Combining Media Processes for Ideation
in 3D Character Design for Computer Animation

A Thesis

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Abstract

This study proposes Selective Media Leveraging as an ideation strategy for designing three-dimensional form. Selective Media leveraging involves the use of creative media actions in an integrated way that utilizes the strengths of each media at precise moments for answering design questions that a particular media can best address. The strategy integrates both traditional and digital 2D and 3D actions using exploratory techniques in form reduction which then are used to assist in the re-establishment of form complexity with improved understanding of the underlying reasoning of the form. Selective Media Leveraging has the potential to fully develop ideas toward becoming unique and impactful design solutions.

Applied studies will show examples of Selective Media Leveraging employed for 3D animation character development to inform decisions about the establishment of character traits, communicative shapes, and parameters for abstraction and simplification of form. In support of the strategy are descriptions and analysis of process and the purposes for using each media type for generating solutions. This is followed by a review of basic volumetric structure and the creative interpretation of form by artists and 3D animation designers for a distillation of form that delineates clearly. Possible implementation of Selective Media Leveraging within a design course that focuses on developing personal ideation processes for students is addressed in conclusion.
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Major Field: Industrial, Interior, and Visual Communication Design
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Introduction

The volumetric design process (the visualization and development of form that occupies space in three-directions: height, width, and depth) consists of several stages arranged in a progression of operations from problem establishment to solution. (Diagram 1.1.)

Diagram 1.1. The scope of this study is the ideation stage. Shown is the relation to the entire volumetric design process.

The ideation stage involves searching out all possible ideas in form establishment. Within the ideation stage there exists a microcosm of the phases of the overall design process shown in diagram 1.1. Ideation involves an analysis of facts through research, followed by the defining of the ideation goal, be it a character design or another designed form. Within ideation there is a constant selection of direction as design decisions are made. Implementation and evaluation in the ideation phase constitutes the making of models, drawings, and sculptures and evaluating
their potential. The uncovering of hidden design possibilities is the strength of ideation when executed in a way conducive to expanding design thinking.

Selective Media leveraging is the repetitive use of creative media in an integrated way that utilizes the strengths of each media for solving different aspects of the design problem. It is idea generation through creative action. Media leveraging integrates both traditional and digital 2D and 3D media actions using exploratory techniques in form reduction, which then are used to assist in the re-establishment of form complexity with an improved understanding of the underlying reasoning of the form. These actions include drawing, collage, cut-paper, vector software, wire sculpture, clay, and modeling techniques using 3D software. Each media carries individual problem-solving capacities. This strategy involves a variety of media and actions to simulate thinking beyond ideation that relies on brainstorming and thumbnail sketching alone.

There is an underlying rationale for strategically choosing different media at precise moments for answering design questions that a particular media can best address. Simply put, action leads to solutions. Moving raw art media by pushing (pencil on paper), shaping (clay between the fingers), carving (paper with a knife), or extruding (polygons in software), stimulates the imagination and promotes problem solving through the media’s inherent properties. At times drawing is apt to help with variations of design, for its speed and flexibility and its ability to imply dimension simply without the physical limits of matter in actual space (weight, support, gravity, light, and scale). Clay sculpting may, at times, outweigh drawing through its tangible quality, discernable by touch, fully interactive angles of view, and a true representation of three-dimensions, actual delineation under light, and a plasticity that makes form experimentation easy and fluid.

Robert H. McKim, the author of Experiences in Visual Thinking, promotes moving flexibly across different thinking vehicles. Thinking vehicles are the means by which the action
of thinking is represented externally. Particular vehicles open the door to different mental operations.¹

Media choice depends upon the question at the time. Media experiments lead to answers about abstraction, simplification, and structure. The specific situation dictates which media a designer should choose to best answer design questions. This will be demonstrated through two applied studies using Selective Media Leveraging to development 3D characters for animation. Media actions informed decisions about the establishment of character traits, recognizable and communicative shapes, parameters of abstraction, simplification, and form.

The unique strength of the Selective Media Leveraging strategy is expressed by the lines within the diagram (Diagram 1.2) that represent pipelines between media actions and the idea by which answers to design questions flow in a direct and fluid manner. The core strength of the strategy is action-based ideation that flexibly integrates media types based on the answers each media can provide and focuses creative thinking by externalizing form ideas so that they can be evaluated and fully developed.

For implementation to be most effective the designer must possess experience with tools, materials, and art principles. Selective Media Leveraging is a design strategy that assumes a level of experience in its users that is post basic design or art school training. Proficiency with tools and experience in drawing, sculpting, arranging, and visualizing in two and three-dimensions are important skills in support of using Selective Media Leveraging. Knowledge of design principles is assumed. Decisions are made by the designer utilizing media as the vehicle to employ design principles such as unity, emphasis, contrast, variety, balance, proportion, rhythm, positive and negative space, repetition, organization, and pattern. Finally a familiarity with art history and examples of visual abstraction is helpful for directing research that triggers the imagination.
A description and analysis of media actions will be presented to begin the overview of Selective Media Leveraging. The process and purpose for using each media type for generating solutions is provided as a lead-in to the presentation of applied studies that document specific use for volumetric design problems in 3D character design for animation. The applied studies address discoveries and suggestions of what to look for when employing the strategy.

The final chapter is devoted to basic building blocks of volumetric form and the perception of 3D form as an overview of the foundational elements that influenced the decision making during the applied studies. The clear distinction of features by abstraction to simple planes is addressed, supported by primitive carvings from African and Oceanic cultures that employed a style of abstraction and distillation of form. Geometric simplification has been used throughout modern art history and is applicable today in 3D character design.
Chapter 1: Description and Analysis of Media Actions

1.1 Ideation phase of design process

Ideation is a journey. There are stages in this process similar to the legs of a trip. There is often doubling back as well as moving forward. Ideation methods, like routes of travel, are a personal choice. A process will be described herein that follows a deliberate winding path that allows for a design to develop from experimentation with two-dimensional and three-dimensional art mediums. In the travel analogy this would be the equivalent of finding places you’ve never been by driving the back roads, instead of taking the interstate.

The interstate is another option. A design pipeline can follow a linear flow of steps from a starting point straight through to a goal. In volumetric form design this would mean dispensing with divergent thinking stages to focus on modeling straightaway in a linear process. (Figure 1.1)

![Figure 1.1. The interstate route to visual problem solving](image)

There is no rule that divergent thinking is required to design a form. However, divergent and convergent thinking are commonly used in the ideation stages of design. Through divergent thinking, a designer travels a spontaneous path of discovery to generate ideas in a random way.
Divergent thinking involves broad research and experimentation. Convergent thinking involves organizing the results of divergent thinking into a single idea and plan for realization. Divergent and convergent thinking involve the right and left brain respectively. The right side of the brain controls fantasy, imagination, visualization, drawing, and understanding spatial elements. The left side handles logic, order, reason, and planning. The strengths of the right and left brain match the needs of divergent and convergent thinking.

Ideation can be a non-linear approach (Fig 1.2), flowing from a starting point to a goal by way of visiting and revisiting different media throughout the creative process to accentuate each media’s strength for problem solving and raising new questions. Some media excels at translating imagined ideas into concrete shapes. Drawing is strong in this way. Drawing is the interpreter of ideas employed to explore possibilities, work out problems, clarify, and communicate. Like drawing, collage is useful for exploring possibilities. It expands the imagination even further in an expressive way, but lacks the problem solving ease and precision of drawing. Sculpting and software massing offer strength in solving volumetric design issues.

Figure 1.2. A non-linear approach to visual problem solving that allows for extended exploration of research and ideation
Working in actual or virtual three-dimensional space provides an understanding of a multi-sided object that surpasses what 2D media can offer. Each media is part of a toolkit for design solving that works best in collaboration throughout the ideation process. For example it is common to be sculpting or modeling, then return to drawing to work out the personality of a character that needs to be communicated in the model. Some decisions to be made in drawing are resolved by going back to the clay model or the collage process to explore possible component variations.

Diagram 1.2 shows a visual representation of an integrated toolkit of actions that can be revisited as design decisions need to be made. There is no predetermined order of use. Order is freely determined as needs arise within specific projects. The value of the described process lies in the combination of actions based on the awareness of when each action has inherently effective properties to stimulate problem-solving ideas. Analogically a toolbox alone is ineffective without a builder who knows how and when to utilize each tool.
Diagram 1.2. Strategy diagram of Selective Media Leveraging: All actions feed the idea. Each design problem consists of its own arrangement of actions from the diagram, specific to the design decisions to be made at various stages of ideation.
Selective Media Leveraging is a flexible strategy that allows for utilization of actions as needs dictate. Decisions are made by the designer utilizing media as the vehicle to employ design principles. In the book *Art Fundamentals*, author Otto Ocvirk published a diagram that shows the components of form generation as an integration of media with elements of art and design principles (Diagram 1.3). Selective Media Leveraging at its core serves to synthesize in a similar fashion, but the activity flow is not organized in a linear progression as shown in Ocvirk’s diagram. Selective Media Leveraging moves forward, backwards, and side to side between media and principles.

Within media leveraging, the boundaries between 2D and 3D should be considered removed. Integrating these two vantage points of form design strengthens the ideation process. Selective Media Leveraging is organic in structure and personal to the artist who raises his or her own questions throughout ideation. So when it comes to finding answers, 2D and 3D are on the same team so to speak. The basic design principles of unity, emphasis, contrast, variety, balance, proportion, rhythm, positive and negative space, repetition, organization, texture, pattern, and color are all at play in both visual domains. 2D shape is flat, dimensional only by illusion. 3D form occupies space, but can appear flat from one angle of view. The difference is in the point of view. Leveraging is teamwork between media types.
A description and analysis of media categories follows that will suggest the role that each set of media actions plays in the Selective Media Leveraging strategy. At the core of the strategy is a need to understand the strength of each media type to provide results that the designer can interpret as answers to design questions. The rest of this chapter will provide an overview of each media type as it has been used. It is recommended that each designer develop his or her own understanding of media by working first hand with the materials.

1.2 Visual Research

Process

Among all the actions, research is unique in that it is an activator in the problem-solving process. Research plays an important role in defining, analyzing, and ideating before a design path is selected and implemented. In the scope of the media leveraging strategy research is not as actively revisited as other actions within the toolset and thus remains an important, but separate action predominately at the beginning of the described design process. Research primes the pump of imagination to start the flow of a broad range of design ideas. Media leveraging actions rely heavily on gathering visual stimulants and resources of information about the realm that surrounds the type of character to be designed. Generalized research happens before any story or idea is in place. The general research stage is utilized to stimulate the thinking and explore possible story realms. This includes an open search of books, clipping files, and internet sources as well as museum visits and travels with a camera or sketchbook to gather information about topics that potentially could become elements of design. This process is considered an open search or jackdaw technique because it utilizes a mentality of open gathering recognizing potential value in something for future use. The jackdaw is a crow known for routinely collecting shiny objects and hording them in their nests. Creative research is like this in the regard that much is gathered
about all aspects of a subject to be sorted later to determine its usefulness. This has been called the exposure stage. The caliber and abundance of creative output is determined by the amount of collected raw material.

In character design, visual research is used to gather knowledge about shape, texture, emblematic features considered the essence of a creature, facts about a creature’s structure and functionality, and context for the creature’s existence. The use of the word creature in this sense refers to an animate or inanimate object on which a character is based. Research defines parameters for a back story that would help explain the character’s existence.

**Purpose**

In the book *Design for the Real World*, author Victor Papanek writes about idea generation as a function of the unconscious mind and how the quantity of knowledge and memory promote the process to work better. Research involves searching, questioning, gathering, sorting, filtering, synthesizing and analyzing. Research expands upon existing knowledge to inspire creative thinking. When a designer creates, the inspiration flows from training, life experiences, and research. All that we see contributes to the imagination’s vocabulary. The act of creating draws on this vocabulary. Research feeds the imagination’s need for information that can be filed away, recalled, and reassembled for use in problem solving. Immersion in a topic or subject matter that has potential to become a story or character is where details are discovered that can give the end product of design dimension and substance.

Systematic investigation of a subject will lead to a discovery of defining characteristics that can be used to carry an impression to the audience. Expanding upon idea discoveries with research informs the designer of possible back stories on a character and features that could be accentuated or exploited. These can include physical attributes, movement capabilities, physical health, age, diet, relatives, intelligence, fears, goals, and name. Whether it is the design of assets
for an animated film or an industrial object, the look and feel of the design should be true to the culture that is being referenced.

Research is the beginning of the form generation and visual ordering that happens in the design process. Designers are integrators of subject matter with materials or media resulting in a structured form. The more a designer knows about the subject matter the better the unity of design will be. Unity of design is the organization of elements that combine into an ordered whole. Designers at the Pixar Animation Studios consider research an integral part of their creative pipeline for every animated film. Inspiration for the design of characters and assets for Cars was gathered at automobile factories, racetracks, museums, and exploratory trips along Route 66.

According to director Chris Wedge at Blue Sky Animation Studios, characters in the movie Robots were designed to appear as a product from a particular period of industrial design history. Extensive research of materials and manufacturing styles led to creative design solutions. Early 20th century industrial revolution style with heavy rivets and gaskets was used for the oldest robots mainly the villain Madame Gasket and her underground chop shop. The Copperbottom family and Rodney’s friends consisted of mid-century industrial design parts. These were painted metal parts from appliances and automobiles. Modern age metals like brushed aluminum and alloys were used for the rich, restored characters like Big Weld, Rachet and Cappy. Robots is a good example of character design that immediately communicates personality and background information to the viewer by the way characters look.

A discovery process is used to spark character design ideas but also to advance story development. The germ of a story is often a single character. Pixar’s Wall-e originated from the simple concept of a robot built to perform repetitive tasks. According to director Andrew Stanton, the story was formed after the establishment of the two main characters Wall-e and Eve and their surroundings. Deciding upon the visual contrasts of Wall-e as a cube and Eve as an egg shape
as well as their surface materials were important to advancing the story. The value in a systematic creative process for character development lies in the story ideas that are revealed through research, search, and discovery. 8

Ethan Reed, a show animator and designer for Disney Imagineering states that a designer can never do enough research toward believability in their work. 9 According to Reed research translates into confidence in the design process and end results. Furthermore Reed recommends sketching as an important form of research.

1.3 Exploratory Drawing

Process

Drawing is considered one of the designer’s most valuable conception tools. 10 The act of drawing induces creative thought and idea generation and it externalizes concepts into graphic form. The ideas develop as mental images. The approach I follow is to draw as far as I can see and when I reach that point I will always be able to see further. This means that getting started at drawing, even if my ideas about a design problem are limited, will lead to more and more ideas down the line. An idea will develop as understanding increases. One drawing leads to another. Just getting started drawing something, even with no sure direction, is a step toward a developing idea. A stream of consciousness is a succession of ideas and images moving forward in progression. This is what exploratory drawing is all about.

To put it another way, the designer pushes the pencil making lines that engage creative thought. The designer’s eyes and mind follow behind the pencil making rapid-fire decisions about the developing drawings based on design principles and imagination. 20th Century sculptor Henry Moore claimed that he would begin sketching to find forms, making discoveries through drawing 11 (Figure 1.3). There is constant evaluation that happens by instinct in someone ac-
customed to idea searching through drawing. This happens without conscious awareness. As lines are becoming shapes on the page the mind is triggered into making visual connections to all existing forms that the eyes have absorbed over a lifetime. Associations, for example a shape that recalls another form with that same shape, lead to successive idea generating. This constant evaluating for further development was called ETC- Express, Test, and Cycle by Robert McKim in the book *Experiences in Visual Thinking*. 


There is a big difference between ideas in the brain and ideas on paper. The brain functions outside reality. Visualization through drawing brings ideas out into the real world where there are difficulties and details that require solving. Drawing in a way becomes the first test of an idea as to whether the idea can be drawn. If an idea can be expressed in some fashion on paper then it at least can be evaluated as a legitimate possibility.

The trick is to work in a way conducive to free-flowing ideas. I draw with an Ebony pencil on loose, white paper and newsprint. The cheaper paper, the better, because the point is to do many drawings not few. I don’t erase or linger on drawings at this point. Erasure is considered
a correction of an error. There are not any errors in the ideation stage only a building of progressive discoveries toward design solutions. All lines are meaningful in the construction of form that is the translation of an imagined idea into an existing design. Drawing quickly and loosely in the sketch stage allows ideas to flow quickly building in succession.

Holding the pencil appropriately for loose drawing is important. The grip commonly used for writing letters typically rests the hand on the paper with movement controlled by the wrist. The arm remains rather stationary. The result is short, controlled strokes. Loose drawing benefits from incorporating arm movement. Adjusting the grip of the pencil to be one used for drawing with charcoal or conté crayon lifts the palm off of the paper and allows the arm to control the act of the drawing. This grip holds the pencil as a slim brick between the index and the thumb. This puts the side of the lead in contact with the paper instead of the lead tip. The result is broad lines used for motion studies and gesture drawings. As a record of the thinking process behind a design the extraneous lines in conceptual sketches are valuable.

Purpose

Drawing involves visual thought that stimulates the imagination. Drawing combines imagination with the information acquired through research and allows the designer to transfer images onto paper in a flow of ideas that build in succession. This has been called picture fluency, a rapid conceptualization of ideas that flows like a current in a river. The creative process is cyclical. One idea often leads to another. Author William Kirby Lockard calls this the eyemind-hand wheel. The eyemindhand wheel refers to the use of the eyes, mind, and hand to conceive, perceive, evaluate, represent, reevaluate and so on in a rolling process. Any of the three, eye, mind, or hand can take an idea to the next level in development. Ultimately all will contribute. Conceptual sketching is a form of external memory used to free up short-term memory in the mind where invention can flow. Stream of consciousness is allowing ideas to flow freely in
succession without holding them back. Ideas are stifled by mental concern about practicality and concern about drawing quality. Allowing drawings to be loose will produce a wide range of solutions.

Ideation sketching is also called conceptual drawing. This is a visualization practice used to explore a variety of possible design solutions. The transfer of ideas from the imagination into visual representation on paper has been termed visual thinking because of the simultaneity of drawing and imagining. The act of drawing initiates the process of exploring ideas of the mind as part of a systematic approach to a design problem. The design possibilities that accumulate provide structure and begin to show a visual unity or pattern of designs with a style or identity.

In the book Graphic Communication as a Design Tool, author Omar Faruque writes about the value in drawing for solidifying ideas for architectural design. The points he makes apply to all areas of design. Faruque writes that drawing prompts decision making. When a designer is having trouble drawing out an idea it is evident that the idea is yet incomplete or contains conflicts. The resolution is to push forward through drawing where evaluation and development occur. Otherwise an idea will remain as an unrealized wish. Making ideas concrete on paper is how a design is acted upon. It is making visible the inner visions to exist in outer reality. Once ideas are externalized on paper, concepts can be evaluated and expanded upon using the eyes, the mind, and the hands.

Robert H. McKim describes idea-sketching as graphic “talking to oneself.” As McKim states, idea-sketching moves fluidly from abstract form to concrete. Drawing ideas helps the designer to clarify and bring order to imagination much like putting a thought into words. Drawings can describe ideas often quicker and more clearly than words. Drawing encourages the designer to pay attention to details that will make a form unique and provide visual enjoyment and recognition to viewers.
Pablo Picasso used exploratory drawing to expand creative ideas from realistic to abstract. As described in *The Story behind the Painting* by Leo Rosten, “First, he drew her realistically. Then, he began to do what he calls destroying the sketch—using her face, her limbs, her torso as though they were unrelated objects. He drew her in a classical manner, then as a succession of cubes, then in boldly simplified outlines—on and on; he did one variation after another, whenever a new idea struck him, incorporating different styles, always finding some new aspect, however small, to set him off on a new exploration.”

Exploratory sketching is also known as inspirational sketch art. Animated films supervised by Walt Disney relied upon visual development artists and designers to create conceptual drawings and paintings that explored visual ideas. This was considered finding the film. 18

### 1.4 Two-Dimensional Experimentation

*Cut-paper collage*

The 2D art-making methods that I will discuss are cut-paper collage made from gouache painted papers, collages made from magazine scraps of imagery and texture, found objects scanned and manipulated, and stream of consciousness drawing (free drawing of shapes and ideas without judging their practicality for character design. These methods are included for the purpose of exploring ideas for character designs that often arrive through experimentation.

There are two collage techniques used for exploration. One is called scrap collage and the other is cut-paper collage. The purpose behind making the scrap collages is to loosen up my thinking to generate ideas about designs that I may not otherwise think of by drawing alone. By combining shapes and textures from a random pile of magazine scraps there is an element of chance and discovery that guarantees no particular, preconceived solution. Pages from magazines are cut into random shapes with scissors. The pages pulled from magazines carry images with elements that
are intriguing shapes and may associate visually with character features such as eyes (Fig 1.4), mouth, or limbs. A source pile is formed from which pieces are pulled and combined by trial and error (Fig 1.5).

Figure 1.4. Imagery from magazines is cut into random shapes. Parts related to eyes are isolated.

Figure 1.5. Source pile of randomly-cut magazine imagery for scrap collage
This is a method that involves chance and imagination. Two or more unrelated parts of images are arranged together and analyzed to spot a unique combination of forms that triggers the imagination to associate the visual composite with creature forms.

Parts that otherwise would have no relation begin to show a connection when juxtaposed. Fig 1.6 shows a sequence of scrap collage developing from unrelated image shapes cut from magazines. One of the thought processes involved in this technique is recognizing when random pieces combine to create visuals that relate to facial features like eyes and mouths or body parts like arms and legs.

Figure 1.6. Sequence of steps in scrap collage combining unrelated parts to arrive at form ideas that show recognizable character features.
Purpose

Collage is a highly-intuitive illustrative technique that explores the possibilities of disparate subjects by combining elements that otherwise does not coexist. Collage can be a route to synectic thinking. Synectics is the process of creative discovery for problem solving by assembling seemingly unrelated or dissimilar things. This kind of associate thinking shows the ability to find original and unexpected connections in visual elements. Collage elements contain visual possibilities unearthed by experimentation, analysis, and intuition.

Cubist artists were the first to make papier collages made of various kinds of paper. It was the discovery of collage that launched visual experiments known as synthetic cubism. There is a freedom and absence of rules when working with scrap collage that can lead to unusual designs. Design means to plan and to organize leaving little to chance. Positioning the collage exercise at the beginning of design process has the potential to offer solutions that organized planning would miss.

Collage, like drawing, is a form of externalized thinking. Robert H. McKim explains the advantages of externalized thinking in his book *Experiences in Visual Thinking*. The advantages include creative nourishment from direct sensory interaction with the materials, the possibility of unexpected discoveries, problem solving through direct context of sight, touch, and action. The externalized thoughts that result from a creative search using collage provide a tangible form that can be evaluated and developed. The main advantage of externalizing through creative action is the stimulation of the right hemisphere of the brain. 19

Early collage artists Picasso and Braque considered collage to be a bridge between painting and sculpture. Picasso called his assemblages objets trouvés. 20 He would use found objects that resembled forms from nature when combined (Fig 1.7). The magazine scrap collage described originates in the knowledge of Picasso’s methods, using imagery of objects instead of
actual objects. Using imagery offers flexibility in combining objects of diverse scale. Within the action of combining unrelated elements lies the unexpected discovery.

![Picture of object sculpture]


Scrap collage technique involves conglomerating separate, visually interesting pieces into compound forms triggers the imagination to read each arrangement as a coherent whole. Faces are recognized anytime two round objects are arranged side by side above a form that relates to a mouth or a nose. (Fig 1.8) The value of using collage is in the unique combinations of forms that come from fortuitous nature of this method of form discovery. The next step for these designs would be drawing to translate the collage into a more realized character concept. After working out details in drawings the character would move to the clay sculpt stage described later in this chapter.
Figure 1.8. Results of scrap collage technique: A synectic use of otherwise unrelated imagery combined to form features that the designer associates with faces and body attributes producing a character idea in the imagination.
Cut-paper collage

A second collage technique uses gouache-painted paper cut with a knife and assembled on paper. This is a method started by Matisse, who made large scissor-cut paper compositions. I start by painting large sheets of sketchbook paper with gouache. Gouache is an opaque water-based paint. It makes flat, vibrant color. The colors are altered after scanning the collage into the computer. Black gouache is not used because I find that colors of lighter value and brighter hue can be changed best in the computer. Black does not change hue with Hue/Saturation controls in Photoshop (outside of a colorize option, but the results are flat.) There are times when I intend to use the collage only for outlines meaning that I will hand-trace the shapes in Illustrator with the pen tool. If this is the plan, black painted paper works fine.

There is a certain quality that cutting paper with a knife offers that can’t easily be achieved in the computer. The knife naturally leaves imperfect edges with slivers and chards that add edge quality. Cutting with the knife is essentially like drawing and there is a freedom there to work with blocks of solid color as if carving into wood. There is conscious shape drawing performed with the knife while allowing contoured shapes to flow loosely without too much control. Shapes of color are then arranged much like in scrap collage by trial and error where the positive cut shapes are combined with parts of the negative shapes left by cutting. (Fig 1.9)

After collage pieces have been pasted together, they are scanned into the computer for adding line drawings over the shapes. This stage is performed in Photoshop using a custom brush that adds variation in line quality to mimic ink on paper. (Fig 1.10) The line drawing is done digitally because this allows more than one variation to be made on the same collage. The drawing is made on top because the collage establishes just the body mass with flat color. The body mass is given personality through the drawing overlay. Different character personalities can be attached to the same collage by drawing variations.
1.5 Three-Dimensional Experimentation

Process

Three-dimensional experimentation can be performed at any scale. The work should be considered 3D thumbnail sketches. Just as exploratory drawing and 2D experimentation served to expand consideration of shape possibilities with line and flat mass, 3D thumbnails can be com-
municative of ways that physical weight and bulk can arranged. Direct contact with the fingers is a sensory experience that shapes form in a tangible way. The information received about shape is definite, not vague or elusive.

The material manipulated can be pliable or rigid. The action can be subtractive (carving away material) additive (building up or assembling material), or manipulative (shaping of pliable material). The designer can think in terms of solid mass or the outer edges that contain volume. For the former the choice of material might be modeling compound, Styrofoam, foam balsa, or wood. Focusing on outer edges, much like a 3D drawing, a designer could use wire. (Fig 1.11)

Fig 1.11. 3-D experimentation media examples: Left: Plastilina modeling compound used for 3D thumbnails concentration on mass, Right: Wire sculpture is made to explore countour edges and silhouette of form as a 3D line drawing.

Purpose

Two-dimensional descriptions of form show only one viewpoint and serve as visual shorthand for an actual space sensory experience. If the design goal is develop a volumetric form (an enclosed area of three-dimensional space) it helpful to experiment with three-dimensional media in an exploratory way. The shift from 2D to 3D confronts the designer with the physicality of form. Moving from the illusory world of 2D to the tangible object communicates differently because the designer orbits the form and encounters new visual information on each side.
1.6 Developmental Drawing

Process

Design sketching exists in two varieties. The first type is exploratory. As described earlier, this is essentially probing the imagination with help of pencil in hand allowing the drawn lines to lead ideas forward much like what William Kirby Lockard called the rolling of the *eye-mindhand wheel*. The second type of design sketching is developmental. This is where a potential idea found in the exploratory stage is gradually evolved and further developed.

Drawing at this stage it is a very loose style, trying to keep everything round, made with ellipses and straight lines to feel out the possible body and head shapes. Thinking about the silhouette of a character is important. This mass of the character suggests what the personality will be. I practice multi-dimensional thinking in sketching. This essentially means turning objects around in the mind to draw through objects from the front to the back. Considering the hidden sides of objects helps the sketching of dimensional forms. Multi-dimensional thinking is related to mass conception: the simplifying of masses to their essential basic character using a geometric system. This system is based on the belief that all form no matter how complex, is based on and can be reduced to geometric shapes. Comic book artist Burne Hogarth authored several books about artistic anatomy using a drawing method known as massing. A similar method termed *geometric reduction* will be discussed later as it relates to the use of planes in primitive stylizations that is considered useful in character design.

Massing as Hogarth teaches is the reducing of parts of the body down to geometric shapes to establish the solidity form and thrust of the pose. Drawing of human form using cylinders, cubes, cones, and rectangular solids focuses on planes as the building blocks of form. This kind of geometric reduction is useful for developing CG character designs because it translates well from drawing into solid massing in 3D software. Solid massing is a process described later
in this thesis used for blocking in rough form with simple sub-divisional shapes. It is considered the equivalent to working with clay, blocking in mass loosely while beginning to anticipate how a finished model would be realized.

It is the body mass that carries a character’s unique proportions that suggest personality. Each character has proportional references that become recognizable over time as what makes a character look like him or her self. The pose of the body mass is what exhibits the attitude of the character. The attitude could be one of joy, excitement, sorrow, fatigue, defeat, or pride. The animation will go a long way in describing a character’s attitude in the rhythm of a walk and arm movements, but a stationary pose in the design stage of a character can establish the attitude. Developmental drawing is used for establishing stylization of a character. I use drawing to consider features of the character to exaggerate, simplify, and abstract. Stylization is abstraction from realism that exists in levels. With each level of abstraction a drawing takes the viewer further away from the root source, whether it’s an animal, a human or an object of any kind. It is possible to stylize too much and confuse the viewer.

This is discussed in Storytelling through Animation by Mike Wellins. He writes about features that are too stylized, with shapes not quickly recognizable, can interfere with expression and can limit the impression of a thinking character. I use drawing to work out the stylization of facial features mainly. The eyes are very important elements because they show what a character thinks, and suggests personality. It is a good rule to keep facial features within a level of abstraction that is understandable even if the rest of the character design is very stylized.

I use drawing to search for unique stylizations. The appeal of the character is considered. I try to push the exaggeration to be a new and appealing design. Part of the developmental drawing stage is sketching expression studies. This is a series of drawings that explore the range of expressions that a character can make. The size of the mouth affects the design of the surround-
The eyebrows are essential expression conductors and need to be explored. Expression studies matter in finding the scale of forms needed to accommodate complex facial emotions performed by the character. The expression studies lead to satisfying and visually dynamic characters.

Orthographic drawings are made during the developmental drawing stage. These are side, front, and top views of a character drawn to match in scale and proportion side by side on a large sheet of Bristol. The term orthographic is defined as true picture. Orthographic drawings do not show an illusion of space like perspective drawings. Features are lined up with guide lines so that when the drawing is scanned into the computer to become image planes for software modeling, the templates projected toward the x, y, and z axis match up evenly. The orthographic views are drawn in pencil, usually with 2H – HB lead, and primarily as contour line drawings. The H degree lead makes a cleaner line on Bristol than B level leads and smudges less. If the character will have symmetrical features, for example similar arms, legs, and facial features on either side of its center, then only one side is drawn in the front orthographic view. The software model of the one side will be duplicated and mirrored to use as the opposite side.

Purpose

The challenge in designing a character for animation is translating a dimensional form into a flat drawing and then going in reverse to translate a two-dimensional design into a 3D model retaining the personality of the drawing. Drawing is used as a planning tool because it is quick, and it has no limitations. For design of all three-dimensional form there is an understanding that comes through drawing something. There is an open line of communication that flows from the brain to the pencil in hand and discoveries made by making quick variations. As Charles Wallschlaeger writes in the book *Basic Visual Concepts and Principles for Artists, Architects, and*
Designers, drawing is a means to understand, evaluate, and resolve design problems and to visually explore and develop ideas.  

When a line drawing is made of a dimensional form the lines drawn represent the edges of mass. These lines don’t actually exist in space, but the lines drawn are a visual language describing the boundaries of planes. In the modeling process the edges and points that can be manipulated to change the polygonal surface relate to the lines made and altered in the drawing process. Lines are the edges of polygons that separate tangent planes to form the surface contours that light falls upon and delineates. This is how planar visualization in drawing and sculpting connects to software modeling. Envisioning three-dimensional form in terms of planes helps bridge the transition to modeling in computer software.

The appeal of a three-dimensional object is rooted in the assemblage of planes and the way these planes transition from one to another. Planes are the building blocks of proportion and volumetric attributes. Light falls upon facing planes and casts shadows that effect the appearance of a 3D form. Rounded forms do not appear to the eye to be made of planes because the planes are very narrow. The falloff of light on a rounded form where shadow begins will either appear soft or hard edged depending on the intensity of light and the dramatic or subtle changes in the surface contours of the form. Dan Platt, modeler on the movie Bolt by the Walt Disney Animation Studios, states “Without exception, it’s always the subtle plane changes that separate a neutral model that is lifeless from one with a quiet heartbeat.”

1.7 Sculpting

Process

The sculpt material used is plastilina. Plastilina is an oil-based, non-hardening modeling compound. It is permanently pliable. The value in working with plastilina is the problem solving for
transitioning from 2D art to 3D model. For the first time in the process of a character design there is real consideration for all sides and viewing angles. There are decisions made regarding weight, how the character will support itself standing in real space, and there are some realizations made that the features in a drawing may not be as aesthetically pleasing in 3D form. Eyes and mouths translate in unexpected ways when they must function in 3D space and often they need reconsidering. A drawing has the freedom to avoid real issues of practicality of existence. Flare of a drawing style and line quality can carry personality that may be difficult to extend into three-dimensions.

The simple process of translating a drawing into 3D model “boils down” to filling in the white space between the drawn lines. In a drawing body mass is implied by the white of the paper between outer contour lines. There may be some shading to help the suggestion of mass by suggesting a light source and shadow. Many decisions remain to be made about subtleties of surface planes and the smooth connection of body parts for which 3D models require answers in order to construct.

The Styrofoam often has wire pushed through appendages for support and to connect separately carved Styrofoam components. The wire supports vary in weight with the heaviest wire (cut from wire hangers) used as leg supports. (Fig 1.12) The use of wire support relates to the issues of weight distribution that will be suggested in a CG model. In CG there is no gravity and a character does not need to carry its weight in order to stand. Weight is only implied visually to match what the viewer knows exists on earth. But in working with clay there is gravity and this forces the artist to consider ways that the model can stand and hold its head or arms in certain poses carrying weight. This is why working clay is a natural progression from a drawing to a 3D model and has value that would be missed if the artist moved from drawing to CG model directly.
Plastilina is applied over the Styrofoam. It is necessary to work the sculpting compound in the hands to make it pliable. The warmth of the hands loosens the plastilina making it easier to wrap around the Styrofoam. Plastilina is available in grades of hardness from very soft to very hard. The grade used here is no. 2 medium grade. Although maquettes can be made to any scale, they tend to be small enough to rely primarily on tool-sculpting rather than hand-sculpting techniques. Softer modeling compound is best for additive transformation and hand-sculpted, large-scale statues or busts. Harder compounds are better for subtractive transformation, tool-carved and smaller-scale statues.

The sculpting tools are available in wood, plastic, and stainless steel. The stainless steel tools are recommended. The ideal tool has a spatula or scoop on one end and a minarette on the other end. Stainless steel tools are more expensive than plastic or wood but they control the modeling compound in a cleaner fashion and carry more strength to move the material. The rounded scoop end is excellent for smoothing while the pointed minarette end is used for carving. Ribbon
sculpting tools are also available. These are useful for subtracting compound. Sculpting with pliable, reconstituting material like plastilina calls for adding and subtracting of mass. Having tools that make this activity as accurate and easy as possible allows for a free flow of design experiments.

I prefer to sculpt a character in an active pose. Heavy-weight wire is used to support the model on one foot, or leaning to one side. Because the sculpted maquette is part of the conceptual search for personality in a character it is helpful to sculpt the form in an expressive pose. This process is different than software modeling. A character is typically modeled in software in a T pose: arms straight out to each side, weight evenly distributed on legs.

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Purpose

Clay sculpting is an excellent 3D problem solving exercise. Including this step in the process rather than modeling directly in software from 2D art allows for the hands and the mind to work out design issues in actual space. Manipulating a model in actual space is different than doing so in the illusory space on a monitor. Of the two spatial dimensions, actual space is unique in its tactical experience of shaping a form directly with the hands. As the model takes shape it is recommended that the artist keeps it within sight during everyday life so as to look upon it with fresh eyes on a regular basis. This is one of the advantages of building a tangible model in actual space. Problems and possible directions are revealed as an artist lives around a piece of art and studies it over time.

In the book *Launching the Imagination*, Mary Stewart writes about the equal importance of physical and visual connections in the design of three-dimensional form. According to Stewart, connections can be made through contact, through junctions, and through joints. 28 Contacts are mainly visual connections where elements are merely touching each other edge to edge or plane to plane. This kind of connection will only hold together structurally in a place devoid of gravity such as a digital environment. Connections through junctions, (tongue and groove, dowel, box combining) are physically solid, as are joints (ball and socket, hinge, pivot). Physically strong connections that are necessary in form building for actual space carry implied strength when modeled in digital space.

Working in plastilina clay juxtaposed to modeling in 3D software reveals some correlation in the process of building three-dimensional form. The construction of man-made 3D form can be an additive or subtractive process. These methods are called modeling or carving respectively. Modeling is the building up of a sculptural form using soft or pliable materials. This is an additive process building up from a center core and working outward. Plastilina, and clay are
materials that can be used to build up a form, adding more material gradually. The nature of Plas-tilina is that it will incorporate added material cleanly. Another additive process is called assem-
blage. This is the use of objects or images combined into forms outside their original purpose.28

Carving is a subtractive process removing matter from the outer surface progressing
inward. Carving of marble, wood, and Styrofoam usually begins with a block of the material that is carefully reduced to reveal an intended form. These subtracted materials cannot be put back or incorporate again as in the case of plastilina.

Further consideration of the plasticine modeling process shows that it is actually a
combined method of adding and subtracting. This makes the material capable of problem solving through process. Being able to try different 3D solutions in real space by adding and subtracting details of form is an effective way to reach the design that works best as a three-dimensional form. Notice that 3D software solutions are modeled. This is an additive process. It is not additive in the same sense as the plastilina where material is built up in layers but rather complexity of form is built up gradually by subdividing polygons. The push and pull of vertices on the surface of polygonal geometry is the equivalent of the pushing of plastilina with a sculpting tool on surface of a clay maquette.

Much of the process is building up but then trimming back and taking away material to reduce mass. Often a reduction back to simple planes is needed by carving off clay with a knife in order to balance the visual weight of the model. This is where the building of a real space maquette has a benefit. The challenge of sculpting 3D form is remaining attentive to scale, (size of elements relative to adjacent forms) weight, (implied mass) proportion, (relative height, width, and length of components within the whole form) and balance (equality of implied weight and strength). 29 It is important for the artist to step back from the work, or better yet, allow the model or drawing to exist in the living space where the artist can look upon it with fresh eyes over a
period of time. This will reveal areas that can be adjusted and improved that were not obvious while working. One advantage of a physical model over a digital model is that it can exist in the space with the artist outside of the flat screen.

1.8 Software Massing

Process

As an alternative to sculpting with clay, design decisions can be made using software primitives. Software massing relates back to the geometric reduction process of starting with the general and working forward into the specific. I find it is better to start with less geometry divisions so that there are fewer points to move when making large changes in form. Surely you could have simple spheres and cylinders that have a high number of isoparms so I will mention that I usually start with an 8 to 8 horizontal to vertical isoparm count adding isoparms where needed along the way while still keeping the topology as lightweight as possible. I find that the 8 to 8 ratio provides a smooth surface with the least amount of points at the outset. I use hulls mainly at the early going, pulling and scaling to shape large parts of the character. (Fig 1.13)
Fig. 1.13. Software massing using simple, overlapping NURBS shapes

Shaping with hulls is a process that relates to geometric reduction in that large planes are affected on the shape which is essentially what geometric reduction is—working with planes. This is where I see a natural connection between geometric reduction and 3D modeling. Both processes involve surface planes that when subdivided successively (working from the general to the specific), a more complex form appears modeled by light. The same holds true for drawing. Starting with geometric shapes that block in forms, a series of drawings (perhaps done with tissue paper overlays) can be refined further and further until the geometric drawing has been replaced with detailed contour lines and surface shading.

These NURBS forms remain mostly separate objects and overlap to appear attached. (Fig. 1.14) There is some consideration for how these forms would be ultimately attached in a finished working model, but for now I try not to be concerned with limitations.
I prefer using NURBS objects for this process because they seem most like clay. The massing stage is not a finished modeling stage and does not concern itself with seams between components or complex surface details. NURBS geometry is used for its ease of selecting CVs (control vertices) by use of hulls (rows of vertices), pick walking (the moving between single vertices and groups using arrow keys), adding isoparms (lines that represent cross-sections on the form surface in the U and V direction) for more control, and the variable “reach” (the amount of surface geometry altered by moving a CV) that can be utilized to model a basic compound form with personality rather quickly. Being able to pick walk CVs is something that makes NURBS efficient for this stage. In a way, this is trying to match the round sketching process on paper. After I have something built in software that shows potential I will go back to drawing to refine some of the details based on what I learned by modeling. Massing resembles working on a clay maquette. Massing studies in 3D software can be considered digital clay maquettes. Carefully positioning CVs is the equivalent of smoothing clay with a sculpting tool.
Between the developmental sketching stage and the work in software massing there are changes that happen where upon a side-by-side comparison it shows that some qualities of the pencil sketch were lost in software massing. Often there are improvements made in CG that weren’t found in sketching. It is common for the strengths of each medium to progress the model in two different directions. It is then necessary to incorporate the best features found in both the sketching and the software massing. Some new drawings are made with knowledge gained in CG and changes are made to the CG model to retain the details of the drawings.

Purpose

Massing is a conceptual search for structure and form. Structure is the assembly of shape components into a cohesive form. Form is the solidified result of structure that carries personality. Form contains energy and movement that either appears forcing outward or remains passive. An example of an active visual form is The Reclining Figure by Henry Moore. The sculpture of a resting figure is active in the flow of surface contours and assembly of shapes. (Fig. 1.15, 1.16) The experiments of overlapping volumes in software as described above helps lead to visually dynamic forms that imply an organic energy that suggests form that is alive. Ray Eames defined 3-D form as the sum of volumetric parts that have their own flow of implied energy and as a result certain configurations of the parts form a visual whole that is aesthetically pleasing. 31
Massing initiates design thinking from the general to the specific meaning it promotes the ability to think in mass, to feel a form in its entirety, and to disregard small details until after a basic form has been established. Addressing the form in its entirety will help lead to a design with unity and variety. Similarity in shape contours increases unity. Difference in shape increases variety. A form should include both. Too much unity can seem monotonous and form with too much variety of shaping can become chaotic. Software massing is the digital form of plastilina sculpting using CG modeling compound. The NURBS geometry used is pliable like clay. The isoparm lines that control the surface of a NURBS object can be manipulated to transform the shape much like the stainless steel sculpting tools.

**Detailed Software Massing**

Transitioning from the physical maquette to modeling in 3D software involves translating the dimensions of height, width, and depth into points on the x,y, and z axes. For the models made in support of this thesis, sub-divisional cubes were the basic building blocks. Sub-divisional carries the rounded edges similar to inherent quality of the plastilina clay. Sub-D offers the same
control of its core polygonal geometry by switching to polygon proxy mode. The extrusion capabilities and the split-polygon tools are accessible for building out and adding complexity. Gradual build-up from simple to complex has shown more control and better results. The polygon proxy mode displays a mesh reduced to level 0 over the rounded sub-divisional surface. This keeps the surface within a level of complexity that can be deciphered during adjustment. Another reason that sub-divisional surfaces are preferred is the creasing option. For models that will have components that appear to connect through insertion and seaming the creasing of edges works very well.

Working from the general to the specific was referenced earlier in regards to drawing. The same process is followed in software modeling. To work from the simple to the complex is useful in working with polygons because a model that is too heavily subdivided too early in the process leaves an overload of vertices to be selected and manipulated. 33

One way to build complexity gradually is to think about form in planar geometric reduction. According to Christian Leborg author of the book *Visual Grammar* (Princeton Architectural Press, 2006), “Everything we see is experienced in relation to its external limits.” That is to say that every object that the eye sees is set in space where other visual elements lie adjacent to it. The eye analyzes contrast between planes within an object or between the object and its surrounding space to determine separations and differences. If the viewer is making a line drawing of what they see, the edges of separation will be represented by lines. In reality there are no lines in what the eye sees the lines are perceived and used as a visual language. To quote Robert Beverly Hale: “Lines may be used to symbolize the outer edges of an object, the meeting of planes, and the meeting of one color and another.” 34 Lines that represent the changing value of light and shade across an object will in effect be representing planes. All three-dimensional forms conceptually consist of surface planes delineated by light.35
No matter whether the form is organic or geometric an artist can make a representational drawing by thinking in geometric planes of light and shade. According to Eliot Goldfinger author of *Human Anatomy of Artists: The Elements of Form* (Oxford University Press, 1991), “Visualizing a complex area of the figure in terms of a simple plane consolidates it so that it can be better understood and then recreated in art.” A drawing by Luca Cambiaso (1527-1585) shown in Figure 1.17 is an example of composing a complex arrangement of figures using simple blocks and shaded planes.

![Fig 1.17. Ink drawing by Luca Cambiaso. There is a relationship between geometric reduction and three methods of polygonal modeling, Robert Beverly Hale, *Drawing Lessons from the Great Masters* (New York: Watson-Guptill Publications, 1964).](image)

There are three methods of simple form massing to consider. The first is poly-by-poly. Modeling begins with a single polygon created using the Create Polygon Tool. A polygon, (also known as a face), is a three-dimensional plane defined by three or more edges or vertices. Vertices are single points where edges meet. Edges are lines that separate adjoining polygons.
Building off the edges of this first poly using Extrude Edge command and following a pre-drawn curve cage that maps out edge loop placement, a model is gradually formed plane by plane.

(Figure 1.18)

A different method begins with a poly cube or cylinder which is extruded by face or edge in various directions as needed to form the overall masses. Subdividing the faces gradually rounds out the sharp edges. (Figure 1.19)

A third method begins with drawing a multisided polygon with the Create Polygon Tool following a side view reference drawing. That polygon is subdivided using the split polygon tool along natural muscle borders. (Figure 1.20)
Each of these modeling methods of constructing simple mass within 3D software is a possible way to use this media toward developing personality in form that communicates character traits visually to an audience.

Selective Media Leveraging is applicable to ideation in various fields of design. The strategy can be tailored to generate design solutions for graphic design, industrial design, fashion design, interior design, and character design for animation as shown in the analysis above. The following applied studies show examples of Selective Media Leveraging employed for 3D character development. The strategy will inform decisions about the establishment of character traits, recognizable and communicative shapes, parameters of abstraction, simplification, needs for expression, and form that contains unity, variety, balance, contrast, and posture appropriate for the character.
Chapter 2: Applied Studies

2.1 Introduction

Involving different media in a fluid workflow of forward and back is a lateral approach that winds through possibilities and alternatives discovered and conceived along the way. These tools of problem solving are ways for the designer to communicate directly and clearly with him or herself. Media use requires specific skills. Drawing requires an understanding of perspective and ways of translating volume into a flat representation that appears dimensional. Dimensional media like carving or sculpting requires skill in using instruments to precisely remove or add matter and transition edges and planes smoothly.

The selection of the media used to leverage combined with a specific manipulative action is what forces discovery. Pablo Picasso believed in action above all else. Picasso had an appreciation for discovery through the act of creation. He believed that one could not imagine what was to be done but rather had to simply do it. He lived this philosophy long before Nike made a similar mantra their advertising catch phrase- Just Do It. Creative action is at the core of the strategy proposed in this study. The methods used with each media are referred to as actions.

This chapter will describe the use of Selective Media Leveraging for developing 3D characters for animation without the constraints of an existing story or script. This is applicable to animated short filmmakers and students open to a freeform search for character and story ideas that evolve through experimentation and ideation. Each applied study consists of its own order of media actions within the strategy.
2.2 Applied Study 1: Crab Character

The design goal of this applied study was a low-poly, three-dimensional crab character that expressed clear traits of crab species with stylized features for personality, expression, and performance. Close study of the crab shows an intricacy of interlocking component parts much like a robot. While the crab is far removed from humans in appearance, the legs and claws bend much like human legs and arms, and are structured in a similar way. Structural elements that can be related to humans allow the character to perform humanized actions- the quality that endears characters to audiences. Progression of design followed its own arrangement of actions from the media cloud (Diagram 2.1).

![Diagram 2.1. Arrangement of media actions for applied study 1: crab character](image)

2.2.1 Visual Research

The ideation process began with the visual research action to collect reference and learn about crab anatomy. While the character is specifically a coral crab that measures only two inches
across with one large claw and one small claw, the reference search at this stage was of general crab form. It is important to search beyond the specific variety of crab to absorb all possible shape ideas that are emblematic of the essence of crab form. An actual crab carcass was found at the beach. This proved to be helpful for the close examination of component parts. (Fig. 2.1)


Discoveries

The communicative quality of actual objects as opposed to photographs is superior. Familiarity of form is strongest for objects that have been touched, held, and examined in person. In the case of the crab, the legs are segmented, interlocking components that are best understood for drawing by studying an actual crab from all angles of view. There is no substitute for understanding the construction of form that will be the basis for a three-dimensional design. What seem like instinctive actions of design are actually design decisions influenced by information absorbed
in research. Imagination needs to be fed so that when it is in “full gallop” as Picasso called it; there will be no limits to the articulation of form details whether in drawing, clay, or software modeling. Imagination if powered by all that an artist has learned and experienced.  

*What to look for*

The information an artist should gather in research relate to shape, texture, and emblematic features that can be considered the essence of the creature. Seeking answers to “how?” or “why?” the creature is constructed for function exercises the imagination. Parameters are set by research for characters that remain true to the way a creature moves, the proportional balance among features, the actions possible based on joint systems or inter structure, and retention of the surface quality. In the case of the crab, a hard shell covers all components. It is helpful to make imaginative bridges between physical elements and similar forms existing in our world. In the case of the crab, six segmented legs extend out to either side of a body case, like a robotic moon explorer, two claws in front function like hands or nail clippers, eyes protrude either slightly or pronounced like olives on toothpicks, and two segmented fins extend from the back like long steering paddles. These features are consistent across all varieties of crabs studied.

**Research results**

Comprehension of: physical attributes, consistent attributes among different crab types, context of existence, movement capabilities, functionality

### 2.2.2 Exploratory Drawing

The drawing process solidifies information attained from visual research. A benefit of drawing is absorption of information. The term exploratory drawing is used to describe the combined action of eye, mind, and drawing hand to investigate and analyze the creature that a character will be based on for proportions, patterns, and assembly of components. Exploratory drawing consists of three stages: observational drawing, simplification, and stylization.
Observational

The initial stage is to draw forms as seen to get a better sense of the way the crab components are shaped. Observational drawing is feeling an object with the eyes. Focus on the crab in this way led to a familiarity of shape, function, structure, and proportion of the many component parts that are tightly fitted together on this creature. Drawings were made to absorb information about the location of legs, their separation, position, and orientation for function. The joints of the claws and legs were studied closely and drawn to figure out how this enabled and limited movement. (Figures 2.2 and 2.3)
Fig 2.3. Stage one of exploratory drawing continued with focus on (A) individual components, how segmented arms and legs interlock, (B) consideration of structure as it relates to movement (C) details of placement, organization, and attachment.

Simplification

In stage two of exploratory drawing, (Fig. 2.4) the crab was simplified from complex components down to basic shapes. The details of realism were reduced in preparation for stylizing the crab into a character rather than a model of a realistic crab means finding the essence of the crab form. These are basic shapes that represent the crab’s recognizable character: an almond-shaped body mass sprouting six crouched legs to each side that are segmented and taper to sharp end, two pinching claws in front of varied size, and beady eyes that sit atop the head on tubular extensions. These attributes are essential components that contribute to the crab’s personality. These simple shapes will serve as the starting point for 3D sculpts and models that begin as generalized form and progress to specific complexity.
Stage 2 of exploratory drawing- finding the essence of crab form in simple shapes that communicate recognizable crab traits (A) repetition of simple shapes that create rhythm (B) fluidity and gesture in the flow of surface contours and shape assembly (C) repetitive pattern and visual balance, wholeness, unity, and a sense of solidity.
Stylization

The third exploratory drawing action for the crab was free stylization by taking the essential shapes from the second stage of drawing and describing them some flair and attention to repetition, pattern, rhythm, flow, twist, slant, variety, and artistry. Every sketch led something new in its arrangement that leads to another drawing. This process requires a mindset that is open to unexpected results. (Figure 2.5) I contend that this exploratory search stage is important to finding unique designs beyond an artist’s first ideas. First ideas often lead to less promising possibilities. First ideas can often be obvious or too similar to work that has already been published. Allowing the mind to wander past the first ideas into experiments with no predictable outcome has the potential to uncover a unique direction to pursue.
Discoveries

At work in exploratory drawing of the crab is a series of specific, then general, then stylized interpretations. There needs to be a reduction of the complex to reach the essence that makes the creature what we know it to be. That simplified version is returned to complexity through
Stylizations and specificities that will describe the character’s personality. Stripping away of complexity to arrive at the fundamental frame that carries the essence of a creature prepares the artist to rebuild a complex character rooted in simplicity. In other words, complex realism is reduced to the essence of the creature and then complexity is increased again amplifying stylized features that become a caricature of the real creature. (Fig. 2.6)

Figure 2.6. Illustrating progressive abstraction as a two-sided funnel where complex realism is simplified and then reconstituted in complexity of stylization.

What to look for

In exploratory drawing an artist should seek answers to the construction of the creature by analyzing its complexity, intricacy, unity, simplicity, symmetry, balance, continuity, variety, contrast, proportion, and scale. Drawing the parts over and over conveys the descriptive reality of the subject. A form is at once descriptive, narrative, and emotive. The details we see describe the creature’s unique appearance, (textures, patterns, and proportions) suggest its functional abilities, (walking, grasping, and hiding) and evoke a feeling in the viewer in response to the form (joy, sympathy, and fear).

<table>
<thead>
<tr>
<th>Expository Drawing results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis of component part assembly, Decisions about essential shapes (essence of crab), Synthesis of observed elements into stylized simplification, Discovery of basic shapes to represent complex forms, Decisions about repeating elements and symmetry in appendages</td>
</tr>
</tbody>
</table>
2.2.3 Visual Research for Exploratory Drawing

At a point in exploratory drawing of the crab shapes, I noticed that the loose drawings possessed a style that reminded me of the work of Paul Klee, and Joan Miró. The drawings of these artists relied heavily on line as a narrative thread that seemed to be exploring the page for form as it moved. Variation in line quality leads the viewer on a ride up and down along the perimeter of edges that define contained spaces of unusual shape. Miró was known to allow the action of drawing to affirm the direction for his work. (Fig. 2.7) The line lead the artist around the page as he made timely decisions at points in the action to go one way or another with the drawing tool. Decision of how to precede will involved in the action of drawing is based on instinct, experience, and the mindset that allows trial of marks that are unplanned.

Joan Miró wrote about free exploration: “I simply begin and while I paint, the painting affirms its presence, imposing itself or suggesting itself beneath my brush. However, the second phase is thought out in detail. The first stage is free, unconscious, but then the painting becomes totally controlled…” 38

Figure 2.7. Works on paper by Joan Miró, Pablo Lacasa, Palma Territori Miro (Mallorca: Fundació Pilar i Joan Miró a Mallorca, 1996).

*Discoveries*

Figure 2.8 shows a series of drawings by Picasso that progressively abstracts the form of a bull from realism to essential shapes by gradually reducing visual information. I find that studying the abstractions of other artists shows me how much further I can expand my thinking and push abstraction. During the time that I was developing this thesis, I visited the Fundacio Joan Miro, and the Picasso museum in Barcelona. The drawings that I saw have stayed with me and seem to be influencing the way that I approach abstraction. Any opportunity to study originals
of the work by influential artists is beneficial. Drawings carry subtlety of line and evidence of
process that is lost in reproductions.

What to look for

A good practice in visual research is to determine the areas of art history, whether current
design fields or fine art periods, that can influence the ideation process. As I was drawing initial
shapes for the crab it occurred to me to look at the work of Paul Klee, Picasso, Miro and some
of the other early 20th century artists who were exploring simplification in drawing. Knowing
the period or artists to look to is based on prior study of art history, graphic design history, and
illustration history that I have performed. I believe it is essential as an artist to have knowledge of
styles that have been invented.

An Internet or book search of artists will often gather momentum leading to related work
by artists otherwise overlooked. I collected examples of work that I found relative to the way that
I was approaching the distillation of crab forms. Including an art history search as a component
of research expands an artist’s ability to think in simple symbols of three-dimensional form. This
has been a common goal of artists throughout history, to communicate ideas simply and uniquely.
Their solutions to form development can be a road map to the way to proceed.

At this stage in drawing, questions arise about the way the stylizations of the crab will
be viewed in three dimensions. A flat line drawing is seen from only one angle of view. What the
view from other sides look like? Because the goal of this ideation process is a three-dimensional
form it is helpful to interact with media that are characterized by physicality. An appropriate next
step in the crab process was to make 3D line drawings using wire. Follow the stylization ideas of
drawing which address height and width and adding the consideration of depth.
2.2.4. Three-Dimensional Media Experimentation

Stage 1 Wire

Making line drawings that occupy actual space helps bridge two-dimensional ideas of the crab to three-dimensional existence. This is essentially interpreting lines from a two-dimensional page by bending them into shapes that occupy actual space. This is a relatively quick way to get a sense for how the drawings translate into actual space. Immediately there is an awareness of views from more than one angle. The line on the page, when standing in actual space doesn’t hold up visually from all sides. Viewed from the exact angle as drawn the wire shapes of the crab look dimensional. From the side, the edge contours of the legs and claws needed reshaping and some extra lines of wire were added to represent silhouette shapes when seen from alternate angles. Figure 2.9 shows wire sculptures made at this stage. Both address basic form based on simple line abstractions on paper and were each made from one, un-cut piece of wire.

Figure 2.9. Wire sculptures serving as 3D line drawings based on drawings (inset at top). On the left is a gestured form of the essential shapes; legs beneath and claw appendages extending from the front. On the right is wire sculpture that addresses the way that features will occupy the body mass, and how legs will orient forward, side, and back to support the upper body.
2.2.5 Visual Research for 3D Media Experiments

Alexander Calder was the master of 3D wire drawings. As I began translating my drawings of the crab into wire, I searched the work of Calder. Calder’s wire sculptures of animals, human figures, and portraits are amazing examples of curvilinear drawings occupying actual space. (Fig. 2.10) While collecting Calder reference, I became aware of Deborah Butterfield’s horse sculptures. (Fig. 2.11) Butterfield is a living American sculptor who crafts horses from scrap metal, wood, and other materials fastened together with wire. Her work addresses the essence of horse in the way that I was reducing the crab to essential shapes. I also saw a connection to the scrap collages action that I use in ideation.

Figure 2.10. Wire sculptures by Alexander Calder, Joan Simon, *Alexander Calder: The Paris Years* (New Haven: Yale University Press, 2008).

Discoveries

An exercise in 3-D line using wire is a good way to bridge drawing to the 3-D form. Taking the line drawing into actual space using wire as the pencil line helps the mind to consider the third dimension (depth) that flat drawings can only simulate. Essentially a drawing on paper is a serpentine line bent in varying degrees in the x and y direction. In actual space with wire replacing lead the serpentine line is bent in the z direction besides the x and the y. A line drawing in actual space can be held in the hands, rotated, manipulated, and examined from many sides to see the silhouette of line similar to the edge contour of mass when the character is modeled.

What to look for

Alexander Calder claimed that he thought most clearly in wire. That is to say that manipulating line directly with the hands is a device for answering questions about the way line delineates 3D form. The concentration of the hands and mind to produce a model in linear shorthand can promote an understanding of the way a 3D line would move forward and back in space to articulate depth, width, and height. In wire the artist can capture perpetual motion. There is action within the continuity of transitioning shapes. Wire can address a line of force that is the trajectory of a curve that carries the essential silhouette edges of shapes. Look for the positive and negative shape interactions in the subject. Wire sculpting addresses voids and solids. Just as line drawing represents solids with white space, empty space (thin air) represents solids between the wire lines.

To consider the space between the edge lines, a modeling compound is needed. After making 3D wire drawings of the crab I wondered about the ideas that could arise from manipulating the inner edges of surface mass. In plastilina the artist has control over solid mass that is responsive to light and shadow, not just line edges as with wire forming.
Stage 2 Plastilina

After the wire sculptures were made a similar exploration of the crab was performed with plastilina. These can be considered small, dimensional thumbnail sketches. Like the wire, these designs worked in tandem with drawing, where a sketch on paper would be formed in plastilina to glean early ideas about 3D form. These miniature maquettes, (standing 3 inches) expanded my thinking about the crab beyond realism, stretching the possibilities for arrangement of the essential elements. Making these thumbnails in clay set the outer boundary of abstraction for how I thought the character should look.

The realistic crab was the inner boundary and these simple roughs were the outer boundaries. Working the material between the fingers loosely allowing creative impulse and the plasticity of the material to affirm its presence resulted in shapes of the crab that were unique abstractions of what I knew a crab to be. (Fig 2.12) These shapes seemed to take form through exploration and the freedom to become what they would.

Figure 2.12. Exploratory plastilina thumbnail models based on simple line abstractions (Fig. 1.9)

Figure 2.13. Exploratory line drawings used as starting points for plastilina thumbnail models
2.2.6 Sculpting

Concurrent with the three-D media experiments a larger plastilina sculpt of the crab was started. This media action is much different than the way plastilina was used for the small thumb-nails. This sculpt was at a much larger scale and was used to familiarize myself with forming the components of actual crab form in actual space. Similar to the way that drawing from observation began the process of linear abstraction, sculpting from observation served to begin thinking of mass in actual space. There was some early consideration for abstracting facial features to be more expressive than the actual crab. The model contained a Styrofoam core inside the body and wire supports for the appendages. Figure 2.14 shows the model, which at this stage consisted of simplified reduction of elements, observed on the actual crab. The information that was gathered pertained to size relationships, positioning of limbs and claws, ways of simplifying complex joint connections, and abstracting facial features from existing crab parts that would allow expression in a character. Sculpting the crab in this way was the first of two sculpts. The second version, described later, addressed stylizations and specific details. This follows the strategy by which realism is analyzed and reduced first then stylized to become a caricature of the real creature.
By this point in the ideation process a solid understanding of the realistic and essential shapes was established and some stylization ideas were arrived at through drawing. There still seemed to be more possible in way of abstraction that would make the character unique. To find unexpected design ideas, collage techniques are very useful.

2.2.7 Two-Dimensional Media Experimentation

Of all the actions used for ideation, cut-paper collage best expands the conception of possible form designs. Cutting shapes from large sheets of color, and positioning shapes on paper spurs an active assembly of varied arrangements. The birth of character forms on the page by arrangement of oddly cut shapes of color is creative fuel that drives further experimentation.
In the case of the crab, cut-paper collage was the fifth action. It could have been the second action immediately after research. The reason that it was used later was because after the exploratory drawing, wire, plastilina thumbnails and larger sculpt there was still missing a unique shape idea to really expand upon. The need dictated use.

To make such constructions, large sheets of paper were painted with gouache and allowed to fully dry. (Cutting damp paper does not work.) Gouache was used because it is flat- not glossy when dry. What followed was a rolling process of experimentation that involves cutting, arranging, turning, trimming, removing, reassembling, trading, re-cutting, and finally gluing down on paper. There was always more than one arrangement of shapes happening at a time. This is because many variations were cut from the beginning followed by a wealth of pieces cut around the negative space carcass. (Fig 2.15) All of these pieces were moved around in a trial and error “cyclone” of activity that resulted in several form arrangements of the crab at the end. Knowing when to stop, when to “glue down” so to speak, was subjective. When there was a visual result that had satisfied my search for unique, unexpected interpretation of crab it signaled the right arrangement to keep. (Fig 2.16)

Figure 2.15. Negative space carcass that remains in a sheet of painted paper before these shapes are cut up further to incorporate into designs
Discoveries

For ideation, cut-paper collage is conducive to a state of mind that functions with abandonment of preconceived outcomes. This is because after cutting there is a positive shape in hand and a negative shape remaining in the large sheet of gouache. These parts have a close relationship that can be exploited by bringing them together again in some fashion. This means arranging the positive shapes on paper while continuing to cut pieces from the sheet of negative shapes. Exactly what is cut from the sheet around the negative shapes (producing new positive shapes of unusual character) is a reaction to the developing arrangement based on the principles of design.
listed earlier in this section. An artist is capable of making associative connections between flat, silhouette shapes of color on paper to more complex visions of form, in this case actual crab forms. This means that someone familiar with how a crab looks will make a connection in his or her imagination upon seeing the abstracted shapes of color carefully arranged as a crab. (Figure 2.17)

Figure 2.17. A collage assembled from diverse cut images relying on visual associations made in the viewer’s imagination to suggest a crab shape

What to look for

Shapes are cut with knowledge of a subject’s actual form in mind. These cuts can be made in an arabesque fashion, as flowing lines or in a short-stroked fashion that produces straight edges and corners. In either manner the cutting with a blade is done as if the blade was a pencil point. The cut lines are drawn. Usually lines on paper act as the boundaries of mass. When the lines are cuts in paper, the mass is tangible. It can be held in your hand. This is the key difference between drawing with pencil and cutting color with a knife. One works with line and implied mass, the other works with edges and actual mass.
### 2-D Experimentation results

- Exploration of silhouette shapes
- Shape ideas found by synectic associations in collage: overlap, substitute, Isolate, distort, reconstruct, fragment, add, and subtract
- Visual analoging (flat abstractions that correlate to the reference subject)
- Awareness of positive and negative spaces communicating crab form
- Aleatoric grouping (grouping by chance) leading to unplanned form ideas
- Decisions about intervals between shapes and clustering mass

### 2.2.8 Visual Research (cut-paper collage)

Henri Matisse originated the gouache-painted, hand-cut collage. Whenever I work with this media I refer to his work remind myself about using positive and negative shapes to establish form. Matisse’s cut outs are constructions of overlapping and juxtaposed shapes that combine to become silhouettes of familiar forms (mainly figures and leaf shapes). The arrangement of shapes is what triggers the associations made by the viewer. The shapes alone are just pieces but arranged in a particular way become complex forms in the imagination. (Fig. 2.18, 2.19)

2.2.9. Developmental Drawing

The results of the exploratory actions provided plenty shape inspirations. Developing the character further involves drawing body shapes that carry information about the character. Personality (friendly, shy, gruff), age, gender, manner (imposing, yielding), abilities (powerful, weak) are just some of the messages that shape design sends to the viewer. Consider the character styles shown in Figure 2.20 from Pixar’s Ratatouille. The character traits listed above are suggested in these sketches.

![Character sketches from Pixar’s Ratatouille](image)


At this stage in the ideation of character design, the shape results of exploratory actions should be analyzed to find human-associative possibilities within the forms that can be transmitters of character identity. Anthropomorphizing is the act of ascribing human attributes to a non-human. This means recognizing features that relate physically or in functionality to the human body to be used to achieve audience empathy for characters. It is a balancing act to create appealing characters with features that relate to humans but still retain important defining traits of the animal species. Altering animal features to make them more like humans will dilute the visual connections to species at the root of character.

The design of Jiminy Cricket is an example of diluting realism to arrive at a humanized and appealing character. (Fig. 2.21) A cricket in actuality does not possess appealing, and
cuddly physical traits. (Fig. 2.22) The story required that Jiminy Cricket be aesthetically pleasing as the warm and sincere conscience of Pinocchio. The final design is far removed from true cricket structure. Ward Kimball, one of Walt Disney’s Nine Old Men animators was involved with designing Jiminy Cricket. He wrote this about the final design: “How do you make a cricket endearing and cute? There is no way. We got down to that nothing character, which is a blob!” 41

In contrast to Jiminy Cricket is a design sketch for a grasshopper in Pixar’s A Bug’s Life. (Fig. 2.23) The grasshoppers were based on a human gang of bikers. The design maintains more of the realistic features of the grasshopper’s legs, arms, and wings.

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Figure 2.21. A drawing of Jiminy Cricket by Milt Kahl, John Canemaker, Walt Disney’s Nine Old Men & The Art of Animation (New York: Disney Editions, 2001).

Figure 2.22. Photo of a true cricket, http://www.flickr.com/photos/56118141@N00/2572913624/. Web. 5 April 2009.
In the case of the crab, research and experiments revealed that the crab appendages are closely related to human arms and legs in their segmentation and orientation. The interlocking components of the crab legs made them appear to have knees, ankles, and feet, although in reality the legs lack the bone structure of humans. The claws clearly relate to hands with appendages that bend forward like the human arm suggesting an elbow similar to the humerus connection to the ulna in humans. There was a potential association to human function in the legs and claws. Associative thinking asks questions for instance: What activity does the crab posture relate to? Where have I seen this posture before? The six constantly bent legs reminded me of ballet dancers in plié position. (Fig. 2.24)
2.2.10 Visual Research

I started to search visual reference of ballet to expand upon this connection. By looking at images of ballet poses and related visuals this could trigger ideas for stylizing the crab further with features of a dancer. This could be mean designing the ends of the crab legs in the shape of ballet shoes or shaping the upper shell to appear as hair gathered tightly in a knot as is common in ballet. Understanding ballet posture and positions would be helpful in drawing the character as a ballet dancer and communicating this personality. There are specific leg positions and movements that are recognized as ballet: the grand plié, pirouettes, and grand rond de jambe. Familiarity with the most recognized poses will help sell the idea of the crab in this role.

Beyond ballet visuals, attention was paid to the structure of human legs and arms. Drawings were made (Fig. 2.25) to acquire a familiarity with their functional appearance and contemplate how to assimilate the shapes within the crab. (Fig. 2.26)
Fig 2.25. Drawing studies made of human legs and arms to familiarize with their shapes and structure

Figure 2.26. Assimilating human leg postures with the crab body
Discoveries

It became clear that the structure of the crab, with its visual emphasis weighted in the legs and claws, associated well to ballet, a human activity focused on leg and arm expression. Because the crab has two sets of multiple legs the repetition of these delicate forms seemed more like the slender muscle shapes of female anatomy. Male bone and muscle structure is naturally bulkier. There was consideration of how to express femininity in the crab. The eyes are strong contributors to the feminine appearance. Eye stylizations were drawn to get a feel for the features that make eyes look feminine. (Fig. 2.27) The scale (large), shape (teardrop, or almond), the orientation (angled down to the center of the face), extended eyelashes, and heavy eyelids are design choices to consider.

Figure 2.27. Eye studies drawn to consider features that make eyes appear feminine
What to look for

Analyze the posture, movements, abilities, unique surface features, and structure to make visual connections to human qualities, functions, activities, and expressions. This is an exercise in projecting what you know about humans from experience and observation onto attributes that you notice in the creature that is to be stylized. For example if the creature has naturally hulking proportions this could trigger a reference to wrestlers, or circus strongmen, people with strong physical appearance and attitude. A creature of bony structure may appear weak or fragile, a relation to a gangly person with slight muscles, and lanky proportions. Jobs, sports, culture, activities, fashions, and habits are all areas of human existence that can be drawn from to develop an anthropomorphized creature.

Drawings that communicate the look and manner of a character are called model sheets. Once a general direction of style has been established as in the crab as a ballerina, drawings of the character from different angles of view, in various poses and expressions were made. There are still design questions that can be answered in this stage, for instance how facial scaling and alignment can be altered to allow more extreme expressions, or how six legs should attach to the body to allow for poses that will not become tangled. Figures 2.28 and 2.29 show drawings that were made considering facial expressions and leg poses. Detailed orthographic drawings of the character are created within the developmental drawing stage. (Fig 2.30) These serve as clean, outline drawings of finalized details drawn to proper scale. Elements align between views so that the drawings can be used as image planes in final modeling.
Figure 2.28. Facial expression drawings deciding upon placement scale and placement of features for best performance
Figure 2.29. Leg pose drawings to consider personality of character function of legs in various poses

Figure 2.30. Orthographic drawings of the stylized crab
2.2.11 Sculpting

Earlier in ideation there was a sculpt action that was used to translate drawings from observation into a large-scale plastilina model. After establishing stylizations in developmental drawing, a new model was made. The first model was reshaped to match the progression. (Fig. 2.31) The new sculpt reflected the developing character. Reusing the first model as the base for the stylized the crab illustrates the abstractions process described throughout this chapter. Complex realism is reduced to the essence of the creature and then complexity is increased again amplifying stylized features that become a caricature of the real creature.

### Developmental Drawing results

- Analysis of appendages as they relate to humans and ballerinas
- Decisions about expressive qualities of character
- Synthesis of realistic forms with conceptual stylization
- Discovery of basic needs for facial expression
- Decisions about metaphoric assimilation: as a ballet dancer
Figure 2.31. Plastilina sculpt reshaped to match progression in drawings, replacing the mass that was formed in an earlier sculpt version.
In order to incorporate the new ideas, some substantial changes were made to the inner structure of the model in order to support the weight of the material balanced on one set of legs. By subtractive and additive manipulation of the mass, a reworking of the overall appearance began to take shape. Building up modeling compound over carved Styrofoam forms made a gradual conversion from slight abstraction to full-characterization. A side-by-side comparison of the two models (Fig. 2.32) shows that some of the characterization is a matter of reshaping mass to resemble human-like features.

Figure 2.32. A side-by-side comparison of the two sculpted models- one from earlier in ideation and the other from later in the process

The shapes that were the foundation for the first model still remain in the new version, for example the underside of main body approaching the front of the face and the outer shell. The brow line was dramatically reshaped to supply flexible mass for eye expressions. The cheeks that were present in the first model were reshaped to be more prominent for expression. The legs were completely replaced to follow the ballet theme that was established in drawings. They were shaped more like human legs while retaining the interlocking, segmentation of the crab’s legs. These components were modeled separately and assembled on the restyled model. (Figure 2.33)
Discoveries

The plastilina sculpt action prepared a working model for the next stage of ideation. The forms modeled in actual space and analyzed under physical light would be used as a guide for software modeling. The reasons for making a sculpted model are threefold. Foremost it is a tactile experience where 3D form can be manipulated by hand. Sculpting is an effective problem solving media where the act of touch promotes an understanding of the form’s proportions and physically balanced weight. Second, the model can be viewed constantly between work sessions. It exists in actual living space where we experience most 3D objects under various light conditions. Looking upon the model with fresh eyes over a period of time often reveals areas that can be adjusted. Third, the action of shaping clay with a modeling tool is the physical equivalent to the software modeling action of positioning vertices along the surface of a polygonal model. There is a recall of experience that will be helpful when involved in deciding on the selection of vertices to move to accomplish the desired shape. Software modeling will require decisions be made about the subdividing of polygons for smooth shaping. Having experienced the level of simplicity or complexity needed to hold detail in the sculpted model influences these decisions.
What to look for

When incorporating a plastilina sculpt in the ideation process it is recommended that the artist work from the general to the specific. It helps to mass up the entire model and make changes over the entire surface. This will help maintain a unity in the appearance of combined shapes. Be aware of gesture within the developing form. Gesture is the implied thrust of energy within 3D form caused by the pose. To start, wire can be transformed into a gesture line. Subsequently it will serve as a supporting structure under Styrofoam that is carved and attached as the bulk of mass beneath the plastilina.

While working with plastilina or any other 3D media the artist should be aware that the human eye perceives a form in terms of contrasting components. We make comparisons between parts within our visual field to come to an understanding about what we see. The subtler the contrast between details the less recognizable the unique nature of a design will be. That means that making form details distinct or obvious is advised for fast recognition. The viewer can only process so many distinct elements at one time, so it is important to balance areas of quiet surface detail with areas of busy detail.

The understanding that sculpting provides about subtleties of transitions between parts and the perception under light can be mimicked in 3D software massing (described next), however, physical sculpting addresses weight and balance under actual forces of gravity where software does not. Having an understanding of the character’s weight can influence design so that the form appears to be balanced on limbs of proper scale.

<table>
<thead>
<tr>
<th>Sculpting results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis of surface continuity</td>
</tr>
<tr>
<td>Decisions about balance, proportion, and weight distribution</td>
</tr>
<tr>
<td>Establishment of proper orientation for legs to function properly</td>
</tr>
<tr>
<td>Consideration of clearly defined facial features for expression</td>
</tr>
<tr>
<td>Recognition of how light and shadow delineate details</td>
</tr>
<tr>
<td>Analysis of surface texture, transitions, and simplification of interlocking joints</td>
</tr>
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</table>
2.2.12 Software Massing

Software massing is polygonal modeling used to block in the primary contours (the outer edges of contained mass) followed by complementary secondary contours (internal edges) in a gradual progression from general form to specific details. The reason for working in this fashion is to establish and maintain form unity, integrate form variety, balance proportion, balance similarity and contrast, and balance weight across the form as a whole (mass conception). Working with simplified forms to make large-scale changes means holding off detail work until the general shape of the character has been established. If time-consuming detail work is done first (subdividing polygons and arranging large amounts of vertices into specific places) subsequent large-scale changes to the mass could wipe out the details. Keeping the surface complexity down also makes an easier task of selecting vertices (the corners of polygons) or edges for manipulation.

Software massing generally begins with a polygonal or subdivisional cube. Extruding and subdividing polygons of the cube increases the complexity of the surface providing shaping options. Increasing complexity is necessary for expanding a simple cube into a multidimensional form. Subdividing should be done in an orderly fashion so as to balance the number of polygons and keep them evenly distributed around the whole form. To approach the same level of interactivity that was experienced in sculpting the plastilina model, a constant orbiting of the software model should take place to analyze the progress from all angles of view. This will help insure recognition of mistakes in the low-poly character model.

The goal of the software massing action is to create a relatively, low poly model. The action is intended to answer questions about how design ideas developed in other media will translate into polygons. There always seems to be areas of the model that require extra planning, trial and error. Dividing and arranging polygons in the right way to make smooth transitions across compound shapes is a complex task.
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Modeling with polygons (flat planes) is directly related to the way that objects are delineated by light in actual space. Light falls upon objects and reveals their shape by casting a gradient shadow on one side across planes that lay adjacent to each other. Rounded forms are made of many subdivided planes that allow the mass to turn and receive light in a soft gradation. Hard-edged objects contain planes that connect at angles resulting in hard-edged shadows. Constructing surfaces with four-sided polygons relies upon precise adjustment of edges to result in smoothly shaded contours (if that is desired appearance).

What to look for

Primary contours (outer edges) of a form exchange places with secondary contours (inside edges) as an object is rotated in space. This means that a shape that appears a certain way from one angle of view will appear completely different from another angle of view. A good approach to solving design problems related to the complete form is to study the work, as the viewer will do, using selective vision. The viewer will group visual elements together in manageable sets. This is done to quickly make sense of things that are in view. Viewers will group visual elements based on resemblance, proximity, and similarity. ⁴³

Software massing was used twice within the ideation process of the crab. The initial massing study was a subdivisional model based on the first plastilina maquette. This action was performed before developmental drawing took place. It was useful to establish an understanding of way the crab forms would translate in software. (Fig. 2.34) Experimenting in the software while still working out stylization ideas prepares you for some of the modeling issues to be addressed once a fully formed shape idea is established. For example you might consider how an undercut brow feature or interlocking leg segment will be accomplished in a way that in later stages of final modeling would not prove problematic to create a surface map and add a shader.
Figure 2.34. Initial software massing experiment to explore how crab forms would translate into a polygonal model
The second software massing action was performed after stylization was established in developmental drawing and sculpting. The mass extrusion method of beginning with a subdivi-sional cube and gradually extruding faces and edges in an additive procedure was used to produce the end goal of the ideation process. The goal was to create a low-poly, three-dimensional crab character that expressed clear traits of crab species with stylized features for personality, expression, and performance. The CG model would serve as a developed three-dimensional sketch in preparation for a highly-detailed final model with a likely higher polygon count. Final modeling is not performed under ideation. Ideation provides the possible directions, makes design recom-mendations, and communicates the ideas in models and drawings. With the completion of the software massing action providing a polygonal model that communicates stylization ideas, (Fig. 2.35) the ideation process for this case study was finished.

<table>
<thead>
<tr>
<th><strong>Software Massing results</strong></th>
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<tbody>
<tr>
<td>Understanding of surface in terms of adjacent planes</td>
</tr>
<tr>
<td>Manipulation of edges and points functioned as a sensory analog to sculpting</td>
</tr>
<tr>
<td>Construction from general to specific gradually increased surface complexity and understanding of balancing heavy and light areas of detail</td>
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Figure 2.35. Software massing process for stylized version of crab model: starting point was a subdivisional cube gradually extruded.
2.3 Applied Study 2: Electric Mixer Characters

The design goal of this case study was a family of CG character models based on electric mixers that convey different personalities by shape styling alone. There would be no movement or voice to carry personality traits, only appearance. Animation and performance is outside the scope of this ideation process. This would be a study of the way simple shapes in arrangement, as a compound mass, would trigger associative connections to human body types and manners. The questions to be answered pertained to the specific shapes that would best make a character appear to have particular physical, emotional, and social characteristics. This case study possessed its own unique order of leveraging media actions as shown in Diagram 2.3.

Diagram 2.2. Order of media actions performed for applied study 2- mixer characters

2.3.1 Visual Research

Realistic form

Study of an actual electric drink mixer was the first step in visual research. (Fig. 2.36) I examined the mixer from all angles noticing the edge contours and the way that light and shadow
fell on the form. I was looking to gain a sense of its proportions, weight distribution, overall scale, range of movement within the parts, and their potential to be abstracted as features for expression and animation.

Fig 2.36. Close study of an actual mixer to understand its structure

As an industrial object the lines of its silhouette shape were straight with smooth transitions between planes. This mixer had rounded styling and few hard edges. There was edge creasing in the neck, and around the power switch and mixing stick housing. These were details worth noting to maintain in a design that had human qualities yet would still appear as a machine. I noticed the way that components were attached and interlocked to allow movement where necessary. Details that could be used later as expressive features were noted. These included screw heads, vents, stirrer attachment, and head assembly that could become eyes, mouth, nose, and neck.

In addition to the study of an actual mixer, an Internet search was performed to know the design history of mixers. For an object that has existed for a long time, the historical context has potential to spark an interesting design direction or specific feature. For example within the
antique styling of early mixers there were decorative, embellished details and weathered surfaces that could lend to establishing a character with history and depth. (Fig. 2.37) Research has a tendency to lead to more research as discoveries are made along the way. A study of early mixer design led to 20th century design trends like streamlining and art deco that had potential to offer unique character design ideas.


Backstory

The mixer has historical context in mid 20th century malt shops. A scrapbook-style clipplings montage of visual stimulants was assembled to show context for the mixer character and spur developmental momentum. (Fig. 2.38) Developing a back-story on where, when, and how an object existed is a good way to establish an imaginary personality for the character. This will likely influence the look of the design. Bringing an inanimate object to life visually is an imaginary exercise. Stimulating the imagination by performing an expanded search and writing or sketching a back-story scenario (Fig. 2.39) helps to broaden design ideas based on the imagined context of the characters.
The backstory developed for the mixer character involved an old mixer that had been stored away on a shelf of second-hand shop. The sketches above show an idea of entering the “mind” of the mixer as it remembered the days when it was working in an old-fashioned malt shop making milkshakes. The purpose of writing and drawing a scenario for the mixer character
was not to plan what the story was definitely going to be for an animated short but to flood the imagination with visual elements from the context of existence for the character being developed. Thinking about who the character’s friends are, where the character comes from, its age, temperament, abilities, goals, fears, strength, purpose, limitations, philosophy, and appearance are some of the details that can be invented to develop attributes of a character that will influence the way the character is designed to look. A character should suggest its unique attributes and background in its design.

Movement capabilities

A third research direction involved finding connections to animals, and people that visually had relation in posture, movement, function, or physical appearance to the mixer. This would serve as a way to imagine life in this inanimate object by finding examples of living creatures with associative features. Drink mixers had the appearance of standing on a base with two feet-like protrusions. By imagining how this character would walk, three otherwise unrelated creatures came to mind. Penguins as animated in the movie Mary Poppins moved in a wobbling shuffle. (Fig. 2.40) I imagined the mixer would do the same to generate locomotion from short appendages that wouldn’t bend. The kiwi is a flightless bird that came to mind not because of its movement but because of its leaning posture and body silhouette consisting of a long narrow beak much like the mixing stick attached to the “head” of the mixer. (Fig. 2.41) Charlie Chaplin was a third visual connection for his well-known posture and unusual wobbling walk. (Fig. 2.42)

Research results

<table>
<thead>
<tr>
<th>Comprehension of:</th>
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<tbody>
<tr>
<td>Physical attributes of actual mixer</td>
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<tr>
<td>Consistent attributes among different mixer types</td>
</tr>
<tr>
<td>Context of existence and history</td>
</tr>
<tr>
<td>Movement capabilities</td>
</tr>
<tr>
<td>Functionality</td>
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<tr>
<td>Visual connections to Cycladic figures</td>
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Discoveries

The communicative quality of studying objects in person as opposed to photographs is superior. Understanding the structure of form is strongest when objects can be touched, held, and examined in person from all angles of view. In the case of the mixer, information was gathered about the way component parts were connected. The range of movement was noted within joints. A metaphoric relationship of mixer features to human features was found. The motor case seemed like a head with screws that could function as eyes. Air vents located below the mixing stick suggested a mouth. The possibility of utilizing the mixing stick in different ways as an appendage for character interaction was noticed.

What to look for

While examining an inanimate object that is the basis for a character, begin to make imaginative bridges between existing physical features and similar forms in human structure. Most important is the placement of features to be used for expression of emotion. Existing features on the object that can be transformed into eyes, mouth, arms, and legs would offer more cohesion to the character than if extraneous parts were attached. To bring an inanimate object to life convincingly it should use existing features appropriated to function as means for expression.
2.3.2 Exploratory Drawing

Gesture drawing was the first action that was taken to anthropomorphize the mixer. Gestures emphasize energy and potential for movement. In the case of the mixer, the rigid body does not bend in actuality. Ignoring that fact by drawing simple-shape representations of a mixer in squash, stretch and bend poses served to jumpstart my thinking of the object infused with life. At this stage in ideation the limits of abstraction had not been set. Whether the mixer would be designed to bend and stretch freely or remain true to the physics of its rigid materials with only slight exaggeration was a choice to be made. Starting with drawings that explore thinking of the mixer’s flexibility far from its reality is how connections to human posture, manners, and attitude come to mind. Because the character is based on a lifeless object the infusion of movement and expression need to be imagined. Exaggerating the stretching capacity of the mixer form is at this stage a way to stimulate the imagination toward developing the character’s personality. 46 (Fig. 2.43)

Figure 2.43. Gesture drawings that exaggerate the stretching capabilities of the mixer in order to stimulate imagination of design possibilities
The exaggeration of forms is a dynamic action. It functions as an icebreaker to loosen the stiff conception of the mixer based on how the object has been known in actuality. Drawing as a means to establishing design direction is addressed in *Draw! A Visual Approach to Thinking Learning and Communicating*, by Kurt Hanks. The author writes that the two words “is like” represent the thinking process involved in drawing visual metaphors. 47

To make a visual metaphor a person would decide: “The design shape of the mixer IS LIKE a standing human. The motor compartment IS LIKE a human head. The base of the mixer IS LIKE human legs and feet.” Visual metaphors are imaginative associations between unrelated forms based on visual attributes or similarities in function, purpose, or manner of existence. In the case of the mixer drawings, the visual metaphor is the association of the mixer’s component shapes imagined and abstracted as human body, head, legs, and feet. Some early stylization drawings were made with a visual metaphor in mind. (Fig. 2.44)
Watching animation of inanimate objects is useful to analyze how animators balanced the exaggeration of movement with the actual physicality of the object. A good example is *Luxo Jr.* a film by Pixar Animation Studios, animated by John Lasseter. The table lamps possess expressive actions found in humans but the rigidity of the lamp’s structure and capabilities is maintained. In other words the lamps never cease to be lamps. To help analyze some of the sequence, I drew quick sketches of what I saw frame by frame in *Luxo Jr.* The parent lamp pulls itself back at one point to get out of the way of the ball. Without legs, the initiated thrust of weight seems to come from the back of the lamp, an area that would correspond to the hip area of a human. A similar gathering of force is needed to propel the lamp and its base in jumping forward. (Fig. 2.45)
mixer possessed similar rigid limitations to movement. The study of the *Luxo Jr.* animation was used to analyze the parameters that were set for an inanimate lamp to become humanized without losing essential lamp-like qualities. Some of the same parameters were to be considered for the design of the electric mixer character.

Figure 2.45. Sketches based on animated sequence from *Luxo Jr.* used to analyze parameters that allowed humanized actions while maintaining important lamp-like qualities

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The mixer possesses features that could abstracted to visually relate to recognizable human features. I found that imagining an inanimate object to have life requires thinking about how the parameters of its movement capabilities. In conjunction to this end I constructed a simple block model of the mixer in 3D animation software. A string of joints, (a rig), was assembled that would control the topology in a simple test of the way the mixer might walk. (Fig. 2.46) This was an extension of the drawings that exaggerated the stretching capabilities of the mixer in order to stimulate imagination of design possibilities.
Figure 2.46. Simple polygonal model built in software to analyze the way that the mixer might walk (a) simple polygon cubes extruded to form a representation of mixer, (b) a simple joint rig was constructed to control topology in an animation, (c) joints were manipulated and key framed in a simple animated sequence of the mixer walking. (Fig. 2.47)

Figure 2.47. Still frames from an animated test sequence of the way the mixer could walk and interact with its cup: The objective was to find personality in the character by its possible limitations in movement.

**Exploratory Drawing results**

Comprehension of:
Analysis of energy source and potential movement through gestures
Decisions about essential shapes (essence of mixer form)
Synthesis of observed elements into stylized simplification and imaginative metaphors
Discovery of basic shapes to represent complex forms
Decisions about repeating elements and symmetry in appendages

### 2.3.3 Developmental Drawing/Software Massing

The order of media actions leveraged for the mixer character (Diagram 2.2), shows a loop that connects developmental drawing and software massing. Within the case study diagrams the lines that connect media actions represent design questions raised. A line that forms a loop
through two actions represents a series of questions and integrated actions that alternate between two media types concurrently. Developmental drawing and software massing happened side by side.

Through drawing I was establishing a personality within the mixer character finding the need for features that would allow expression. At the same time, using 3D software, I began blocking in mass shapes that conveyed different personalities and would best make a character appear to have particular physical, emotional, and social characteristics. The drawings raised the questions of how to combine shapes in software to construct a hulking bully character, an elderly character, and a child character, all based on the mixer form. This changed the focus from designing a single mixer character to developing a family of mixers that each had different body types.

Software was capable of overlapping simple shapes with the flexibility to rearrange, reshape, and review components from multiple angles quickly to establish basic forms related to familiar body types found in humans. Drawing was suited to explore expressions that established personality. Certainly drawing could be used for massing shapes by making multiple orthographic drawings, but the software allowed for true orbiting of the form with updating light and shadow. Thinking about shapes that carry personality led me to find examples of this used in animation. Figures 2.48-2.49 show the use of simple shapes combined to carry personality and physicality. Figure 2.50 shows the contrasting shapes of the mixer family developed in applied study 2.

Figure 2.48. Contrasting figure shapes from Pixar’s Ratatouille, Karen Paik, The Art of Ratatouille (San Francisco, CA. Chronicle Books, 2007).
Figure 2.49. Character shapes from Pixar’s *Monsters Inc.* that are based on simple geometric shapes, Karen Paik, *To Infinity and Beyond!: The Story of Pixar Animation Studios* (San Francisco, CA. Chronicle Books, 2007).

Figure 2.50. Contrasting character shapes of mixer family developed in applied study 2 including the hero mixer, a female mixer, an old mixer, a pugnacious bully, and a baby mixer.

Software massing was used for the mixer family to block in the primary contours that establish and maintain form unity, integrate form variety, balance proportion, balance similarity and contrast, and balance weight across the form as a whole (mass conception). Unique to the mixer study was a consideration for producing variations of body types that communicated idiosyncrasies for a family of characters. This would require experimental arrangements of especially
shaped masses for the different body types. The best way to achieve this was to use NURBS shapes that could be combined and formulated in broad terms by manipulating CVs and curves. The range of influence afforded by control vertices to effect broad surface areas smoothly was appropriate for the mixer shape massing. The crab consisted of many appendages extending from either side of the form. Extrusion of polygonal faces seemed the best way to build up mass that extended out in several directions. The mixer does not possess limbs. Its essence is a sturdy trunk made of smoothly transitioned planes, rounded edges, and rounded projections. NURBS geometry excels at curvaceous surfaces and rounded shape components.

The modeling of shape composites with smooth transitions and distinguished planes reminded me of the marble idols carved by ancient Cycladic civilizations. A search of visual reference of this art form showed that the statues commonly depicted arms that were crossed and tucked inside the outer silhouette of the body. (Fig. 2.51) There seemed to be a metaphoric relationship to the vertically contained torso of the mixer. The simplification of human features related to the way that the mixer shapes would be abstracted to be more figurative. The Cycladic idols are reduced to the essence of human forms. Finding the essence of a subject was discussed earlier pertaining to the design process of the crab. It was equally important to work with the essential shapes for the mixer; an economy of the basic features that would meld best as a living machine.
The thinking process involved in stylizing the body of the mixer specifically for each of the five characters focused on variations to the following features. The mixing stick was considered a key component that could vary in its placement, orientation, size, physical appearance, and purpose. (Fig. 2.52) In the bully mixer the stick was positioned like a cigar. For the girl mixer the stick became hair extensions like pigtails. The old mixer had a mixing stick that was decrepit and used as a cane. The baby mixer’s stick was short and used as a pacifier. For the mixer hero, the stick was designed straight forward as an extension of his face but would be telescopic with a propeller tip that could grasp objects like a hand. Because the mixers did not have arms or hands the mixer stick was planned as a utilitarian appendage.
The eyes would be made for each character by appropriating two screw heads on either side of the motor case. The stylized use of the screw head would change according to the needs of expression for each of the mixers. The bully received small screws for beady eyes with an overhanging brow shape. The baby mixer had large eyes with screw stylization that appeared as heavy eyelids. The outer casing of the screw split open like an eyelid with a layer underneath serving as the pupil. (Fig. 2.53)
Body mass of the mixers was an important communicator of personality. The five characters had calculated differences. (Fig. 2.54) The bully mixer was a hulking mass, wide at the top with a smallish head and large face. The girl mixer was shaped like an hourglass with long hair-like features over the motor casing. The baby mixer had a proportionally large head with a body that was bottom heavy like a baby in diapers. The old mixer was hunched over with surface folds, weight settled in lower portions of the body, and slight upper half and neck. In contrast the hero mixer was shaped to look well balanced with a wide stance, strong shoulders and neck, and upright posture. To inform my thinking about ways that character appearance can suggest personality, I examined the work of animator Preston Blair, and Warner Bros. artists who effectively communicated character traits in simple shape designs.

Figure 2.54. Examples of body style differences in the mixer characters

Massing of the individual mixer characters incorporated assistance from drawing and visual research that happened concurrently. Figures 2.55-2.59 show results of NURBS massing for different members of a mixer family alongside drawings and visual references that had an impact on decision making.
For the pugnacious bully mixer character type (Figure 2.55) the focus was on mass conception of hulking forms while following the basic mixer shapes. The bully was made of three main components that overlap- seaming and transitions between parts was not addressed at this stage. His mixing stick was oriented as a cigar in the mixer’s mouth. Heavy overhanging eyebrows were formed to hide the eyes and suggest a meanness. Simple shape drawings were made concurrently with software massing to establish the essence of the character’s appearance. These were used to think about simple silhouette shapes and posture of the character, two things that could be accomplished easily in drawing. Visual reference was gathered of animated characters with similar characteristics- large upper body, small head, large face, short legs, and narrow mid section. Artists Preston Blair, Tex Avery, and Warner Bros. character designers were inspirations for ways to communicate hulking form and pugnacious personality in this mixer.

Like the work on the bully mixer, massing the baby mixer character type (Figure 2.56) involved establishing essential shapes. Proportionally large head and eyes, stout lower half of the body as if in diapers or pajamas, mixing stick shortened and stylized as a pacifier, rounded star shape, and predominate eyelids to appear sleepy were shape considerations. Drawings of simple shapes, maintaining spherical forms that relate to baby toys and balled-up, rounded bodies of infants were made to address silhouette shapes. To communicate the mixing stick as a pacifier an addition of pursed wrinkles around the face as if holding the stick in the mouth was needed. Reference was used toward designing the stick to relate to a pacifier. Eyelids were designed as screw heads that have been opened in half to show an eye shape inside. A curled tubular form was added to the top of the head similar to a curled strand of hair.

For the old mixer character type (Figure 2.57) there was a focus on ideas about how shapes should be arranged to imply age (without textures at this stage). At first the character was made with a hunched over body but with a neck that then appeared too strong. This was reshaped
to be thinner and the posture was leaned forward to use the mixing stick like a cane. A drawing of simple shapes and weight distribution suggested that the first massing models did not carry their weight low enough to suggest sagging of the body in old age. The head was too large as well. Adjustments were made to bridge the important details of the sketches with the software shapes. Combining features from early massing with answers found in the drawing resulted in a form that related more closely to an old mixer. Visual reference from Blue Sky Animation Studios’ *Robots* helped drive imagination about visual characteristics of an old machine. For example posture, dents, creases, heavy sagging, clunkiness, and tiresome eyes were considered.

The female mixer character type (Figure 2.58) utilized simple curved shapes to form an hourglass silhouette. The top of the motor casing was addressed as ways to imply long hair that would lend to a feminine appearance. Visual reference of primitive carvings were an influence on applying a hair-like feature that was stylized to blend with the shapes of the head. Further stylizations were considered including the mixer stick as twin pigtails, recessed shaping in front with shelves for two mixing cups, and edges and contour lines added for a more shapely silhouette. Cycladic statue reference was an influence on simplification of form with a feminine silhouette.

The hero mixer character type (Figure 2.59) is the main character of the group that served as the model of the basic forms that the others were based upon. To abstracted from the actual mixer more prominent legs were established based on the existing mixer base that suggested legs. The mixer base was shaped to appear more like feet. Shoulders shapes were implied although there are no arms on the mixer. Posture was meant to show strength and balance as a main character. Drawings of head shape possibilities were made, taking cues from primitive mask carvings in regards to planar recesses, protrusions, and lines that divide the forms geometrically. Details like eyes formed from screw heads that separate to become eyelids were established. A telescopic mixing stick that would allow the mixer to reach and grasp objects was assembled.
Figure 2.55. Pugnacious bully mixer character type (a) Mass conception of hulking forms while following the basic mixer shapes, made of three main components that overlap- seaming and transitions between parts is not addressed at this stage, mixing stick oriented as a cigar in the mixer’s mouth, heavy overhanging eyebrows hide the eyes and suggest a meanness (b) Simple shape drawings to establish essence of the character’s appearance (c) Visual reference of characters with similar characteristics- large upper body, small head, large face, short legs, and narrow mid section, left to right: Preston Blair, *Cartoon Animation* (Laguna Hills, CA: Walter Foster, 1994), John Canemaker, *Tex Avery: The MGM Years* (New York: Turner Publishing, 1996).
Figure 2.56. Baby mixer character type (a) Essential shapes established—proportionally large head and eyes, stout lower half of the body as if in diapers or pajamas, mixing stick shortened and stylized as a pacifier (propeller end made a plump, rounded star shape, predominate eyelids to appear sleepy (b) Drawings of simple shapes, maintaining spherical forms that relate to baby toys and balled-up, rounded bodies of infants (c) concentration on communicating the mixing stick as a pacifier, addition of pursed wrinkles around the face as if holding the stick in the mouth, cues from actual pacifier about designing the stick to relate to a pacifier, eyelids are screw heads that have been opened in half to show an eye shape within (d) A curled tubular form was added to the top of the head similar to a curled strand of hair.
Figure 2.57. Old mixer character type (a) Working through ideas about how shapes should be arranged to imply age (without textures at this stage), at first character was made with a hunched over body but with a neck that then appeared too strong, this was reshaped to be thinner and the posture was leaned forward to use the mixing stick like a cane (b) A drawing of simple shapes and weight distribution suggested that the first massing models did not carry their weight low enough to suggest sagging, and old age, the head was too large as well (c) Combining features from early massing with answers found in the drawing resulted in a form that related more closely to an old mixer (d) Visual reference from Blue Sky Animation Studios’ Robots helped drive imagination about visual characteristics of an old machine, for example posture, dents, creases, heavy sagging, clunkiness, and tiresome eyes, Amid Amidi. The Art of Robots (San Francisco, CA: Chronicle Books, 2005).
Figure 2.58. Female mixer character type (a) Simple curved shapes are formed in an hourglass silhouette, top of motor casing addressed as ways to imply long hair that would lend to a feminine appearance (b) Visual reference of primitive carvings were an influence on applying a hair-like feature that was stylized to blend with the shapes of the head, Colin Rhodes, *Primitivism and Modern Art* (New York: Thames and Hudson, 1994). (c) A progression from the first mass conception shows the base mixer shapes being reestablished with a base and contour along the front of the body that would fit a mixer cup (d) Further stylizations considered, the mixer stick became twin pigtails, recessed shaping in front with shelves for two mixing cups, edges and contour lines were added (e) Cycladic statue reference was an influence on simplification of form with a feminine silhouette, http://www.flickr.com/photos/44124324682@N01/442026760/. Web. 8 August 2008.
Figure 2.59. Hero mixer character type (a) As the main character of the group the hero was designed to appear as the essential mixer shape that the others would be compared to, abstracted from the actual mixer more prominent legs were established, the mixer base was shaped to appear more like feet, shoulders were implied although there are no arms, posture was meant to show strength and balance as a main character (b) Drawings of head shape possibilities taking cues from primitive mask carvings in regards to planar recesses and protrusions, and lines that divide the forms geometrically (d) Details like the eye formed from a screw head that separates to become eyelids, the telescopic mixing stick that would allow the mixer to reach and grasp objects like a hand (e) Examples of visual reference of primitive carvings that influenced my thinking about shaping head, facial and body features as transitioning planes that would catch the light in recessed areas and raised edges, William Rubin, *Primitivism in 20th Century Art, Vol. 1 & 2* (Boston: Little, Brown and Co., 1984).
Expression studies were made along side software massing to assess the designs that I was making in the face. (Fig. 2.60) The brows are important features for expression especially with a character like the mixer, which has a mouth that is below the head. The main concern was the height of the eye sockets and the amount of brow weight to supply above the eyes that could be used for expressions.

Figure 2.60. Expression studies to analyze the ways that the character would show emotion, and to determine the placement and size of facial features
After the mass conception of shapes that would be the hero mixer, a more detailed model was made using sub-divisional geometry based on what had been established with NURBS. The switch to sub-D for this detail study was to take advantage of creasing edges. An industrial object often has an edge quality that is cleanly transitioned between planes. The mixer possessed edges that were rounded creases. This stage of massing was used to further stylize the hero character to retain some of a machine-made surface quality.

The modeling process using sub-divisional geometry (Figure 2.61) focused on surfaces that appeared to be machine-made. Beginning with a sub-D cube for the head, polygonal faces were extruded and shaped then creased in places that accentuated stylized planes. Areas around switches, screws, and nested components were carefully manipulated to form rounded edges that appeared to be stamped by machine.
Figure 2.61. Modeling process using sub-divisional geometry focused on surfaces that appeared to be machine-made. Beginning with a sub-D cube for the head, faces were extruded and shaped then creased in places that accentuated stylized planes. Areas around switches, screws, and nested components were carefully manipulated to form rounded edges that appeared to be stamped by machine.
The end result of the sub-D massing study is shown in Figure 2.62. Compared to the earlier massing results in NURBS, this model appears more like a machine. Components were carefully modeled to fit together tightly like a mechanical device. The legs were much more resolved to suggest that the mixer could walk and where the pivot of the legs would occur. There were now hip joints and knee joints. The neck was designed to look as if it could be raised form within the shoulders and tilted at the connection to the head. The mixing stick, which is hidden inside the cup, was fitted with a propeller hand that could be rigged to use as a grasping device. Changes were made to the eye sockets so that they protruded away from the face as well as recessed for an eye that was a flatter screw than earlier designed.
Figure 2.62. Final results of software massing in sub-divisional geometry with attention to edge creasing, component fittings, implied mechanical functions such as joints for pivoting and extending, machine-like details such as screw heads.
Selective Media Leveraging has been used in this study to design three-dimensional characters for animation. The applied studies show the within a design discipline the order of media actions used will be unique to the design problem. The selection of the media used to leverage combined with a specific manipulative action is what forces discovery. Visual research was consistently an important component to establish the context and parameters of the crab and the mixer characters. It was common to return to visual research at times throughout ideation process.

The use of Selective Media Leveraging for the two applied studies showcased the strength of a free search for form through experimentation with media actions. The concept of the crab as a ballet dancer was discovered after exploring many form ideas in drawing, collage, and sculpting.

The mixer family developed in a different way, mainly through drawing and software massing.

The design of form that communicates character personality using simple shapes was a focus of both applied studies. Each media was used in connection with design principles. Supporting my use of media for ideation was a knowledge of basic three-dimensional form structure, visual perception of volume, and familiarity with the work of artists who have interpreted form in sculpture and for 3D animation. The chapter that follows will address the ways a viewer perceives three-dimensional form.

<table>
<thead>
<tr>
<th>Developmental Drawing/Software Massing results</th>
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</thead>
<tbody>
<tr>
<td>Recognition of simple shapes that suggest personality</td>
</tr>
<tr>
<td>Construction from simple shapes provided control over development of form as a cohesive whole: proportional balance, symmetry, planned variety</td>
</tr>
<tr>
<td>Establishment of consistent but varied elements that linked family of mixer characters: abstracted mixing sticks, eyes adapted from screw heads or bolts, body postures</td>
</tr>
<tr>
<td>Construction from general to specific gradually increased surface complexity and understanding of balancing heavy and light areas of detail</td>
</tr>
<tr>
<td>Consideration of stylizations based on related primitive carvings</td>
</tr>
<tr>
<td>Decisions about expressive qualities of character through drawing</td>
</tr>
<tr>
<td>Discovery of basic needs for facial expression</td>
</tr>
<tr>
<td>Synthesis of realistic forms with conceptual stylization</td>
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</table>
Volumetric design can be enhanced by an understanding of the ways that the physicality of 3D form differs from 2D. Primarily a three-dimensional form is experienced from many angles while two-dimensional design is constrained to one viewing angle. Bridging the design thinking from flat media to dimensional media involves the basic elements of form in 2D (points, lines, and planes) mirrored in 3D (vertices, edges, and surfaces). The arrangement of these elements is a matter of understanding that the mass of three-dimensional form expands in many directions based on the advancing and receding planes and the flow of the edges that separate the planes. As foundational support for volumetric form design using Selective Media Leveraging the following section will address elements of volumetric structure, perception, and simplification for clear communication of design ideas.

3.1 Structure

The basic building blocks of volumetric form are points, lines, and planes. A point is the primary element that initiates form. It represents a position in space but has no direction. A point marks the meeting place of lines forming the corner of a plane. A point extended becomes a line with length, direction, and position. To quote Bauhaus teacher Paul Klee: “A line is a dot that goes for a walk.” Points and lines create the boundaries of planes. A line extended in a direction perpendicular to its intrinsic direction becomes a plane with length, width, shapes, orientation, and position. Constructing a volumetric form with length, width, and depth requires planes laying tangent to each other to create a surface. (Figure 3.1) Subdividing planes into smaller planes
allows a surface to turn and appear rounded. A surface created with planes that encloses space becomes a volumetric form with length, width, and depth, which in 3D design translates into measurements on an x, y and z axis. Planes define the boundaries of volume.

![Image](image_url)

Figure 3.1. Screen capture of software massing in progress for crab character showing the cooperation of connected planes forming the surface boundaries of volumetric form.

Volume is the space that a form occupies. There is mass volume which refers to a solid form such as a stone. There is space volume which refers to hollow form such as an empty snail shell. Both form types consist of planar surfaces that enclose volume. These planes combine to bring areas of mass forward and push other areas back visually as a person studies an object. The human eyes perceive mass and volume by tracing imaginary lines across the surface being observed. Sight is attuned to the sense of touch in that the eyes caress the surface of an object to scrutinize its visual information.

Light and shadow delineate planes. When designing dimensional form it is important to effect how light will fall upon the surface. Areas that need to be emphasized should collect more light or more shadow to stand out the eye. This is accomplished by exaggeration of changes in depth so that an area catches more light than another or falls into deeper shadow. The eye is
always looking for a separation of dark and light areas. The viewer is always seeking information about what they see so as to understand the shape.

The mass of three-dimensional form expands in many directions based on the advancing and receding planes and the flow of the edges that separate the planes. The surface of forms shapes whether spherical, cylindrical, or cubist carries its own characteristic light distribution. The sphere distributes light in an even flow from light to dark. A cube or other angular form distributes light in sudden change of light and dark. When the eye sees an even flow of value across a turning form it senses a curved surface. A sudden contrast of value implies to the viewer a hard-edged or angular form. (Figure 3.2)

Figure 3.2. Detail of plastilina sculpt for typewriter character in development that shows the contrast of light and shadow across shapes with rounded and angular qualities.
Viewers of form will seek to reduce visual information to the simplest shapes. Simple and regular shapes are easier to read. Simplifying shapes and exaggerating features have been ways of abstraction used by primitive artists and followers to create visually dynamic forms that read quickly. Quick recognition of form is important in 3D animated features for details of movement to be legible and for the characters to stand out from their surroundings. Legibility of form designed for living space is an aspect of the aesthetic quality often called clean lines.

3.2 Perception of Volume

Perceiving objects in space is accomplished by our binocular vision. Each eye sees an object from a slightly different angle sending the brain a set of two-dimensional views. The brain combines both views to create a three-dimensional image with a sense of the object’s depth. Perceiving three-dimensional images involves three processes: reception, extraction, and inference.

Reception relies on light reflecting from the surface of a form. The photosensitive cells in the human eyes receive light returning from surface planes to extract basic visual features. Through extraction the eye collects information about a form’s silhouette edges, size, orientation of planes, location in space, and movement. Inference involves the eyes continuously scanning objects to make sense of shapes and their relation to other objects in space. The vision of elements in three-dimensional space is constructed of quick succession of scanned images. With this in mind, the design of a three-dimensional form for rapid recognition should result in objects that delineate well under light to send clear messages to the viewer.

Edges convey to the eyes objects in space. Perception of edges is effected by the angle of tangent planes that catch light. Distinction between object and environment depends upon the light, the surface shape of the object, and visual contrast between the form and the surround-
ing space. It can be said that the shape of an object is the edge contour of planes also called the silhouette. The silhouette is the first means by which a viewer identifies a form. (Figure 3.3)

![Figure 3.3. Silhouette shapes of the crab character plastilina sculpt from applied study 1. Proportions, posture, balance, rounded forms, variety of complex and simple shapes, and suggestion of physical capabilities are communicated by silhouette alone.](image)

All three-dimensional forms possess mass and volume. Mass is defined as a quantity of matter cohering together to become one body. Volume is considered the amount of space that an object occupies. The aesthetic quality of form is a result of sculpting the mass in a way that implies a flowing integration of components that reads as a cohesive whole. Volume plays a role mainly in the implied weight of a form. Forms may need to convey lightness or weight depending on its function. Aesthetic forms are the products of structural precision or imprecision, proportions that seem in harmony or discord, and clarity or ambiguity.  

### 3.3 Plastic Perception

Gyorgy Kepes writes in the book Language of Vision: “To perceive an image is to participate in a forming process; it is a creative act. The word “plastic” therefore is here used to designate the formative quality, the shaping of sensory impressions into unified, organic wholes.”

The perception of three-dimensional form is the result of organizing visual information and
knowledge from prior experience of interaction with the form in view. Humans interact with forms in space through touch. For objects we can not touch, we project assumptions based on similar objects with which we have interacted. This is the equivalent of reducing objects visually to geometric shapes. An object that appears to relate to a cube implies information about the sides hidden from view. Understanding form through vision alone without touching it (including all form viewed in cinema) requires informational cues. When cues are ambiguous due to the design of the object or angle of view there will be contradicting messages received in the viewer’s mind.

An example of simultaneous form perception is the Necker cube. (Fig. 3.4) Published by Louis Albert Necker in 1832, the line drawing of a cube without depth cues becomes an optical illusion that is ambiguous and can be interpreted by the viewer as four different angles of view. The Necker cube shows how the eyes study a visual form to organize information in a meaningful way. The human visual system prefers order and understanding over confusion. A second version of the Necker cube allows for the same interpretations as the earlier version but also can flatten visually to seem two-dimensional and three-dimensional simultaneously. This is an example of multistable perception, the subjective interpretation of an object in more than one way simultaneously. It is interesting to examine how the eyes decipher the difference between 2D and 3D shapes in view.

Figure 3.4. Necker cubes first published in 1832 by Louis Albert Necker; redrawn version shown
This brings up an interesting point about three-dimensional design for screen-based delivery. An object that virtually contains depth, height, and width is returned to two dimensions when rendered in a frame of film. We live in a three-dimensional world filled with two-dimensional visuals that represent three-dimensional forms. For example, all visual art is created through a language of abstraction. The picture has been interpreted by the artist’s eyes and recorded on a flat plane. The picture is not the object itself but a representation of an object. Surrealist painter René Magritte painted a picture of a pipe in 1928 and inscribed below the object “This is not a pipe.” (Fig. 3.5) The painting was an image of pipe, not an actual pipe. There is an interesting shared existence of 3D and 2D shapes in the world around us.

3.4 Primitivism, Cubism, and Beyond

Architect and designer Le Corbusier believed that objects based on the platonic solids—cube, sphere, and cylinder are appealing because of the way light naturally delineate these forms clearly. Platonic solids are forms generated from the circle, square, and triangle. Forms based on platonic solids are shaped through dimensional transformation, subtractive transformation, or additive transformation. Dimensional transformation refers to altering one or more dimensions of
a shape to produce variants. Subtractive and additive transformation is when shapes are altered by removing mass as in wood carving or adding to volume as in clay massing. Retaining the shape’s visual connections to platonic solids depends upon the extent to which the shape is altered with attention to geometric regularity.

Primitive carvings from African and Oceanic cultures employed a style of abstraction and distillation of form in platonic solids. In researching primitive abstraction, I visited the Tropenmuseum in Amsterdam and the Museu Etnologic in Barcelona. (Fig. 3.6) After studying and drawing copies of many of the carvings I realized that there is a connection between the style of the African art and the simplified forms used in polygonal modeling of my characters in software. These polygonal models are made in progressive complexity. The geometry is constructed of very few polygons to start and gradually is subdivided as needed to elaborate form. The early reduction to the fewest polygonal planes is primitive abstraction in CG.

Figure 3.6. Tropenmuseum, Amsterdam and Museu Etnologic, Barcelona. Photos by the author.
There is a clear distinction of features by abstraction to simple planes that delineates well by casting shadows that result from bold protrusions and recessions. This striking contrast of light and shade is what gives primitive carvings their unique strength as three-dimensional objects. As stated earlier, the eyes continuously scan objects to make sense of shapes and their relation to other objects in space. Objects that delineate well under light send clear messages to the viewer. The perception of primitive carvings is quick, effected by the angle of tangent planes that catch light. Distinction through visual contrast is useful in character design for audiences to comprehend the actions of a character separate from its surroundings. The clear representation of form has been sought by artists throughout history.

The early 20th century cubists were inspired by geometric, subtractive transformation they saw in primitive carvings from African and Oceanic cultures. As Colin Rhodes wrote in *Primitivism and Modern Art*, “The small pictorial planes, or facets, used by Picasso and Braque to construct their pictures appear to be related to the simplified geometric surfaces of certain African and Oceanic prototypes. However, the value of the Cubist facet lies not in the geometric abstraction of the human body, but in the possibility it raises of constructing a pictorial space that has the same effect in painting as the closed form in sculpture. Cubist space possesses an internal logic distinct from external reality— one that contains, connects, and seals objects.” In researching cubism, I visited the Fundació Joan Miró, and Museu Picasso in Barcelona. (Fig. 3.7)
Below are examples of planar abstraction found in animation character design. Primitive sculpture and cubist art are shown next to animation stills. (Figure 3.8, 3.9)

Primitive abstraction has an influence on today’s design of 3D form. Whether by conscious interpretation or by assimilation from casual exposure, similarities in abstraction to the African and Oceanic carvings can be found in character designs from recent 3D stop-motion and CG animation. Figures 3.10 and 3.11 show some examples of primitive abstraction as it influenced figure representation in Picasso’s painting Les Demoiselles d’Avignon.

Design of form that relates to this principle can be found in characters from The Tale of Despereaux released by Universal Pictures in late 2008. Facial features of the human characters are constructed of simplified planes that recall some of the designs from oceanic carvings and cubist influenced art of Modigliani in the early 20th century. Compare images of Princess Pea from The Tale of Despereaux (Fig. 3.12) with a portrait of Jeanne Hébuterne (Fig. 3.13) and a stone carving of a head (Fig. 3.14) both by Modigliani to see similar abstraction of planar forms and exaggeration of the features such as almond shaped eyes, miniscule mouth, and an elongated nose constructed from three planes. Then consider two masks from the Ivory Coast that reduce facial features to flat planes and of the forehead, cheeks, and chin with similar exaggeration of eyes as almond shapes, elongated nose, and reduced lips. (Fig. 3.15, 3.16) Tribal art influenced much of the portrait work of Modigliani. 21st century character designs that relate to the early 20th century art of Modigliani (1909-1915) show how the design of representational form has commonalities for artists living centuries apart.


Simplification and abstraction found its way into animation by the mid 20th century. Ward Kimball, one of the Nine Old Men at Disney, had an appreciation for the abstract and modern art methods. He injected fresh, stylized design into the Disney shorts with *Adventures in Music: Melody* (1953), and *Toot, Whistle, Plunk, and Boom* (1953). Both of these shorts showed a similar graphic style to UPA animation which experimented with degrees of depth using highly stylized, flat, abstract shapes and outline. Kimball’s drawings had an edge to them that was different than the usual Disney warm, rounded look. There is an evident visual influence by Cubism in the visual design of objects by Ward Kimball. Compare the images from *Toot, Whistle, Plunk, and Boom* in figure 3.17 with a painting by Cubist Juan Gris in figure 3.18.

2.5 The Use of Simplification

As described by Hans Bacher in the book *Dream Worlds: Production Design for Animation*, “Visual development is the early stage in production where all the different ways to translate a story idea into visuals are being explored. That includes the search for a style to fit the story, in all areas: background, characters, color, composition and editing. It also includes the research and concept-design based on possible stylistic directions.

The simplification of form can be both a means to an end and a stylistic choice. Animation design can be realistic or abstract and stylized. The amount of visual detail is a consideration in the visual development stage. The design of characters based on geometric simplification is becoming more common in computer animation. There is a trend toward angular and planar stylization in 3D animation. Figures 3.19-3.21 show character designs from *Madagascar* (Dream-
Works, 2005), *Ratatouille* (Disney-Pixar, 2007), and *UP* (Disney-Pixar, 2009). A stylization shift from earlier 3D animation is showcased in these movies reminiscent of a trend toward angular abstraction of 1950’s style animation commonly referred to as UPA (United Productions of America) style. UPA was derived from modern art and specifically Cubism. Amid Amidi authored the book *Cartoon Modern* and wrote about the desire of animators to break away from the rounded character forms established by the Disney Studio. Amidi writes: “Designers discarded their earlier reliance on circle and oval graphic formulas and created cartoon characters with a variety of sophisticated modern elements, including hard-edged Cubist shapes and organic biomorphic forms reminiscent of Miró, Calder, and Norguchi.” 59 Similar to the changes in two-dimensional animation there is now a broadening of character design ideas in 3D animation that is graphically diverse from the more rounded character designs of CG animated movies from the late 1990’s and early 2000’s.

![Figure 3.19. Melman, Marty, and Alex from Madagascar released by DreamWorks, 2005, http://www.madagascar-themovie.com/downloads/1_800x600.html. Web. 8 February 2009.](image-url)

A shift from rounded forms to angular is a natural progression of abstraction that is a recurring theme in modern art. All visual art is an abstraction of real life. A drawing, no matter how realistic, is an abstracted recording of what an artist sees. Throughout art history, when artists sought to express ideas beyond realism (after photography was invented) they dissected objects into different geometric shapes progressing from round to cubist to flat. As designers seek to match the look of characters to storylines that contain increasingly exaggerated performances, character designs that are clearly abstract and stylized are combined with sets that are realistically rendered. A good example of this merging of stylized with realistic is in the Pixar short *Presto* released in 2008. (Fig. 3.22) The main characters are very stylized (man and rabbit) in appearance and movement surrounded a less stylized environment. Judging by the popularity of recent releases that employ abstracted character designs, audiences are accepting of stylized characters in realistic sets.

This section has been devoted to the basic building blocks of volumetric form (points, lines, and planes) and the perception of 3D form as an overview of the foundational elements that influenced the decision making during the applied studies. Transitioning from 2D to 3D form requires a consideration of multiple angles of view. It may not be an easily understood conversion process. For designers to think in two and three dimensions concurrently, an understanding of how silhouette exists in both visual domains is helpful. A silhouette exists in 2D by its pencil-drawn boundary or knife-cut edge in paper collage. The silhouette of a 3D form changes as the object is rotated or the viewer orbits the form. Inner edges become outer edges as the angle of view changes. The key to moving between the visual domains is to remain aware that points, lines, and planes exist in both flat and dimensional form. Two-dimensional form can appear three-dimensional just as the reverse is true. Without proper delineation under light 3D form can appear flat. Knowing that the vision of elements in three-dimensional space is constructed of quick succession of scanned images by the viewer should influence the design of form to delineate well under light to send clear messages to the viewer. To accomplish this, geometric simplification has been used throughout modern art history and is applicable today in 3D character design. Many examples of geometric reduction of complexity for clear visual recognition and stylization were provided.
Conclusion

This study identifies Selective Media Leveraging as a useful strategy in the ideation phase toward uncovering of hidden design possibilities. The behavior of selectively leveraging different media at precise moments for answering design questions is an action-based strategy that has the potential to fully develop ideas toward becoming unique and impactful design solutions. The core strength of the strategy is its flexibility to move between 2D and 3D media actions as needs dictate. It is important for a designer to acquire a reliable ideation strategy that effectively solves a wide range of design problems. One generally held belief is that generating many ideas improves the chance that at least one of the ideas will have great potential. A skilled problem-solver armed with a tried and true strategy that incorporates the designer’s experience, abilities, and passion for creative thinking can generate great quantities of ideas that are both fluid and flexible. A fluid idea generator excels at rapidity of ideas. A flexible idea generator finds a variety of distinctly different ideas. The ideal strategy bridges these two types of idea generators and can be relied upon for forming paths to take toward diverse and efficient idea generation and ways to express ideas.

The media types used in Selective Media Leveraging for the applied studies described in chapter two possess unique capabilities that can be utilized at the appropriate time. The capabilities of each media type are summarized in Figure 4.1. By way of the applied studies it has been the goal to demonstrate the capacity for Selective Media Leveraging to improve problem solving within design ideation through informed use of media actions.
Creative actions serve as sensory stimulants activating an inquisitive mindset. Being predisposed to discovery and chance allows the uncovering hidden design possibilities to happen. Whichever ideation strategy a designer uses it should be conducive to expand thinking about the problem in more than one way. One way to achieve this is by analysis, concept, and synthesis. 63 In other words, take something apart (through research), decide on its meaning (through drawing and creative experiments), and then assemble a unique solution (through abstraction and stylization) based on evaluation.

Discovery through creative action is an inertia-breaker. When creative thinking is inert it needs a jumpstart. Generating momentum is the first step to idea flow. Momentum steadily accumulates as one discovery leads to another and one question leads to an answer, which leads to another question, and so on. Ideation is a series of questions asked by the designer to himself.

<table>
<thead>
<tr>
<th>Research</th>
<th>2-D Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeds the imagination</td>
<td>Reveals ideas by experiment and chance</td>
</tr>
<tr>
<td>Gathers knowledge about: shape, texture,</td>
<td>Expands the conception of possible forms through exploration</td>
</tr>
<tr>
<td>emblematic features, how? and why? of</td>
<td>and synectic design</td>
</tr>
<tr>
<td>construction and function, the surrounding</td>
<td>Capable of making associative connections from</td>
</tr>
<tr>
<td>context of existence</td>
<td>flat, silhouette shapes to more complex form</td>
</tr>
<tr>
<td>Defines parameters of design</td>
<td>Working with mass (cut-paper) rather than line</td>
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<tr>
<th>Drawing Exploratory/Developmental</th>
<th>Sculpting</th>
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<tbody>
<tr>
<td>Flexible (achieved on any surface)</td>
<td>Tangible (achieved through direct touch)</td>
</tr>
<tr>
<td>Implies dimension</td>
<td>Fully-interactive angles of view</td>
</tr>
<tr>
<td>No physical limits of actual space (gravity)</td>
<td>True representation in actual space</td>
</tr>
<tr>
<td>Promotes analysis of the observed object</td>
<td>Delineation under actual light source</td>
</tr>
<tr>
<td>Capable of simplifying complex shapes</td>
<td>Plasticity to make changes easily</td>
</tr>
<tr>
<td>Externalizes ideas quickly</td>
<td>Promotes comparison of parts within the whole to understand</td>
</tr>
<tr>
<td></td>
<td>unity, contrast, balance, and proportion</td>
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<table>
<thead>
<tr>
<th>3-D Media</th>
<th>Software Massing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Considers design in actual space</td>
<td>Economy of form shaping using software primitives</td>
</tr>
<tr>
<td>Bridges drawing to 3D form</td>
<td>Focus on shape alone to communicate personality</td>
</tr>
<tr>
<td>Manipulates solid mass responsive to light</td>
<td>Overlapped shapes remain separate for easy changes</td>
</tr>
<tr>
<td>and shadow</td>
<td>Promotes thinking in mass to feel form in its entirety</td>
</tr>
<tr>
<td>Promotes awareness of transitioning planes,</td>
<td>Disregards small details until basic form is established</td>
</tr>
<tr>
<td>proportion, and volumetric attributes</td>
<td>Can remain simple geometry or made more complex</td>
</tr>
</tbody>
</table>
These include “what, could, which, how, if, is, why, and where?” As in what does this remind me of? Could this shape be combined with this one? Which of these ideas has the most potential? How will the viewer perceive this form? If the form is viewed from this angle is it legible? Is there a way to make the features more expressive? Why do elements of the form seem disproportionate? Where have I seen similar shape characteristics before?

For implementation to be most effective the designer must possess experience with tools, materials, and art principles. Selective Media Leveraging is a design strategy that assumes a level of experience in its users that is post basic design or art school training. Decisions are made by the designer utilizing media as the vehicle to employ design principles. There are many design principles that a designer is expected to understand: unity, emphasis, contrast, variety, balance, proportion, rhythm, positive and negative space, repetition, organization, texture, and pattern. Proficiency with tools and experience in drawing, sculpting, arranging, and visualizing in two and three-dimensions are important skills in support of using Selective Media Leveraging. Finally a familiarity with art history and examples of visual abstraction is helpful for directing research that triggers the imagination.

For some designers and students transitioning between 2D and 3D form may not be an easily understood conversion process. Proposing a strategy toward solving design problems is done so under the realization that designers think in many varied ways and have different talents and skills with creative media. There is also the awareness that constraint of time can force ideation to conform to a more linear approach of sketching to final modeling. There are no universally accepted ways or means to generating design solutions. The purpose in identifying the Selective Media Leveraging strategy raises the awareness of an ideation process that designers engage in already at some level. Visualized as as an ideation cloud of 2D and 3D actions all feeding the idea, this allows designers to view the process as a whole, conscious of its collective power.
A possible next step in the recognition and use of Selective Media Leveraging can be to develop a design course that focuses on the personal ideation process of students. This course could be designed to be taught in the third year of a design program, working under the assumption that students have previously had introductory courses in basic graphic design principles, some historic research, as well as a first-year foundational drawing training. Varied levels of experience with different media could be addressed through collaborative learning. Students with strength in 2D visualization or 3D visualization could be intermingled to work as teams generating design solutions. Students would be encouraged to experiment, search and discover methods of working that lead them to successful results. Students’ processes would follow an integration model of media actions similar to Selective Media Leveraging used for 3D character design.

The Selective Media Leveraging strategy can be tailored to generate design solutions for various design fields: industrial design, fashion design, interior design, and landscape architecture to name a few. The categories used for organization within the ideation cloud would remain but the media within the categories can be exchanged with possible variants being the use of pastels, paints, foam balsa, plaster, cloth, wood, and various imaging and design software. In all form design problems there are questions to be answered about the essence of the problem, shapes that conjure feelings or associations from viewers, and variations of possible shape solutions. These questions and others span the entire design process. Within ideation there is a microcosm of the larger design process involving the reduction of problem elements to basic needs and functions, selection of design directions to pursue, application of creative actions toward resolutions, and the integration of discoveries made and ideas sparked into a cohesive design solution.

The applied studies showed the use of Selective Media Leveraging for developing 3D characters for animation without the constraints of an existing story or script. This is applicable to animated short filmmakers and students open to a freeform search for character and story ideas.
that evolve through experimentation and ideation. Use of the strategy for design problems with constraints can be tailored to expand thinking for specific needs. This would mean concentrating on the core functionality and purpose of the form to be designed, be it a character within a story or a product intended for a particular audience. A product that has no basis of form would begin as an abstract shape to be evolved into communicative form that triggers associations in the mind of the viewer. For example if the core purpose of a product relates to speed, then form search within the Selective Media Leveraging strategy would progress based on visual research of movement, velocity, flight, racing, streamlining, and the like so that the design would carry form details that suggest speed. The use of media actions like exploratory and developmental drawing, collage, sculpting, and software massing would generate a progression of ideas to be evaluated and built upon toward communicating function or personality through stylization.

The unique strength of the Selective Media Leveraging strategy is expressed by the lines within the diagram (Diagram 1.2) that represent pipelines between media actions and the idea by which answers to design questions flow in a direct and fluid manner. The core strength of the strategy is action-based ideation that flexibly integrates media types based on the answers each media can provide and focuses creative thinking by externalizing form ideas so that they can be evaluated and fully developed.
Endnotes


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