is the end product of visualization, which creates the dramatic effect as seen in the real world. In my field (Plant Pathology), scientist draw mainly to share the information or facts or research findings to other colleagues. Children draw to express their feelings, same as writing. A great picture is equal to 1000 words, means one can express several messages from a single picture, so I think people want to make their visualized feelings into a form of art and that is why people tend to draw.

24. | I used to doodle while listening to the teachers (it started in elementary school and continued throughout the grad school). It was like a drug - I was addicted to it and couldn't stop and it wasn't just that I was bored and I needed to challenge my mind. I guess I needed to employ my hands in some way and express my subconcious thoughts.
They say picture is worth more than a thousands words or something like that. Most people seem to perceive a graphic form better than text or numeric forms. I belong to those people - I prefer to look at a graph rather than a giant table of data. Explaining concepts via figures/pictures is more efficient than using just the text/words.
Then there's the whole idea of many forms of art - drawings, paintings, and sculptures that represent different ways of expressing peoples feelings, moods, states of mind... We get to think about life etc. and analyze/overanalyze our situation in life, feelings, etc. Whether there is the talent or not, drawing or other forms of visual art help people to unload their feelings. Some people need it more than others.
I'm a plant biochemist, Assistant Professor

25. | I am a scientist-biochemist/molecular biologist.
I draw to clarify what I am saying to myself or others, to help me remember something important later, sometimes to express what I cannot say or to express even more than I could say with words.
I also draw when I am bored with what someone else is saying and need something else for my brain to focus on.

26. | I draw to clarify things to others and in my mind. So I can see the relationships between things. I am a scientist and work with a lot of data. Drawing helps to clarify what the numbers are showing us. I also draw for relaxation when on vacation. I do not draw very well. I also draw funny pictures to amuse my kids. My profession is Forestry. I draw pictures to explain concepts to students.

27. | In my discipline (plant pathology) I primarily draw to record structures of microbes, their measurements, shape, etc.

28. | I sketch to represent a concept or idea graphically, so as to visualize it and understand it more.
I doodle to pass the time in a meeting, perhaps so that I'm doing something besides listening.
I "try" to draw to be creative when working on a craft project.
I actually don't draw too much because I don't think I'm good at it. I never had drawing lessons during adulthood, and I'm not naturally inclined.

29. | To express ourselves.

30. | Creative expression is as human an activity as eating or making love. It is something almost everyone can do, from a very early age to a very advanced age. It is satisfying and allows for infinite variety. At its most basic level, it is "effectance"--look what I've done!
On a more mundane level, I draw when I'm bored, during meetings!
I am a communicator by profession. (Writer)

31. | We draw, as a way to communicate.
Profession: scientist.

32. | To communicate or express ideas or information.
Professor of Horticulture and Extension Nursery Specialist

33. | To illustrate ideas to others. To visually get an idea of scale and proportion. I am a research associate by profession.

34. | I draw for a number of reasons.
1. To communicate information and ideas
2. To formulate how things interact in space with each other
3. To save a copy of something when I need to remember size, shape, function and interaction
4. Artistic for the purpose of form, beauty, and texture
5. Doodling to make notes, react to something I have seen,

heard, felt or thought about.
Academic Background: BS Engineering
Currently an MS student on-line in the College of Agriculture and Life Science
Profession: Engineer CALS Extension

35. | I draw to convey an idea in an alternate form to spoken or written language. Also, I often want a drawing to convey a message to a broad audience or an audience who has limited time to receive my message.
Expertise: food safety, food microbiology, food processing, regulatory affairs
Profession: faculty, food science and technology

36. | While it has been "forever" since I have drawn anything, the first thing that comes to my mind at this stage of my life is to pass the time (ie. boredom) mostly during meetings, phone calls, etc. where attention to the topic has become limited at best. This is more from a "doodling" perspective than a drawing one...
In general, I would guess that many people who draw do so from a creative perspective and for the emotional value that they receive by putting pen/pencil to paper. Whether to share their thoughts and feelings with others or to just express themselves in a personal way that they will keep only to themselves, drawing can provide a release.
Drawing also serves as a way to capture the image of something. People tend to think "beauty" when considering capturing images of something; however, objects that are not "pretty" that people want to remember are also drawn.
With technology as advanced as it is, people don't seem to draw the way they once did. It's easier to take a picture than it is to draw one. Whether for time constraint reasons or perhaps just laziness, drawing has become an unfortunate loss over time.
I am considered college administration.

37. | To illustrate concepts in a concise manner and show relationships between those concepts.

38. | Human Development Doctoral Student & Marriage and Family Therapist
1.) We as humans draw for many reasons. I think there is an impulse for creativity from a very early age that some of us engage in more than others. One reason is to capture our environment, another is to escape from it, and still another is to create another one.
2.) Human Development is an Academic social science. The reason we draw in here is to make points as we teach or do research: making charts, brainstorming, and structural equation modeling. We also draw to model theories.
3.) Marriage and Family Therapists draw to help understand connections between family members, families and the environment, etc. We draw to help our clients understand us and to help us understand our clients. Finally, we use drawing as a medium for healing.
4.) I draw for all of these reasons in the first three questions. I also draw because it's fun and because I am a visual person. I sometimes sketch out art projects that I do whether that be beadwork or pottery.

39. | I am a human development major. I am not what anyone would call an artist. When I draw its usually just doodles done upon a friends hands or on the sides of my notebooks. Almost every time I am on the phone with someone I will be unconsciously drawing shapes and figures. I took some art classes in high school and so sometimes my doodles will be of cones, cans, perfect circles, ect. Drawing is something that is fun for me and I don't feel the pressure to draw pretty things so I just draw to my heart's desire.

40. | Make diagrams.

41. | Human Development graduate student
I don't draw much anymore, except perhaps conceptual models, but I did draw a lot as a child. I drew in order to capture what I saw, in my mind or before me, and/or pay tribute to something beautiful. Sometimes it was completely creative, such as an underwater scene with mermaid. Other times it was completely functional, such as building plans for my tree house. My concept models now could be functional as my tree-house plans, but I don't typically draw creatively anymore. I stopped drawing that way when I realized that I did not have the skill to truly capture what I saw/wanted to pay tribute to and became frustrated. Photography has since become my outlet for that I think.

42. | I draw for two reasons: practical and inspirational. The practical reasons for drawing often include schematics, or symbolic representations of a room / space so I can determine the location of items I would like to include. Drawing for me, in many ways, is a tool I use to function in the world. I almost always draw for a practical reason. Usually, my drawings are crude and nondescript, but they serve an important function, presenting information to me and others that is hard to put into words.
The inspirational reasons for drawing are to express myself in an artistic fashion. However, I am a horrible artist, so most of my drawings end up looking like a 5 year old's. Regardless, sometimes I am struck by the inspiration to draw, usually a scenic picture, to express something that I am not getting out in other ways.

43. | To release thoughts and ideas that are difficult to describe in words. As in, "a picture is worth a thousand words."
I use drawing in my work as a therapist in order to get at things that people may have a difficult time explaining

verbally. I also think that drawing takes clients to a place hard to reach when just thinking and answering.
Ph.D. Human Development Specialization in Marriage and Family Therapy

44. | For creativity, for relaxation, for the ability to present ideas and show others what we are thinking.
Drawing is artistic or technical, or both at the same time.
It displays emotions.
As a human development major, I don't necessarily use drawing for my profession, but drawing is used in therapy as a way to get clients to express thoughts and emotions in a creative way--a way to express what words cannot. It is also therapeutic in itself. We draw for a sense of relaxation.

45. | My drawing is exclusively functional as a planning and communication tool, either for myself or with others. I do not doodle or do relaxation/pass-the-time-while-waiting kinds of drawings (although I have done some simple cartoons in the past). My field is horticulture with a strong orientation to the science and technical side but having a personal background and 20+ years of teaching responsibility in the artistic side in floral design. In another responsibility area I am involved in landscape design, and from my personal activities I do woodworking as well as home and landscape construction. In each case the drawing may be be considered as technical drawing, whether in simple sketches to help students visualize 3-D images on 2-D media or more involved detail drawings to help me develop furniture style images, estimate component dimensions and materials required, and then plan the assembly methods and sequence. All in B&W except for few occasions when color may add clarity to components in the drawing.

Why We Draw

An Exploration Into How and Why Drawing Works

Parental Permission Form

Investigator:
Jonathan Mills
Graduate Student, Industrial Design, School of Architecture + Design
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phone: 540.455.2299

Purpose:
The purpose of this study is to gather drawings produced by children under the age of 10 (and descriptions of those drawings as explained by the authors) as examples of how our drawing abilities grow and change during the first 10 years of life. This study is part of a body of work that aims to encourage drawing as adults as a means of social interaction and conversation, a key component of which is studying how humans draw as children and why they either continue or discontinue drawing as they mature through adulthood.

Procedures:
Participants (children under the age of 10) will be asked to create a drawing, the subject matter of which is entirely up to the participant (though encouragement can be given to draw observable objects such as people, animals, places, etc.), which will be collected along with an explanation of the drawing by the child.

Risks:
Child subjects need to be reminded that they are not being evaluated on their drawing skill and should be encouraged to draw at their own pace and in their own style. The slight possibility of emotional distress exists if the participant chooses to draw a particularly painful experience, however an attempt will be made to avoid the production of these types of drawings to minimize such risks.

Benefits:
The benefits of participating in this study relate to how the understanding of drawings produced by children serve to inform adults about how to draw what they *know* rather than merely what they *see*.
No promise or guarantee of benefits have been made to encourage you to participate.

Extent of Confidentiality:
I understand that my name as well as the name of my child will be known to the researcher, but the researcher has promised not to divulge this information to anyone. The names of participants and authors of any material used in publications of this research will be changed for publication purposes.
It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subjects involved in research.

Compensation:
Subjects will not be compensated, monetarily or otherwise.

Freedom to Withdraw:
As the subject's parent, I understand that I have the freedom to withdraw my child from this study at any time, as well as refuse to participate in any research activity that I choose without penalty.

Subject's Responsibilities:
I voluntarily agree to allow my child to participate in this study. I have the following responsibilities:
1 | provide the drawings requested in the "Procedures" section above.

Subject's Permission:
I have read the Consent Form and conditions of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent.

____

If I should have any questions about the protection of human research participants regarding this study, I may contact Dr. David Moore, Chair Virginia Tech Institutional Review Board for the Protection of human Subjects, telephone: (540) 231-4991; email: moored@vt.edu; address: Office of Research Compliance, 2000 Kraft Drive, Suite 2000 (0497), Blacksburg, VA 24060.

:: Glossary of Terms

A

• ad libitum: adj; 1) at one's pleasure, without restriction; 2) freely, as needed; abbreviation: ad lib.

B

C

• cognition: n; the mental process of knowing, including aspects such as awareness, perception, reasoning, and judgment.

• cognitive psychology: n; a branch of psychology concerned with mental processes (as perception, thinking, learning, and memory) especially with respect to the internal events occurring between sensory stimulation and the overt expression of behavior.

• comprehension: n; capacity of the mind to perceive and understand; power to grasp ideas; ability to know

• communicate: -v; 1) to give or interchange thoughts, feelings, information, or the like, by writing, speaking, etc.; 2) to impart knowledge of; make known.

• concept: n; 1) a general notion or idea; conception; 2) an idea of something formed by mentally combing all its characteristics or particulars; a construct

• concise: -adj; expressing or covering much in few words; brief in form but comprehensive in scope; succinct; terse

D

E

• eidetic: adj; 1) of, pertaining to, or constituting visual imagery vividly experienced and readily reproducible with great accuracy and in great detail; 2) of or pertaining to eidos.

["pertaining to the faculty of projecting images," 1924, from Ger. eidetisch, coined by Ger. psychologist Erich Jaensch (1883-1940), from Gk. eidetikos "pertaining to images," also "pertaining to knowledge," from eidesis "knowledge," from eidos "form, shape"]

• extemporaneous: adj; 1) done, spoken, performed, etc., without special advance preparation; impromptu; 2) previously planned but delivered with the help of few or no notes; 3) speaking or performing with little or no advance preparation; 4) made for the occasion, as a shelter.

F

• fovea: n; a small rodless area of the retina that affords acute vision.

G

• grapheme: n; 1) a minimal unit of a writing system; 2) all of the letters and letter combinations that represent a phoneme, as f, ph, and gh for the phoneme /f/.

H

I

• interdisciplinary: adj; 1) combining or involving two or more academic disciplines or fields of study; 2) combining or involving two or more professions, technologies, departments, or the like, as in business or industry

• interface: [WEBSTER'S] (n) 1) the place at which independent and often unrelated systems meet and act on or communicate with each other;
2) the means by which interaction or communication is achieved at an interface

• interface: n; 1) a surface regarded as the common boundary of two bodies, spaces, or phases; 2) the facts, problems, considerations, theories, practices, etc., shared by two or more disciplines, procedures, or fields of study; 3) a common boundary or interconnection between systems, equipment, concepts, or human beings; 4) a thing or circumstance that enables separate and sometimes incompatible elements to coordinate effectively

J

K

L

• language: n; 1) a body of words and the systems for their use common to a people who are of the same community or nation, the same geographical area, or the same cultural tradition; 2) communication by voice in the distinctively human manner, using arbitrary sounds in conventional ways with conventional meanings; speech; 3) any system of formalized symbols, signs, sounds, gestures, or the like used or conceived as a means of communicating thought, emotion, etc.

• lexeme: n; 1) a lexical unit in a language, as a word or base; vocabulary item; 2) the fundamental unit of the lexicon of a language. Find, finds, found, and finding are forms of the English lexeme find.

• lexicon: n; 1) the vocabulary of a particular language, field, social class, person, etc.; 2a.) the total inventory of morphemes in a given language.

M

• method: n; 1) a procedure, technique, or way of doing something, esp. in accordance with a definite plan; 2) a manner or mode of procedure, esp. an orderly, logical, or systematic way of instruction, inquiry, investigation, experiment, presentation, etc.; 3) the procedures and techniques characteristic of a particular discipline or field of knowledge

• methodology: n; 1) a set or system of methods, principles, and rules for regulating a given discipline, as in the arts or sciences; 2) the underlying principles and rules of organization of a philosophical system or inquiry procedure; 3) a branch of pedagogics dealing with analysis and evaluation of subjects to be taught and the methods of teaching them.

• morpheme: n. a meaningful linguistic unit consisting of a word, such as man, or a word element, such as -ed in walked, that cannot be divided into smaller meaningful parts

• multidisciplinary: adj; composed of or combining several usually separate branches of learning or fields of expertise

N

• narrative: n; 1) a story or account of events, experiences, or the like, whether true or fictitious; 2) a book, literary work, etc. containing such a story; 3) the art, technique, or process of narrating.

O

P

• phoneme: n. the smallest phonetic unit in a language that is capable of conveying a distinction in meaning, as the m of mat and b of bat in English.

Q

R

S

• sememe: n; the meaning expressed by a morphemes.

• semantics: n; 1) the study of meaning; 2) the study of linguistic development by classifying and examining changes in meaning and form; 3) the meaning, or an interpretation of the meaning, of a word, sign, sentence, etc.

• spacial: adj; 1) of or pertaining to space; 2) existing or occurring in space, having extension in space.

• spaciotemporal: adj: existing in both space and time; having both spacial extension and temporal duration.

• syntax: n; 1a) the study of the rules for the formation of grammatical sentences in a language; 1b) the study of the patterns of formation of sentences and phrases from words; 2) a system or orderly arrangement.

T

• temporal: adj; 1) of or pertaining to time; 2) pertaining to or concerned with the present life or this world, worldly; 3) enduring for a time only, temporary, transitory.

U

V

• visual: -adj; 1) of or pertaining to seeing or sight; 2) perceptible by the sense of sight; visible. -n; 1a) the picture elements, as distinguished from the sound elements, in films, television, etc.; 1b) photographs, slides, films, charts, or other visual materials, especially as used for illustration or promotion.

W

X

Y

Z

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