Improving Design for Sequential Instructions

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Improving Design for Sequential Instructions

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Contents

Thesis Definition

Introduction

Developing effective instructions for complex, sequential tasks is a challenging information design problem. The focus of this thesis is on the non-verbal, visual explanations. This thesis attempts to define a set of instructional communication standards necessary to develop highly functional graphic design solutions to complex instructional information.

These standards are then applied to free-weight instructions to improve their clarity and usability. Free weights, or dumbbells, are heavy-weight, metal bars that are lifted in repetitive steps to gain or tone muscles through resistance. When attempting to use currently available free-weight instructions, most people are unsure how to interpret them. This can lead to unnecessary confusion, and even injury in some cases. An established set of standards that simplifies and clarifies sequential visual explanations will result in less confusion and fewer injuries.

It is hoped that these standards for instructional design will be useful to a wide range of similar design problems where complex, sequential instructions need to be conveyed with clarity, simplicity and grace.

Documentation of Need

There are many graphic design standards that already exist within instructional design. The importance of this thesis is that it will help those in the graphic design field to clarify specific considerations necessary to successfully communicate instructional content successfully. Society will benefit from this thesis which serves as a model for improving information design. While researching, this designer expanded her knowledge of instructional design and through this thesis brings to the graphic design field a set guidelines that will further organize the standards for solving complex instructional design problems.

Situation and Audience

The main audience for this thesis study consists of graphic designers and students who have worked in, or are familiar with, information design. The main audience for this thesis application are adults who are introductory, intermediate or advanced level, free-weight lifters, male or female.

Mission and Goals

This thesis will help to further define standards for instructional design, resulting in the effective communication of sequential tasks. This author will define and emphasize the important considerations of sequence, characteristics of pictorial imagery, use of color, and a range of visual variables that contribute to effective instructional design.

The goal of this thesis application is to employ the newly defined set of design considerations in an instructional poster explaining the correct procedure for doing the concentrated, bicep curl, weight-lifting exercise.
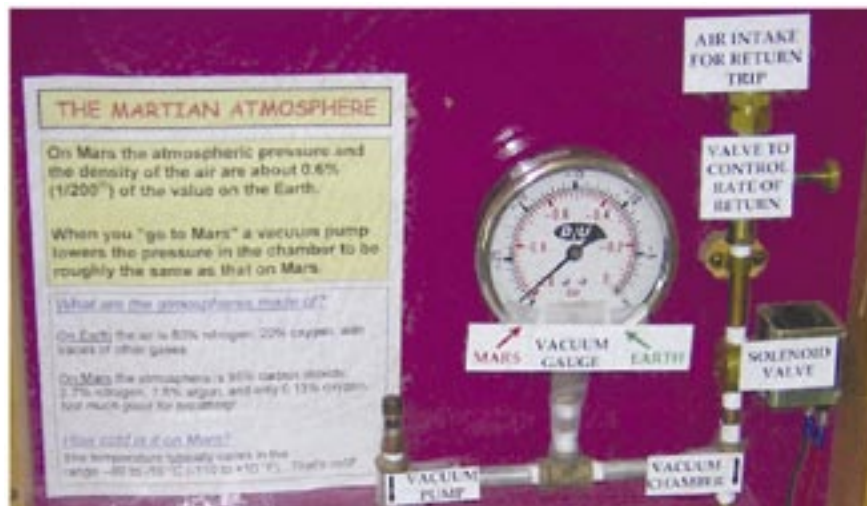
Precedents

The Children's Sciencenter

The Children's Sciencecenter is a two-story center that is located in Ithaca, New York. The Sciencenter has many instructional and informational activities from which children can gain knowledge. Children can follow the written instructions near each game or hands-on activity to learn specific scientific and environmental issues while also having fun. Many of the instructions are not easy to read, especially for young children. The mix of different labels, colors, formats, use of all capitals and upper and lower case typography, and lack of clear hierarchy makes the instructions unnecessarily complicated to follow.

Impact

The impact of this precedent on this designer is it shows that the instructional design is not effective because of the use of too many variables. In addition, the choice of typeface and the style of language is inappropriate for the audience. The use of multiple colors is confusing to the user and makes it difficult to read the directions.

Martian Atmosphere Activities
Children's Sciencenter
Ithaca, NY

Precedents continued

Will Burtin

Will Burtin was accomplished in typography and design. He practiced design in Germany before moving to the United States in 1938. He worked for the Unites States Army Air Force designing graphic communications and exhibitions before becoming art director of *Fortune* magazine in 1945. In 1949, he started his own design firm. Burtin translated complex information into visual solutions that are easily understood. He used clean lines and shapes to make images more accessible, and cinematic techniques of silhouetting and repetition to clarify sequence and motion. For example, in the spread from a gunnery manual pictured below, the headings for each step are bold and the detailed instructions are a lighter weight, but the same size. The images are detailed and photographic, yet cropped to show only the necessary information.

Impact

Burtin's attention to detail and his ability to reduce large amounts of complex information into clear, effective solutions makes this designer more aware of the interrelationships between text and imagery in a layout. As a result of studying the work of Will Burtin, this designer has a better understanding of type, weight, and structure in relation to an image within an instructional design context.

Burtin, William. "Design and Communication. *Education of Vision*. Ed.G. Kepes. New York: Braziller, 1965: 62

Illustration in Graphis No.22 ; 1948; to demonstrate The Visual Flow, a page from US Army Training Manual, c1944. The dotted line is the eye's first passage over the page. The dashed line is its second passage.
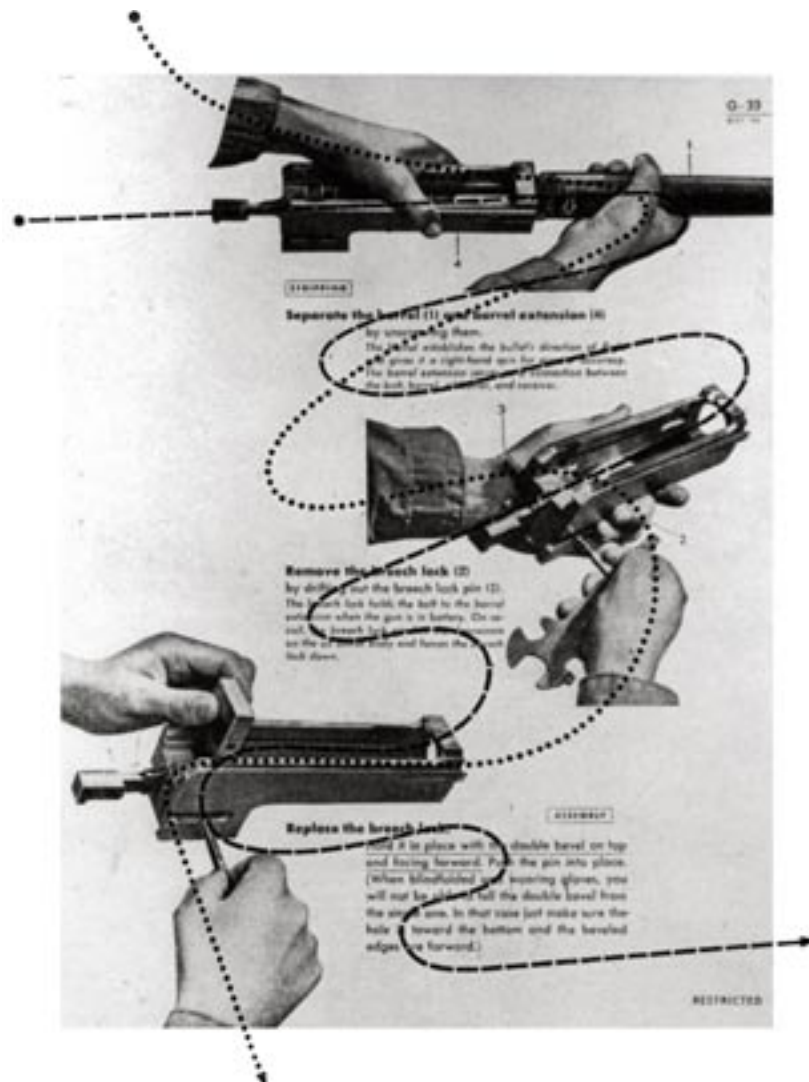
The Photographic Sequences of Duane Michals
Duane Michals is a poet, philosopher, and photographer. Michals combines poems and short stories with his images, and photographs are often arranged in a consecutive sequence to tell a story.

Impact

By looking at Duane Michal's photography, and the steps he takes to tell a story, this designer becomes more aware of how information can be conveyed in a sequence over time. The process Michals uses to develop a storyboard has an impact on how this designer views and interprets sequence. Michals' use of photography informs this thesis by providing an example of movement through time using only images. The images clearly show each sequential step without showing any unnessary steps that could confuse a viewer.

Michals, Duane. *Photographies, Sequence, Text.*
Oxford: Museum of Modern Art, 1984: 60

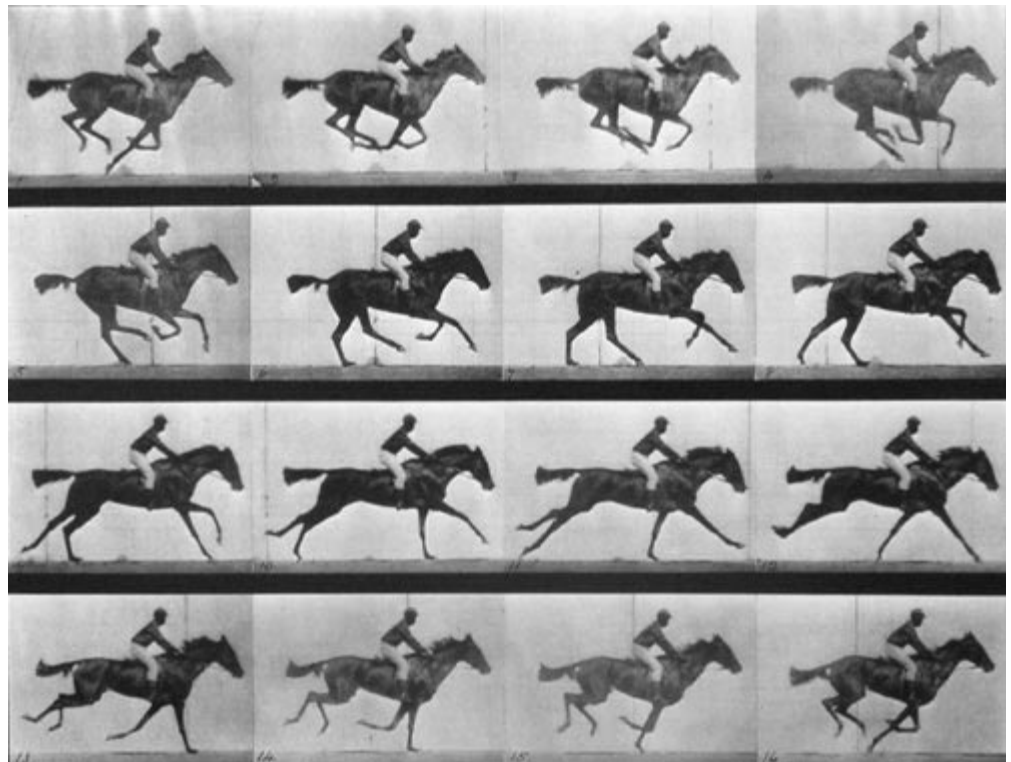**Precedents** continued

Eadweard Muybridge

Eadweard Muybridge was a photographer "who gained worldwide fame photographing animal and human movement imperceptible to the human eye. Muybridge used photography to prove that there was a moment in a horse's gallop when all four hooves were off the ground at once. He produced thousands of images that captured progressive movements within fractions of a second" (Muybridge 10).

Impact

Eadweard Muybridge was the first person to photograph a set of serial images of fast motion. To successfully capture the images of sequence and motion, he photographed race horses. "He took twelve cameras, equipped with a 'fast' stereo lens and an electrically-controlled mechanism to operate the cameras' special shutters. The twelve pictures were taken in about half a second" (Muybridge 20).

This designer thought that using Muybridge's idea of fast-motion photography, and taking a series of pictures of the bicep curl movement, would allow users to see the step-by-step movement they would actually be doing in the bicep exercise.

Muybridge, Eadweard.
Animals in Motion.
New York City: Dover,
1957: 20

Edward Tufte
Edward Tufte is a statistician, Yale professor and author of three books on the
visual presentation of quantitative information. He recommends clarity and accuracy.

Impact

Tufte has inspired this designer to improve instructional design by
designing free-weight diagrams that are unique and easily understood.
The two examples below contain the same information, each displaying
numerical data. The graph on the left shows the data within complex boxes.
The graph on the right removes the complicated boxes and just uses lines
and spaces to show the amount of data. This helps emphasize the numerical
data without unnecessary, complicated lines.

These graphs display numerical data

Tufte, Edward.
*The Visual Display
of Quantitative
Information*.
Cheshire: Graphics
Press, 1983: 125
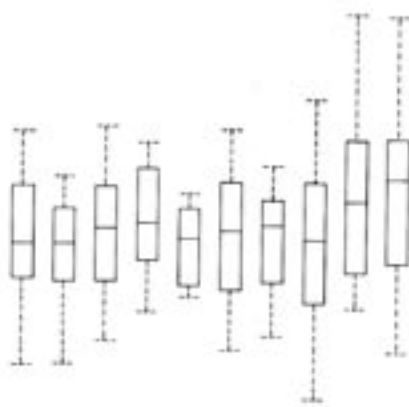
Similar to a column bar graph, the box
graph is a more complex unit comprised
of a line that shows a flexible range, an
internal box that shows the distribution of
data within the flexible range, and a mean
or average within the range.
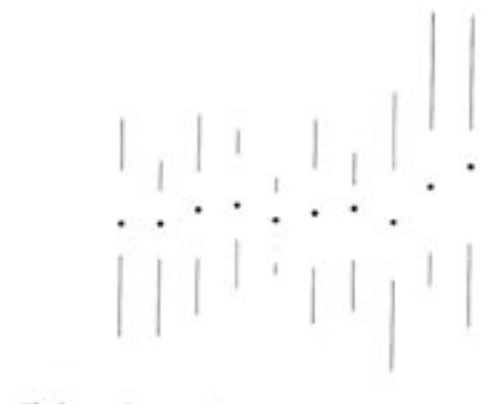
This is a more visually efficient alternative
where dots prepresent the mean or
average, and the box represent the
flexible range is implied. All unecessary
lines are removed. Emphasis is on data
not on non-data.

Research

The first step this designer took when researching the topic of instructional design was to look at the role psychology plays when writing and designing instructions and to look at how information is worded and delivered in instructions.

The second step was to look at how designers organize information and images when designing sequential instructions to learn how sequential imagery is placed and how the format of the imagery and text work together in an application. This step involved gathering instructional design examples and identifying their specific visual variables, such as transparency, sequence, motion, color, line, labeling, detail, numbering and arrows. These attributes were then categorized and documented as effective or ineffective. The synthesis section of this thesis will clearly show visually why certain instructions could be ineffective and effective, by comparing different types of instructions. Specific guiding principles were derived to show designers what should be considered when designing instructional diagrams.

The third step was researching photography. Photography was explored to determine the range of ways in which photographic images can be used to convey information, particularly sequential information.

Finally, verbal instructions were explored so this author could determine the amount and kind of text needed to support the instructional imagery; however, verbal instruction was not a primary focus in this thesis.

Psychology

Viewers learn more effectively from information that is organized and structured in a sequence. The sequence of information is about what comes first, what comes second, and so on. Sequencing involves "the selection and organization of the knowledge, skills, and additional factors of any topic" (*Kemp 44*). It was important in this research for this designer to focus directly on the order in which an illustration or image shows the correct order of movements.

When researching in the field of psychology, this designer discovered cognitive learning. "Cognitive research points out that the short-term memory of humans can easily be overloaded with new material and that careful pacing, structuring, and sequencing assists the learner with processing new information" (*Shambaugh and Magliaro 89*). Cognitive learning theory is a general approach that views learning as an active mental process of acquiring, remembering, and using knowledge. Learning is evidenced by a change in knowledge which makes a change in behavior possible. Learning itself is not directly observable.

Cognitive learning theory identifies three kinds of memory in the human brain: sensory, working and long term. The sensory register is a system of receptors which holds sensory information for a very brief period. It retains an exact image of the information as it occurs; however, since retention of all stimuli exactly as seen, heard, smelled, felt, or tasted would quickly exhaust the capacity of the sensory register, this information lasts but a split second. Only the things perceived to be needed are moved into working memory.

Working memory is also known as short-term memory. Information from the short- term memory registers what is being focused on at a given moment, and that information can be held for approximately twenty seconds without repeated rehearsing of the information.

Long-term memory is the place where the brain permanently stores information. It appears to have an unlimited capacity. The problem of remembering lies in the method of retrieval, for example remembering a series of numbers, rather than loss of information.

Psychology indicates that people perceive information differently depending on their knowledge of the verbal or visual language being used. Their education level also contributes to how well they understand instructions.

Design

Paul Mijksenaar is one of the designers who came to mind when this author first started to think about this thesis topic. Mijksenaar feels "that if most people know that they are going to get a long complicated manual with the product they're buying, they will buy it anyway but almost always never use the manual" (Mijksenaar and Westendorp 23).

He also states in the book, *Open Here*, that, "Any instruction is the same whether giving driving instructions or reading instructions for a complicated electronic device. If the language and visual representation is unclear, you will have problems" (Mijksenaar and Westendorp 23).

In his book, *Visual Function*, Mijksenaar also talks about "developing and designing instructions that include their capabilities, dimensions and their limitations" (Mijksenaar 49).

The examples in Mijksenaar's book emphasize the importance of including not only the correct ways, but also the incorrect ways to complete an exercise.

This example indicates the part of the CD that should not be touched.

This example indicates the right way to pick up a CD.

This example shows the the incorrect way to dispose of trash.

This example shows the correct way to dispose of trash.

Mijksenaar's book also says that visual information makes full use of new imagery that is usually borrowed from another discipline such as film, photography and sometimes from technical illustrations and comic strips. For example, a series of comic strips could be combined into one illustration. That one illustration then could be used as a single icon to help identify the comic book company.

Research continued

Photography

Muybridge was the first photographer to capture moving objects in sequences. He developed a way to photograph fast moving objects in a way that was clear and in consistent order.
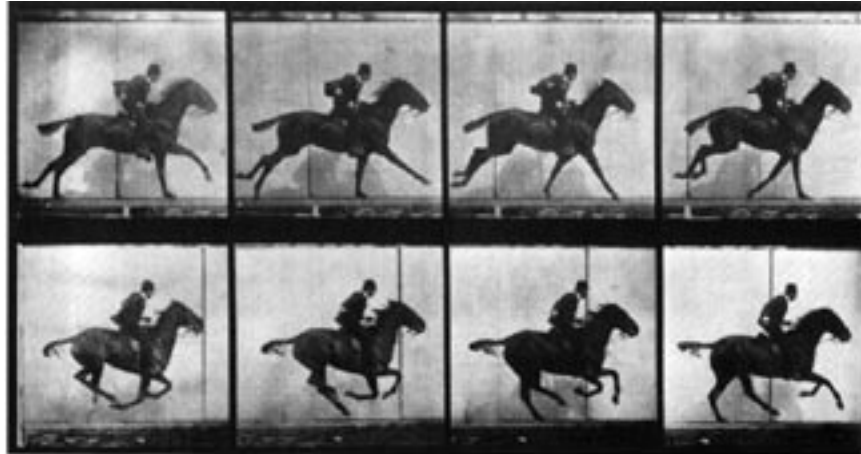
After looking at Muybridge's photographs of sequence and motion, this designer had the idea to photograph a model doing the specific exercise of the bicep curl from different points of view. From these photographs, this designer could actually see the steps taking place in a sequence.

Information Design Journal, mentions that orientation, color, texture, value, size and shape are continuous fundamental visual when designing instructional illustrations. Using these visual variables allows this designer to come up with her own visual variable attributes which consist of transparency, motion, numbering detail, value, color, weight, sequence, arrows, and orientation. After listing these attributes, this designer listed the effective and ineffective examples for each of the variables and identified the most important attributes that she could use when designing the visual instructions.

Verbal Instructions

Verbal instruction is not the main focus of this thesis, but it is a part of the final application and was examined with pictorial and sequential instructions.

When writing verbal captions to be used in conjunction with sequential instructional imagery, text needs to be simplified so that the image will be the more dominant element when viewing sequential instructions. When designing instructional diagrams, it is important to determine which parts are most important. Appropriate terms, language and imagery that reinforces the instructions should be thoughly researched.

Research continued

The article, *An Exploratory Study of Reading Procedural Pictorial Sequences*, states that "verbal language and reading directions are generally used to follow pictorial sequences" (Spinillo and Dyson 158). However, when the "graphic configurations used to represent sequences are unfamiliar and the starting point of the sequence is not clear in the configuration, pictorial content influences the reading direction" (158). An example of this problem is shown below. It is a person demonstrating how to use a side horse. The arrows show the direction in which the person is moving around the horse.

Cooper, J. M. and
Glassglow, R. B.
Kinesiology.
Saint Louis:
The C.V. Mosby
Company, 1972: 12

In the same article, Spinillo and Dyson also state, "Among the results of studies in pictorial sequences, there has been a suggestion that verbal language reading directions and picture content (meaning of the picture) may affect the ways such sequences are read… This refers to pictorial sequences in which no verbal or numerical elements are provided" (Information Design Journal 86).

This author learned from the Informational Design Journal article that orientation, color, texture, value, size and shape are continuous fundamental visual variables to carefully consider when designing instructional illustrations. These visual variable attributes of orientation, color, texture, value, size and shape should be considered every time an instructional diagram is made so the finished design is clean, accurate and easily readable for all viewers. Even where a main image and text are placed on the page is important. If the image is placed before the text, then it is likely the viewer will look at the image first and then the text. If the text contains important information that is not clear in the image, then the text should be placed before the image.

Synthesis

The synthesis section of this thesis has two parts:

1 Part One: Basic Concepts from Psychology

This part consists of developing a category of basic concepts that governs content, language (clarity of wording, amount of text and relationship of text and imagery), memory comprehension (how much does a person remember at one time) and visual presentation (how well is the diagram precieved by the human eye.

2 Part Two: Basic Visual Attributes of Imagery

This part consists of examples of instructions that were found for exercising, weaving, camera operation, diaper changing, and sign language. The examples are of combined imagery and verbal language that were analyzed to form specific ideas. Elements in these examples are categorized as effective and ineffective visual variables. The visual variables used are orientation, directional arrows, color contrast, numbering, transparency, complexity of detail, value contrast, weight contrast, sequence, directional lines, and motion. These categories are found within every instructional image that this author explored. These variables can be used when designing pictorial instructions.

After researching the range of visual variables, this designer isolated the most important attributes which were sequence, transparency, directional arrow, color, and motion and started to explore the different ways that the visual variables could be used within a photograph. This designer decided these were the most important attributes by assessing the effective and ineffective visual variables in the comparative matrix.

This designer took many sequential photographs of a bicep lift and determined how many photographs would be required to develop a logical sequence of imagery. Three consecutive photographic images were selected and given to a medical illustrator who combined the three images into one. (View 3 photographs and the final illustration on the next page)

The illustrator drew a muscular drawing over the arm, embodying the most important attributes of color, shape, arrows, transparency and sequence. The color blue was used to fill in the bicep and the outline of the arm. Each arm is done with a different opacity level to help show the arm's actual movement. A single arrow was also used to show the arm moves in an upward direction. (See images on page 13)
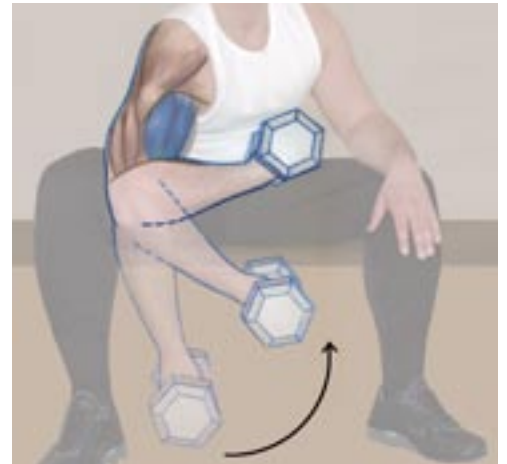
Synthesis continued

Photo 1

Photo 2

Photo 3

Final Illustration

Synthesis continued

Part One: Basic Concepts from Psychology

Cognitive Process
The Cognitive process relates to the brain, and how the brain interprets information.

Memory
The amount of memory is how much or how many steps can be remembered at one time. The active mental process is the act of acquiring, remembering, and using the knowledge gained at any given moment. The short-term memory registers what a person is focusing on at a given moment. Information can be held for approximately twenty seconds without maintenance rehearsal. Maintenance rehearsal means the repetition of material to keep it in the working memory for a while. Long-term memory is the place where the brain permanently stores information and is unlimited in capacity. The problem of remembering lies in the method of retrieval, for example, remembering a series of numbers.

Visual Comprehension
Visual comprehension is how a person interprets images or instructions depending on the person's prior knowledge. For instance, for people to understand specific instructions, they have to have basic a knowledge of the subject matter, the relevant vocabulary, and basic reading and problem-solving skills that are learned in elementary school.

Language
Language considerations are used within psychology research; they come into play when writing instructions that pair with a diagram. For instance, when reading a diagram that is an example of how to perform a particular movement in a sequence you can use the language (text) as a reference to refer back to, if you don't understand a part of the diagram. Language refers to the sentences that accompany a diagram. Language provides explanation for parts of the diagram. Considerations include specificity and clarity of content.

Layout and Placement
Layout and placement is the arrangement of text within instructions. For instance, if text is placed too far away from the imagery that is being explained, the reader might become confused and read the instructions improperly. Also, if the reader is supposed to focus on the diagram and try to interpret the diagram first, then the text should not be placed before the diagram.

Limiting Amount of Text
By limiting the amount of text, the viewer will be able to remember the steps of the instructions more easily. If there are more than six lines of text for each step, it is then best to separate the most important parts of the step and put them under a specific heading or title, and then bullet each specific step. For example, *Preparation, and Start of an Exercise* are the two main headings in the application. They are separated so the viewer can prepare before the actual exercise starts. The first bullet shown under the *Preparation* heading is "sit on the edge of the bench", which prompts the viewer to be ready for the exercise sequence to start.

Synthesis continued

Part Two: Basic Attributes of Imagery

Detail of Line
Having too many lines within an illustration can create confusion.
The fewer the number of lines, the easier it is to recognize and comprehend
the image.

Size
The format size is important so that the text and imagery
is readable. For instance, if the text size is too small, viewers will be
less likely to read the instructions or have difficulty reading them.

Color
Color can be used to identify and isolate specific parts of the image.
Too many colors in an image can be distracting and confusing.

Color Contrast
Do not use contrasting colors that are similar in tone. The viewer may not
be able to separate the two colors from each other and they might also see
something to separate the two colors from each other and they might also
see something different other than what the designer intends to portray.

Symbols
Symbols can be arrows, dotted lines, or color mapping. They all can be used
to show a flow of direction within a diagram. Transparency can be used to
separate directional flow by using dark colors to show the beginning of
a motion or movement and a lighter more transparent color to show
a gradual ending

Movement or Motion
Determining how many steps it takes to show a specific movement in
a specific instruction. There are many steps within an exercise.
Each movement has an important role within the direction of motion.

Orientation or Placement
Orientation or placement is the arrangement of image and text. When reading
a diagram, the viewer should be able to recognize the difference between a first
step and a last step. The imagery and text within the diagram should be properly
labeled and placed in the best and clearest position within the instructions.

Orientation of Pictorial Sequence and Visual Organization
Orientation of pictorial sequence and visual organization is how verbal
language is generally used to follow pictorial sequence. Verbal language
should be used as a reinforcement for the imagery. The imagery should
have primary emphasis and be reinforced by language (a secondary emphasis).

Synthesis continued

The examples of instructions shown next were found in books, magazines and instruction manuals. The visual attributes in these examples were separated into categories of effective and ineffective visual variables. The visual variables are: orientation, directional arrows, color contrast, numbering, transparency, complexity of detail, value contrast, weight contrast, sequence, directional lines, and motion.

These attributes were chosen based on researching the visual variable examples. This designer reviewed and collected many visual instructions and exercise instructions to determine what would be the most effective way to use the many attributes that were discovered. The most effective attributes and ineffective attributes of each instruction were listed to determine which are the most common and best visual variable attributes.

After rating the attributes, some of the original variable terms were combined and some terms were simplified, such as color contrast, hue and color blocking. For instance 'color blocking' was changed to the simpler word, 'color' and 'directional lines' was changed to 'arrows'.

The guiding principles were determined by the ineffective and effective variables of all the instructions that were collected and then this designer determined which variables should be clearest and easiest to read.

An ineffective variable could have too many variables within one pictorial instruction. This causes the viewer to become confused and makes the attributes ineffective. For instance, if a pictorial instruction is detailed with too many lines and words overlayed on top of the lines, plus a different color that indicates a single line, this instruction is ineffective. The viewer would not know what the instructions are trying to convey.

Visual Variables: **Value**

Effective

Weaving

The darker value string indicates which string should be pulled first. The darker value is the piece focused on first.
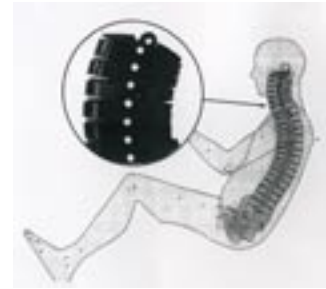
Body

A darker color value can be used to emphasize certain sections.

Guiding Principles

Value can be used to separate elements within a step by step procedure.

Value can identify specific sections within one image.

Ineffective

Diaper Folding

There is not enough contrast in colors to distinguish the background from the foreground of the object. The values are too similar.

Seat Diagram

The two contrasting colors do not separate the parts of the seat from the arms well enough.

Visual Variables: **Transparency**

Effective

Forearm Exercise

Thin lines concentrated in one
particular section show specific
muscle groups within the forearm.
This reveals what is invisible in
a solid figure.

Figure 7.21 Finite element dummy.

Model Diagram

The use of different transparencies
and gradient patterns helps to
distinguish different sections of
the model.

Guiding Principles

Use of concentrated lines
within a simple figure drawing
reveals what is invisible.

Overlapping transparent tones
helps to show different sections.

Ineffective
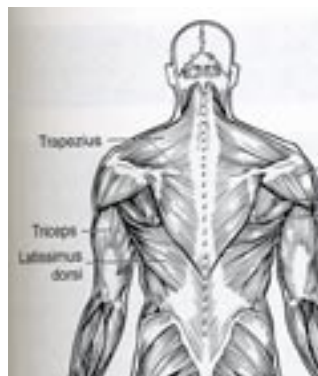
Skeletal Model

There is too much line detail in
this skeletal diagram.
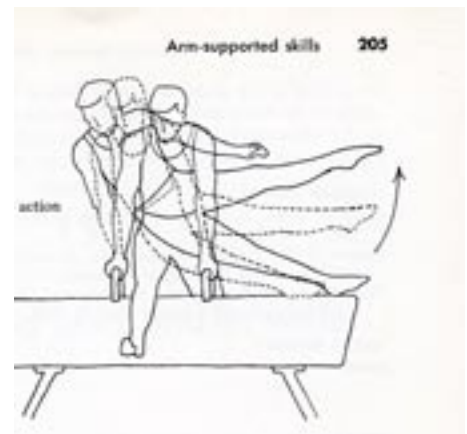
Horse

Too many overlapping figures make
it difficult to view the position of
the body at any given point in
the sequence.

Visual Variables: **Sequence**

Effective

Hurdlers

A figure shown in motion in
a step-by-step order shows
movement in a sequence.
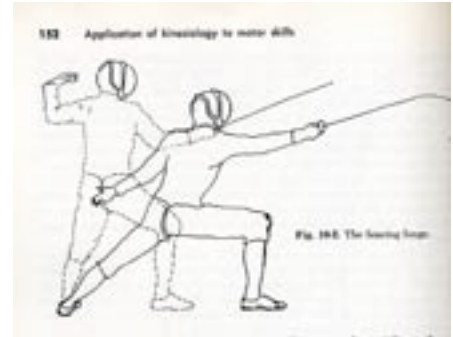
Fencing

Dotted lines that overlap a
solid line help identify
different motion sequences.

Guiding Principles

One step followed by another
indicates a sequence is being used,
but too many unnecessary steps
can be confusing.

Dotted lines shown individually in a
sequence can be easily recognizable,
but too many solid lines with a dotted
line can be hard to comprehend.

Ineffective
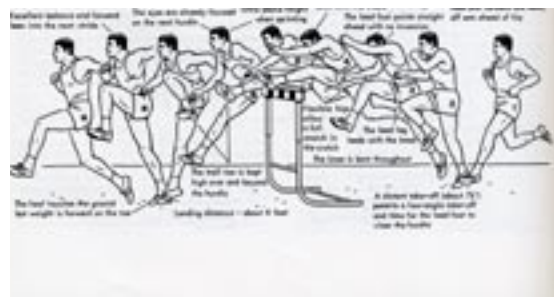
Hurdlers

There are too many overlapping figures
in this illustration to see and understand
the action being conveyed.
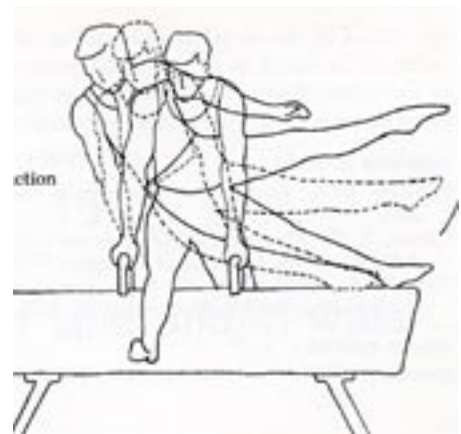
Horse

It's hard to determine the number
of sequences because there are
too many overlapping lines.

Visual Variables: **Motion**

Effective

Basketball

Using two kinds of lines to separate
the two parts of an illustration helps
show the direction of motion.
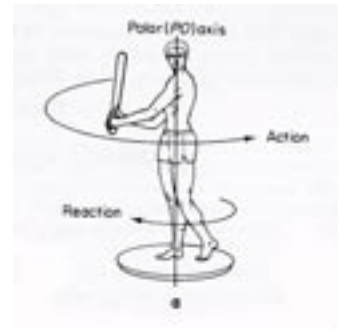
Pivoting Baseball Player

A sequence of illustrations to
show key positions, accompanied
by simple arrows, helps to
communicate the actual pivoting
motion of the player.

Guiding Principles

Different kinds of line width can help show
the position of movements. Showing
different arm orientations within motion
can also help represent different positioning.

A sequence of images with a specific
pivoting point shows different
orientations, that combine arrows
which help to show correct movement.

Ineffective
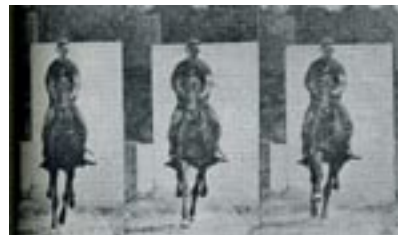
Horse Racing

This illustration only gives a frontal
point of view to show movement.
Showing one point of view for human
or animal movement is not enough.

Lifting

This illustration only shows one side
of the lifter, or one point of orientation.
Identifying proper placement of the
elbow in relation to the body is
difficult to see.

Visual Variables: **Less Detailed vs. Detailed Line Drawings**

Effective

Basketball

A less complex line contour showing smooth curves makes the diagram easy to read.

Lifting

When showing the movement of the lift, it is easy to identify the degree of motion because of the use of simple lines.

Guiding Principles

Separate kinds of line width can help show positioning of movement.

The detail of a simple line arrow can show movement within an exercise. Do not use too many lines that describe specific parts in a drawing.

Ineffective
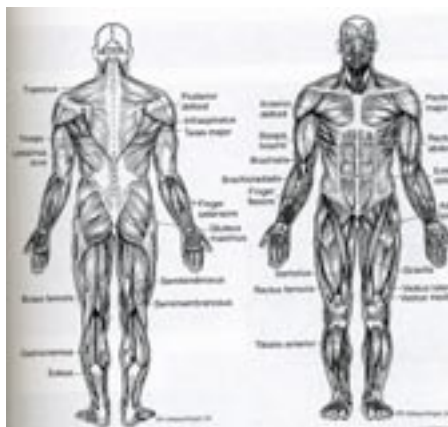
Skeletal Muscles

The number of contour lines in this diagram makes it difficult to identify specific parts of the body.
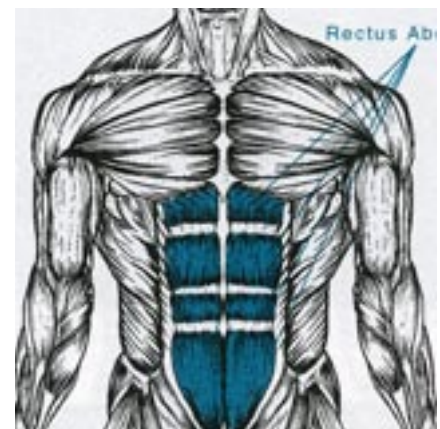
Abdominal Muscle

The similar lines in this diagram make it difficult to identify specific muscle groups.

Visual Variables: **Color**

Effective
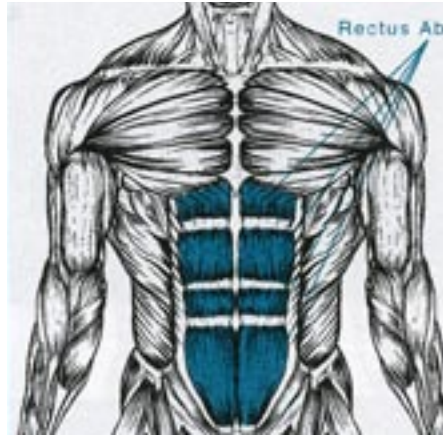
Abdominal Muscles

A single color is used to show the specific muscle groups in this drawing. The color separates one muscle group from another.

Sign Language

A dark background separates the yellow hand from the background.

Guiding Principles

Color helps emphasize specific sections. The use of color can separate individual parts.

Contrasting colors help distinguish primary objects from the background.

Ineffective

Nose Spray

There is no color to differentiate individual objects.

Diaper Folding

There are no contrasting colors to distinguish the folded panel from the table surface. (white on white).

Visual Variables: **Numbering**

Effective
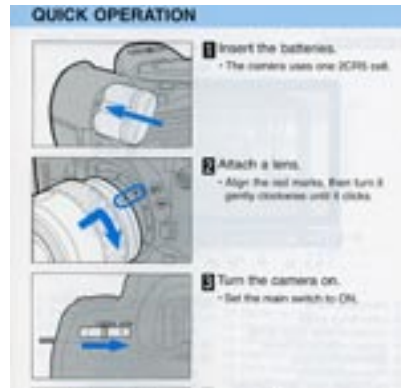
Camera Directions

Each step uses reversed white numbering on bold rectangles to identify consecutive steps..

Diaper Changing

Numbers located in the corner of the photograph surrounded by color make the instructions easy to follow in a step–by–step order.

Guiding Principles

Bold numbering helps the viewer locate the consecutive steps.

Bold numbering and headings located in the upper corners of the instructions help the viewer to determine the order of steps more easily.

Ineffective
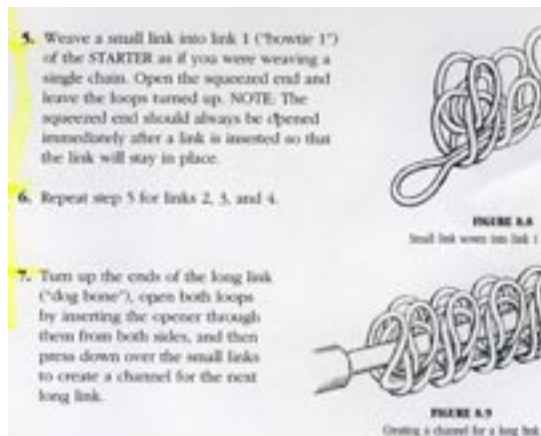
Weaving Instructions

The numbering system on the diagrams is not consistent because the figures are not numbered the same as in the written instructions.
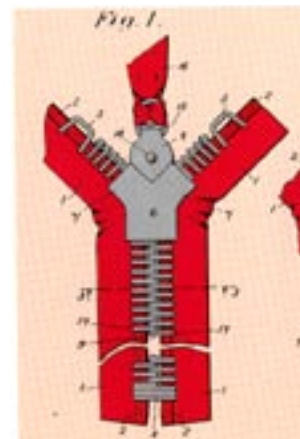
Zipper

There are too many unreadable numbers.

Visual Variables: **Color and Arrows**

Effective

Camera Directions

The shape and color of the arrows
on a contrasting background helps
indicate direction.

Ink Cartridge

The red arrow is used to show the
proper direction to remove
the old ink cartridge from a printer.

Guiding Principles

Colored arrows on a black and grey
background help to distinguish specific
directions within a diagram, but colored
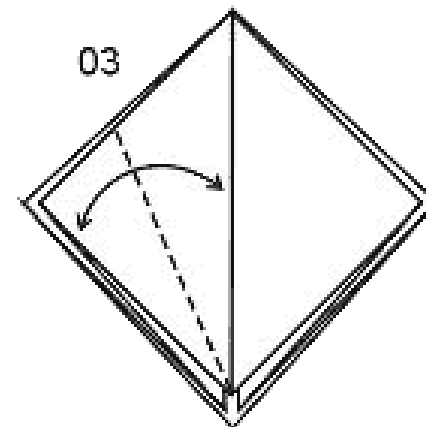arrows blend together on a
gradient background.

Two colored arrows with two arrow
heads are used to show proper
direction or placement. One arrow
with two heads can be confusing.

Ineffective
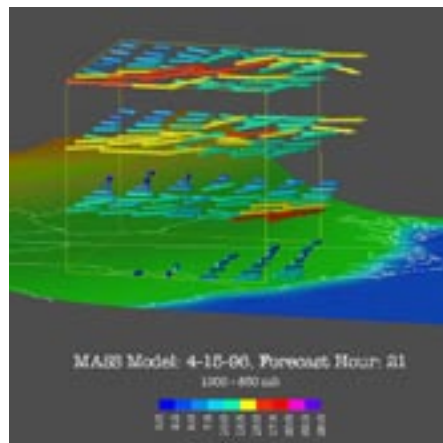
Forecast Model

There are too many contrasting
colored arrows within one image.
The values lose contrast when they
are against a gradient background.

Origami Directions

There are two arrow heads in the
diagram that are pointing in two
different directions.

Additional Works continued

Color and Numbering
Diaper Changing
Baby Center Changing A Disposable Diaper. Balmex.

2005. Baby Center LLC. 15 Febuary 2005

http://www.babycenter.com/general/3833.html

Color and Numbering
Diaper Folding
Baby Center Changing A Disposable Diaper. Balmex.

2005. Baby Center LLC. 15 Febuary 2005

http://www.babycenter.com/general/3833.html

Color
Nose Spray
Mijksenaar and Westendorp. *Open Here.*

New York City: Joost Elffers Books, 1999

Color
Sign Language (image only)
British Sign Language Finger Spelling Alphabet.
British Sign Language. 1*5 Febuary 2005*

http://www.scoutingresources.org.uk/images/codes_signlang01.gif

Color and Less Detailed vs. Detailed Line Drawings

Abdominal Muscles
Yessis, M. *Muscle Match.*

Indianapolis: Master's Press, 1992

Additional Works continued

Less Detailed vs. Detailed Line Drawings and Transparency
Human Model
Howley Edward T. and Franks Don B. *Health Fitness*

Instructor's Handbook. Champaign: Human Kinetics Books,1992

Less Detailed vs. Detailed Line Drawings and Motion
Kinesiology Basketball
Cooper, J. M. and Glassglow, R. B. *Kinesiology.*
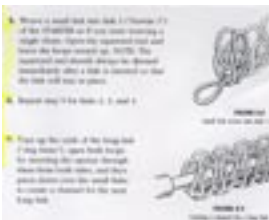
Saint Louis: The C.V. Mosby Company, 1972

Less Detailed vs. Detailed Line Drawings
Lifter
Howley, E. T. and Franks, D. B.

Health Fitness Instructor's Handbook.

Champaign: Human Kinetics Books,1992

Numbering
Chain Making
Stark, J. R. and Smith, J. R.

Classical Loop-in-Loop Chains & Their Derivatives.

Portland: Brynmorgan Press, 1999

Numbering and Color & Arrows
Minolta Camera
Camera Directions, 1999

Numbering
Zipper Fastener
Mijksenaar and Westendorp. *Open Here.*

New York: Joost Elffers Books, 1999

Motion
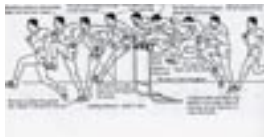*Muybridge's Horse*
Muybridge, E. *Animals in Motion.*

New York: Dover Publications, INC.,1957
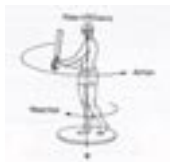
Motion
Hyperextension of Shoulder
Kelley, D. L. *Kinesiology; Fundamentals of Motion Description.*

Englewood Cliffs: Prince-Hall Inc.,1971

Sequence
Hurdlers Sequence
Shmottlach, N. and McManama, J.

The Physical Education Handbook.

Boston: A Simon & Schuster Company, 1997

Sequence
Kinesiology Fencing and Kinesology Hurdlers
Cooper, J. M. and Glassglow, R. B. *Kinesiology.*

Saint Louis: The C.V. Mosby Company, 1972

Transparency
Bicep Image
Yessis, M. Ph.D. *Kinesiology Of Exercise.*

Indianapolis: Masters Press. 1992

Transparency and Value
Human Model
Seiffert, U. *Automotive safety handbook.*

Warrendale: SAE International, 2003

Transparency
Kinesiology Side Horse
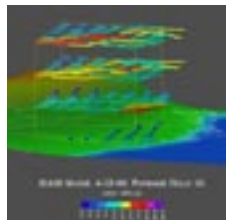Cooper, J. M. and Glassglow, R. B. *Kinesiology.*

Saint Louis: The C.V. Mosby Company, 1972

Color and Arrows
Epson Printer
Sticker located on the 1280 printer

Color and Arrows
Forecast Model
"Origami Basics". Forecast Model.

2005. 15 Febuary 2005

http://http://coastobs.pol.ac.uk/modl/metfcst/airtemp/latest.php?im=3.html

Additional Works continued

Color and Arrow
Origami Directions
Origami Basics. Origami for everyone.

2005. 15 Febuary 2005

http://www.paperfolding.com/diagrams.html

Value
Basket Weaving
Wright, D. *Complete Book of Baskets and Basketry.*

New York City: Scribner's Sons, 1977

Value
Seat Diagram
Seiffert, U. *Automotive safety handbook.*

Warrendale: SAE International, 2003

Final Synthesis Conclusion

The main attributes this designer will be using in this thesis
application will be sequence, motion, transparency, color and arrows.
These attributes were chosen based on the research results that were
conducted on the visual variable examples. Several visual instructions
and exercise instructions were collected to determine what would be
the most effective way to use the many attributes that were discovered.
The information that was collected was categorized and examined. Each
instruction was organized by listing the most effective and ineffective
attributes of each instruction to determine which were most effective.

This designer talked with personal trainers to gain their perspectives
as to attributes that would be more effective in the final application.

A hand drawing is overlayed on top of a low opacity photograph
that uses transparency, motion, sequence, value, color and
arrow attributes.

The sequence attribute will be shown with three arms, each
having different levels of transparency which will help to identify
the way the arm moves.

The color attribute is the color blue that indicates the muscle that is
being worked during the exercise and is also the color that outlines the arms.

An arrow attribute is used to show the direction of motion in which
the model will actually move his arm when doing the concentrated bicep
curl. These attributes were determined to be the most valuable attributes
that were found from the visual research collected.

Ideation

This section documents the sketching and exploration made to develop an appropriate solution for the application of this thesis. The following images will show the concentrated bicep curl exercise which works and tones the bicep muscle.

This exercise was chosen because of the many ways the exercise can be done. The positioning of the body is very important when exercising because a person may injure part of the body or gain improper body definition if the exercise is done incorrectly. The position of the arm, wrist, feet and posture all come into consideration when completing this exercise correctly. This is why this designer decided that the application will include correct and incorrect body positioning.

The verbal language is also important when writing instructions. Verbal instructions were edited to simple sentences providing the step-by-step sequential instructions that must be read quickly and easily understood. This was determined from the cognitive theory principles and the written instructions collected and explored.

Once the application content was determined, this designer took many photographs of a model doing the concentrated bicep curl to determine the best point of view or angle to show in the final application. This designer chose the frontal view of the model doing the concentrated bicep curl exercise. After researching the visual exercise examples that had been collected, it was logical to show one point of view that would explain this particular exercise and that was clear, without adding any confusion with other points of view. This designer also asked the opinion of professional trainers about what they felt would most benefit the viewer. They agreed showing the frontal point of view would be the most effective solution for the final application.

From the synthesis stage, this designer determined a set of attributes that were more effective than others, such as transparency, motion, sequence, color and the use of directional arrows.

This designer integrated effective attributes into early explorations using photographic images and sketches which included different kinds of attributes, such as colored lines, dotted lines, arrows, and color sectioning.

This designer then developed many sketches to produce the one that would complete all of the graphic design guidelines such as alignment, point size and orientation of imagery. The final application is located in a pocket in the back cover of this book.

Ideation stage 1

This is a series of sequential photographs taken from the frontal view of
the model doing the concentrated bicep curl lift. The model was chosen for
his actual knowledge of weight lifting. The model is wearing a light colored cut
off t-shirt so the viewer can see the whole arm, and dark colored pants are worn
so the light-toned arm stands out in contrast to the dark pants. A silver dumbbell
is used because it is easier and more visually interesting to look at
than a black dumbbell.

1

2
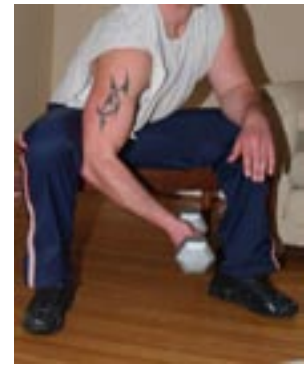
3

4

5

Ideation continued

This is a series of photographs taken from a side view
of a model doing the concentrated bicep curl lift.

1

2
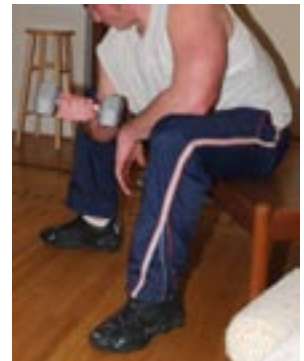
3

4

5
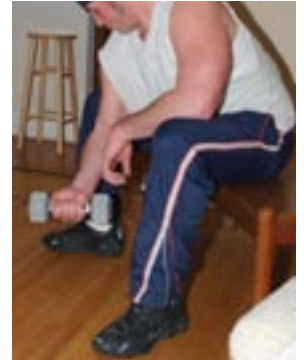
6

Ideation continued

This series of photographs focuses on a comparison of correct and incorrect lifting positions. During this process of evaluating the larger image and reflecting on research gathered, it was determined that certain details could be further clarified if more detailed images were provided. Photographs were made showing correct and incorrect positions.

Correct Position   **Incorrect Position**

Wrist

Arm

Grip

This image served as a base, upon which illustration components were layered to provide more effective visual attributes. The following pages show a sequence of images that represent the concentrated bicep curl. This image shows a series of three photographs that were combined to explain the three main positions of one repetition of the concentrated bicep curl exercise.

Ideation continued

Diagram Sketch 1
A hand drawing using transparency, motion, sequence and value attributes.

Ideation continued

Diagram Sketch 2
A hand drawing using transparency, motion, sequence and value attributes overlayed on top of a muted photograph.

Ideation continued

Diagram Sketch 3
A hand drawing using transparency, motion, sequence, value, color
and arrow attributes.

Ideation continued

Diagram Sketch 4
A hand drawing using transparency, motion, sequence, value, color
and arrow attributes overlayed on top of a muted photograph.

Ideation continued

Diagram Sketch 5
A hand drawing that uses transparency, motion, sequence, value, color
and arrow attributes overlayed on top of a muted photograph.
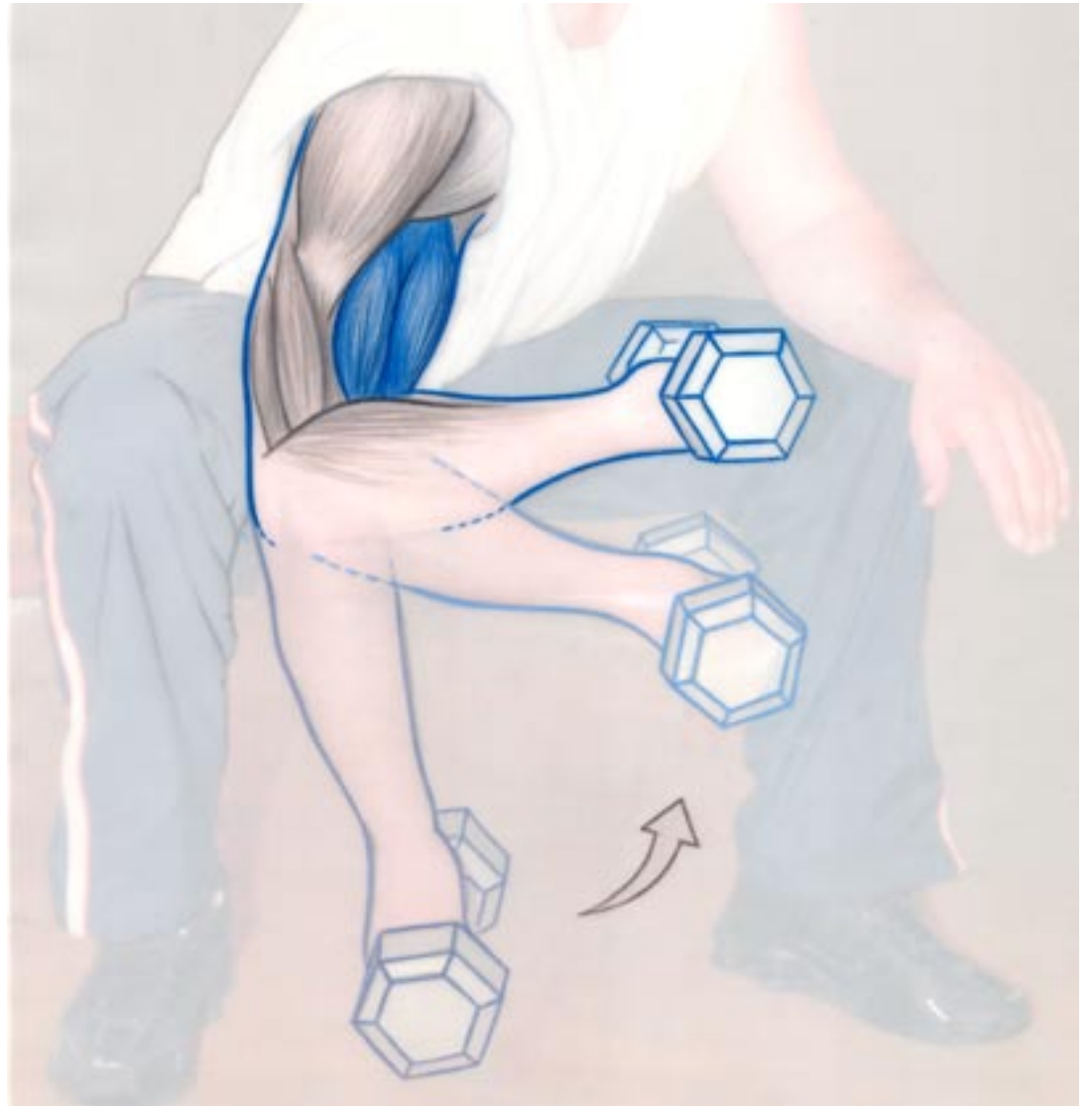
Ideation continued

Diagram Sketch 6
A hand drawing that uses transparency, motion, sequence, value, color and arrow attributes overlayed on top of a muted photograph. This is the same image as sketch 5, except the intensity of the photograph is slightly muted. The photograph is slightly muted more than the previous sketch, so the viewer can see the illustration more clearly.

Ideation continued

Diagram Sketch 7
A hand drawing that uses transparency, motion, sequence, value, color
and a single line arrow to show direction of arm movement overlayed
on top of a much muted photograph.
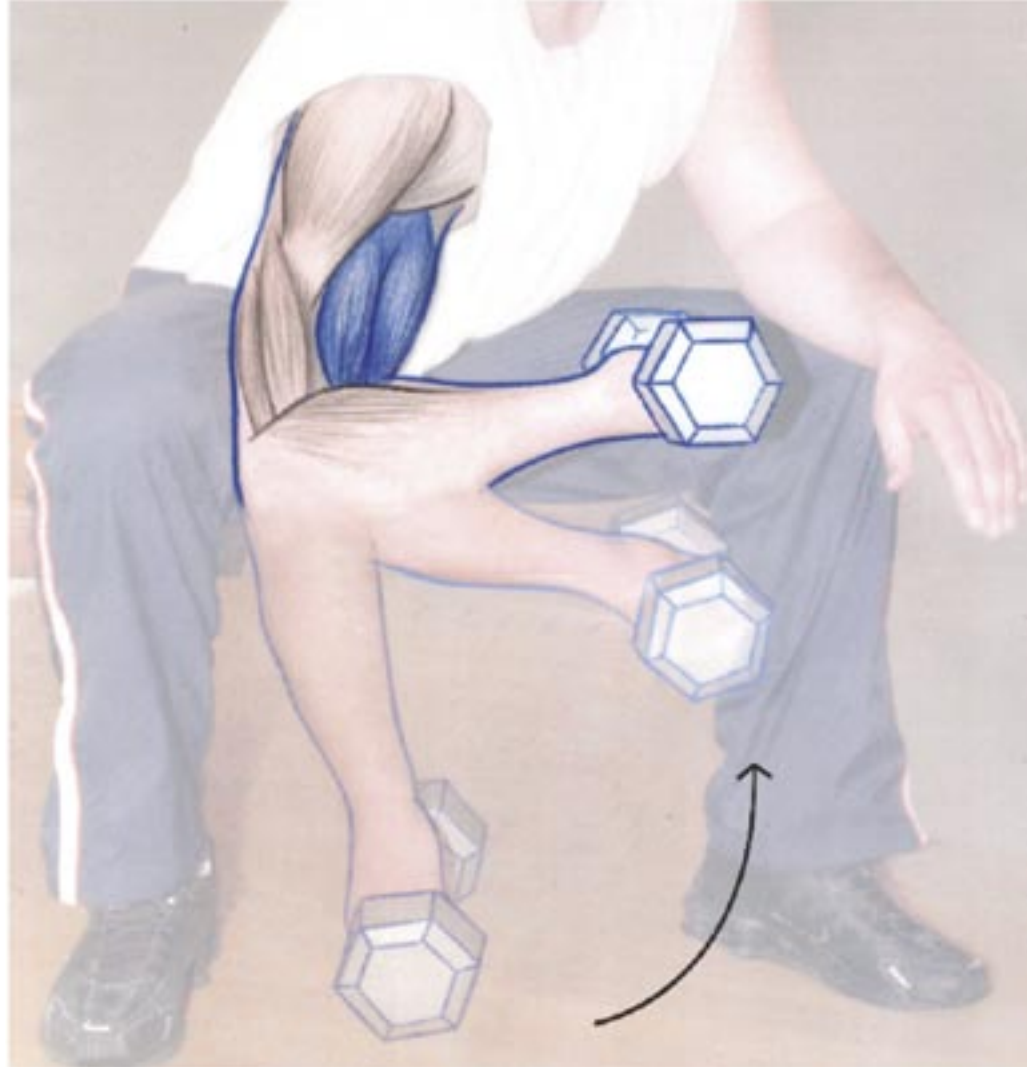
Ideation stage 2

Photograph 1 in the Fnal Photographic Series
The model was re-photographed with more form-fitting attire to better show his actual shape.
The next three images in the series were silhouetted from the background and placed on a more
neutral and less distracting background. This image shows the arm in the beginning position
of the exercise.

Photograph 2 in the Final Photographic Series
This image shows the arm moving in an upward direction and is the second
arm postion of the exercise.

Ideation continued

Photograph 3 in the Final Photographic Series
This image shows the arm moving in the upward direction and is the last arm postion
of the exercise.

Ideation continued

Final Pictorial Diagram
Photographs 1, 2 and 3 were cut and reassembled to show a diagram using movement, sequence, transparency, color and line. The original sketches were refined by drawing the blue outline of the arm slightly darker than that of the first stages. The reason for drawing the blue line in stages helps to show the movement of the arm in sequence and time. Based on feedback this designer received from the questionnaires, it was best to draw the blue outline in this way.
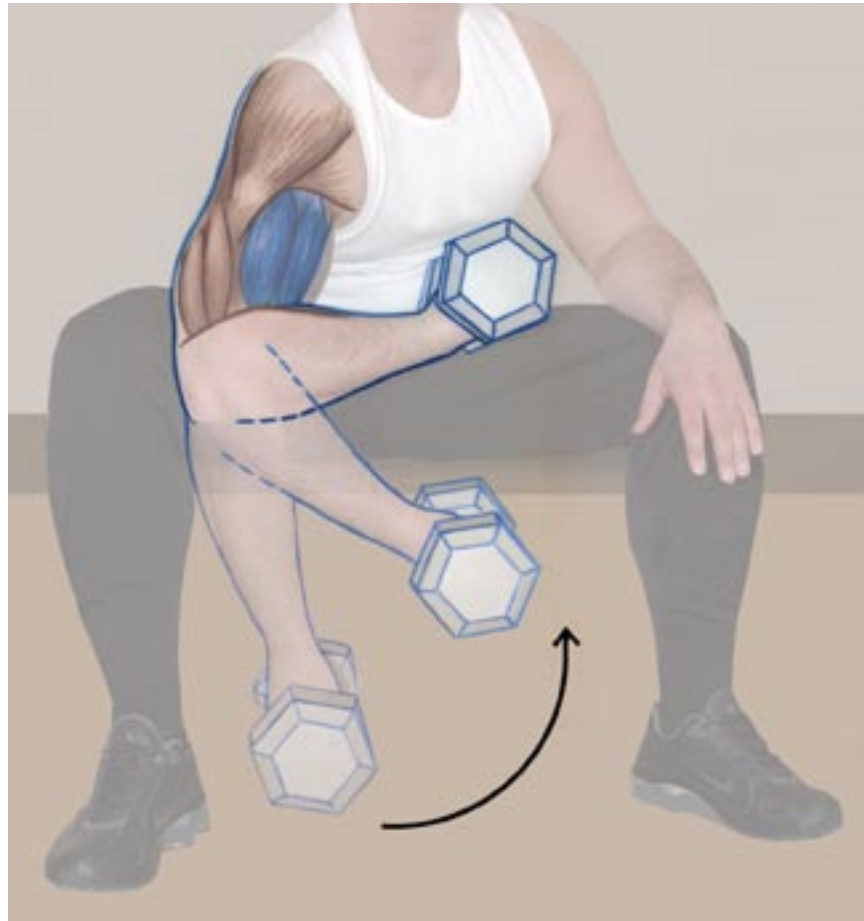
Intermediate Evaluation

To successfully evaluate the instructional diagrams that
were constructed, all of the diagrams that were generated
during the ideation process needed to be examined.
The best way to evaluate the success or effectiveness of
the final application posters was to have a sample group
compare different versions of the images, some with the
attributes of dotted lines, color, arrow, and outlines included,
and some without. Then it was necessary to ask the group
a few follow-up questions related to the diagrams and images
they had just viewed.

On the first page of the evaluation the group was asked
to answer a few yes/no questions about correct and incorrect
arm positioning. This was to determine if it was necessary
to show correct and incorrect positions within the final application.

The second page included the six diagrams with the attributes,
arrow, color, transparency, sequence, and motion, included and
taken out of each diagram. The group was asked which was the most
successful and unsuccessful by asking a series of questions
about the diagrams. The answers were then evaluated to determine
which was the most effective diagram.

The last page asked viewers to give an overall assessment, choosing
one solution as most successful in helping to perform the exercise.

One group of ten people involved in an introductory wellness class at RIT
and a second group of ten people who had little knowledge of weight training
were asked to participatein the evaluation.

In this section is the questionnaire that this designer distributed to
the two evaluation groups and the tally of each group's answers
to specific questions.

Concentrated Bicep Curl Evaluation
Preliminary Positioning

Correct (straight wrist)

Incorrect (bent wrist)
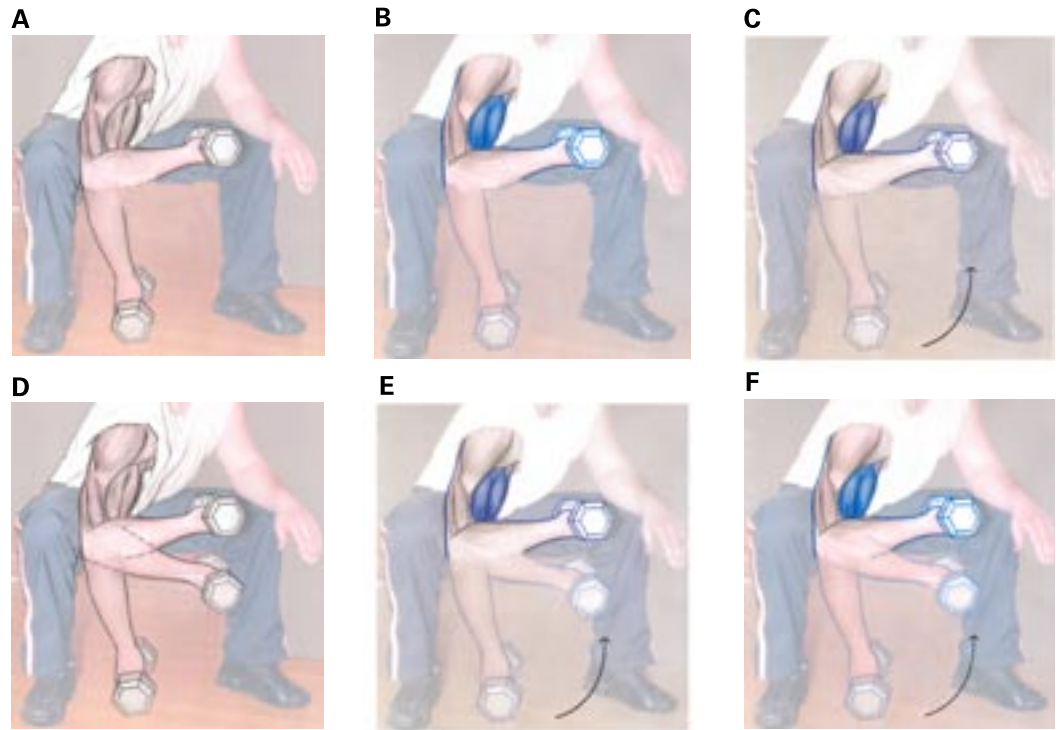

Correct elbow position

Incorrect elbow position

Please answer yes or no for the following questions?

1   Do you think showing the right and wrong images helps you to indicate
    the proper body positioning?
    yes   no

2   Do you feel that if these images were on an exercise poster,
    would they help you understand the directions easier?
    yes   no

3   Do you think the de-saturation of the image outside of the circle
    is helpful in identifying the positioning?
    yes   no

4   If these images were on an exercise poster would they reduce
    the chance of you hurting yourself?
    yes   no

Concentrated Bicep Curl
Evaluation

A

B

C

D

E

F

Please answer the following questions with the diagram letters A, B, C, D, E, F.

1 Which diagram could you use to successfully complete or replicate the exercise?____

2 Which diagram best illustrates correct elbow position ?____

3 Which diagram best illustrates correct wrist position?____

4 Which diagram indicates the best direction of movement?____

5 Which diagram best shows the actual muscle that you are contracting?____

6 Which diagram best indicates progression of movement within the arm?____

Please rate these diagrams from unsuccessful to most successful.
(Circle 1 being unsuccessful and 5 being successful)

A   1 2 3 4 5
B   1 2 3 4 5
C   1 2 3 4 5
D   1 2 3 4 5
E   1 2 3 4 5
F   1 2 3 4 5

Concentrated Bicep Curl
Additional Feedback Questions

**Please answer these questions based on the diagram
that you rated the most successful.**

List the diagram you felt was the most successful here_____.

1   Is it difficult to determine the direction in which you are to move your arm?
    If yes why?

2   Do you know what muscle group you are contracting?

3   Do you think that showing an arrow in a diagram is necessary?

4   Do you think showing the different positions of the arm is necessary? Explain.

5   Would you add anything to the diagram that you chose?

Thank You!

Intermediate Evaluation Conclusion

After reviewing the final results of both group evaluations, it became clear that two diagrams, figures D and F, could be combined to form successful diagram.

D   F

The feedback for Figure D indicated the diagram showed good progression of the exercise sequence, but needed an arrow to show proper direction of movement. Another comment was that Figure D also needed color to distinguish the bicep muscle; however, the drawing was considered to be successful.

Figure F got the best feedback of all 6 diagrams that were shown in the questionnaire, but some people thought the line weight or dotted lines weren't dark enough.

The first step is to redesign this diagram based on the thesis committee's feedback. Their suggestion was to photograph the model in more form-flattering clothing.

The next step will be to combine the best features from figures D and F and apply them to the photograph so that each attribute is clear and understandable to the viewer.

Concentrated Bicep Curl
Evaluation Answers

A

B

C

D

E

F
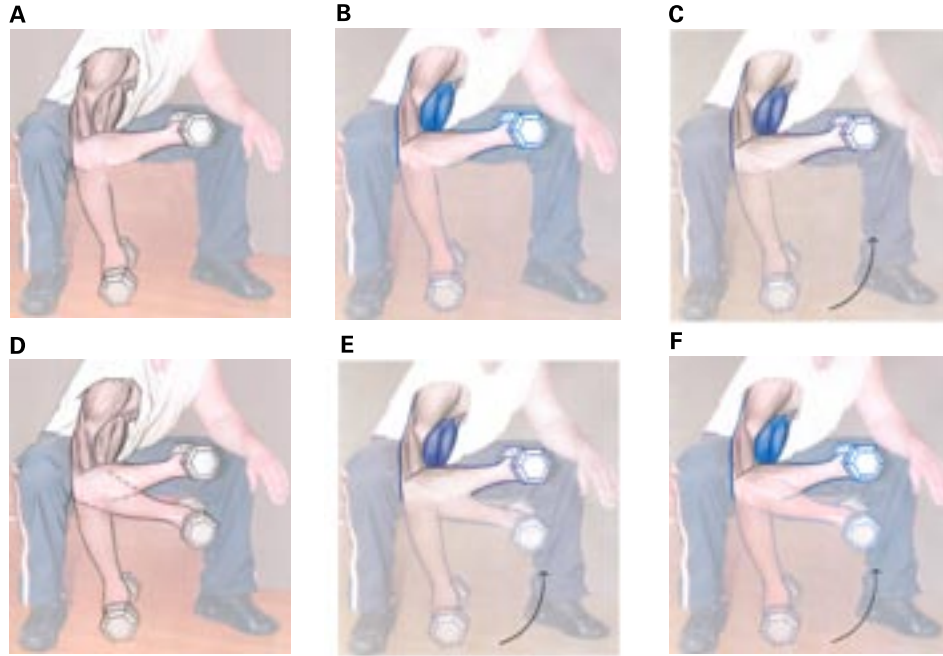
The following questions were answered with the corresponding
diagram letters A, B, C, D, E, F.

**These are the results from the survey given to a group of ten people
in an introductory wellness class at RIT, on April 12 at 10 am in the
RIT Fitness Center.**

Questions   Number of responses for each figure

1 Which diagram could you use to successfully complete or replicate the exercise?
0 answered with figure **A**
1 answered with figure **B**
1 answered with figure **C**
0 answered with figure **D**
2 answered with figure **E**
9 answered with figure **F**

Figure F had the most votes for the most successful diagram.

2 Which diagram best illustrates elbow position?
0 answered with figure **A**
0 answered with figure **B**
2 answered with figure **C**
2 answered with figure **D**
0 answered with figure **E**
7 answered with figure **F**

Figure F had the most votes for the most successful elbow position.

Questions   Number of responses for each figure

3 Which diagram best illustrates correct wrist position?
  2 answered with figure **A**
  2 answered with figure **B**
  3 answered with figure **C**
  4 answered with figure **D**
  3 answered with figure **E**
  8 answered with figure **F**

  Figure F had the most votes for the most successful wrist position.

4 Which diagram indicates the best direction of movement?
  1 answered with figure **A**
  0 answered with figure **B**
  1 answered with figure **C**
  1 answered with figure **D**
  1 answered with figure **E**
  7 answered with figure **F**

  **Figure F had the most votes for the most successful
  in showing motion.**

5 Which diagram best shows the actual muscle
  that you are contracting?
  0 answers with figure **A**
  2 answers with figure **B**
  3 answers with figure **C**
  0 answers with figure **D**
  4 answers with figure **E**
  7 answers with figure **F**

  **Figure F had the most votes for the most successful
  in showing direction of movement.**

6 Which diagram best indicates progression of movement
  within the arm?
  0 answered with figure **A**
  0 answered with figure **B**
  0 answered with figure **C**
  3 answered with figure **D**
  2 answered with figure **E**
  6 answered with figure **F**

  **Figure F had the most votes for the most successful in showing
  the muscle group being contracted.**

These diagrams were rated from successful to least successful.

***Total: Most Successful Figure F had 40 votes.
Least Successful Figure A had 18 votes.***

Concentrated Bicep Curl
Additional Feedback Suggestions

1   Is it difficult to determine the direction in which you are to move your arm?
    If yes why?

    • yes

2   Do you know what muscle group you are contracting?

    • yes

3   Do you think that showing an arrow in a diagram is necessary?

    • not necessary but helpful for beginners.
    • yes to show proper movement

4   Do you think showing the different positions of the arm is necessary? Explain.

    • all three help show proper form for whole range of movement.
    • can be confusing–people want simple, quick, easy directions
    • reminds you of motion
    • shows progression of movement

5   Would you add any thing to the diagram that you chose?
    • color in the bicep
    • an arrow pointing down
    • it could be a good idea to show which diagram if followed
      would be out of line and injury prone.
    • it is good that you mute out everything but the arm in figure F
      it's more neutral, it emphasizes the parts that I'm working.
    • more information about the wrist being straight throughout the exercise.
    • add numbers to show sequence start to finish.

Concentrated Bicep Curl Evaluation
Preliminary Positioning Answers

Correct (straight wrist)

Incorrect (bent wrist)

Correct elbow position

Incorrect elbow position

The following questions were answered with a yes or no.

**These answers were from a group of eight people
in an introductory wellness class.**

1 Do you think that showing the right and wrong images will help you to indicate
proper body positioning?
8 **yes**
0 **no**

2 Do you feel that if these images were on an exercise poster,
would they help you understand the directions easier?
7 **yes**
1 **no**

3 Do you think that de-saturation of the image outside of the circle is helpful
in identifying the positioning?
7 **yes**
1 **no**

4 If these images were on an exercise poster would they reduce
the chance of you hurting yourself?
7 **yes**
0 **no**

Concentrated Bicep Curl
Evaluation Answers

A

B

C

D

E

F
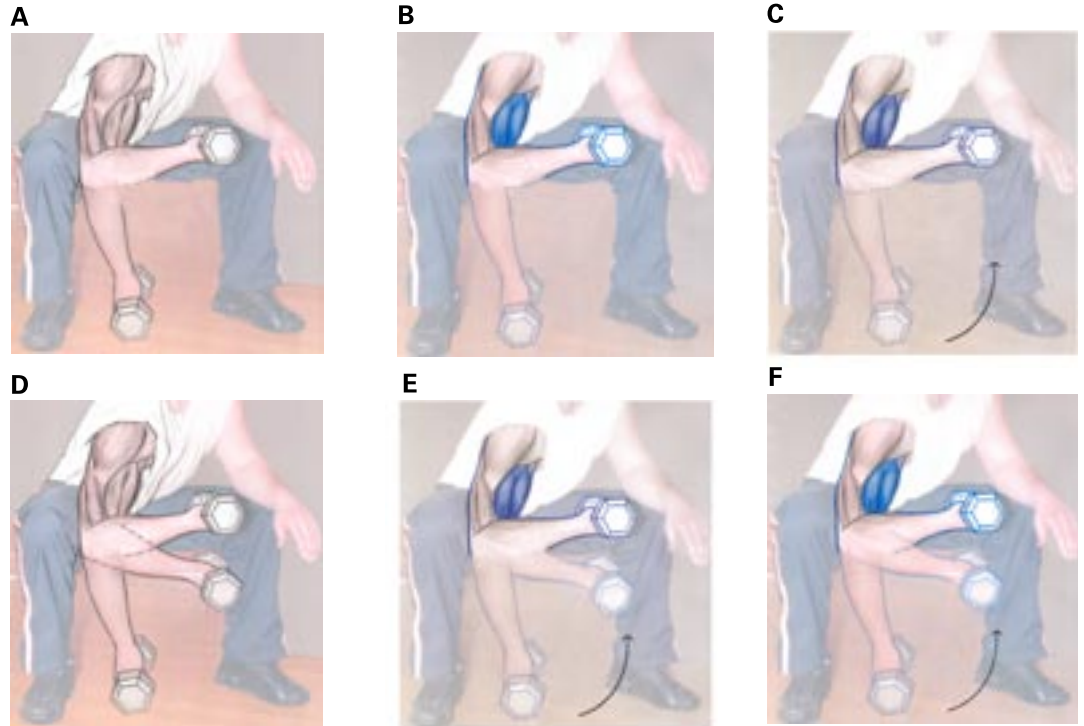
The following questions were answered with the appropriate diagram letters A, B, C, D, E, F.

These are the results of the survey given to a group of ten non-lifters who are students at RIT.

Questions   Number of responses for each figure

1 Which diagram could you use to successfully complete or replicate the exercise?
  0 answered with figure **A**
  0 answered with figure **B**
  4 answered with figure **C**
  4 answered with figure **D**
  0 answered with figure **E**
  6 answered with figure **F**

  Figure F had the most votes for the most successful diagram.

2 Which diagram best illustrates elbow position?
  0 answered with figure **A**
  0 answered with figure **B**
  2 answered with figure **C**
  7 answered with figure **D**
  1 answered with figure **E**
  6 answered with figure **F**

  Figure D had the most votes for the most successful elbow position.

Evaluation Answers

3 Which diagram best illustrates correct wrist position?
   0 answered with figure **A**
   0 answered with figure **B**
   2 answered with figure **C**
   5 answered with figure **D**
   2 answered with figure **E**
  10 answered with figure **F**

**Figure F had the most votes for the most
successful wrist position.**

4 Which diagram indicates the best direction of movement?
   0 answered with figure **A**
   1 answered with figure **B**
   4 answered with figure **C**
   6 answered with figure **D**
   2 answered with figure **E**
   8 answered with figure **F**

**Figure F had the most votes for the most successful
in showing motion.**

5 Which diagram best shows the actual muscle
   that you are contracting?
   0 answer with figure **A**
   3 answer with figure **B**
   6 answer with figure **C**
   1 answer with figure **D**
   4 answer with figure **E**
  11 answer with figure **F**

**Figure F had the most votes for the most successful
in showing direction of movement.**

6 Which diagram best indicates progression of movement
   within the arm?
   0 answered with figure **A**
   0 answered with figure **B**
   4 answered with figure **C**
   5 answered with figure **D**
   1 answered with figure **E**
   9 answered with figure **F**

**Figure F had the most votes for the most successful in showing
the muscle group being contracted.**

These diagrams were rated from most successful to least successful.

Total: Most Successful Figure F had 67 votes.
Least Successful Figure A had 23 votes.

Concentrated Bicep Curl Evaluation
Preliminary Positioning Answers

Correct (straight wrist)

Incorrect (bent wrist)

Correct elbow position

Incorrect elbow position

The following questions were answered with a **yes** or **no**.

**These are the results of the survey given to an inexperienced
group of ten non-lifter students of RIT on April 12th.**

1   Do you think that showing the right and wrong images will help you to indicate
proper body positioning?
10 **yes**
0   **no**

2 Do you feel that if these images were on an exercise poster,
would they help you understand the directions easier?
10 **yes**
0   **no**

3 Do you think that de-saturation of the image outside of the circle is helpful
in identifying the positioning?
10 **yes**
0   **no**

4 If these images were on an exercise poster would they reduce
the chance of you hurting yourself?
10 **yes**
0   **no**

Concentrated Bicep Curl
Additional Feedback Suggestions

1 Is it difficult to determine the direction in which you are to move your arm?
  If yes why?

  • no

2 Do you know what muscle group you are contracting?

  • yes

3 Do you think that showing an arrow in a diagram is necessary?

  • yes, unless there is another way of showing where you start and finish.
  • yes, shows proper arm movement.

4 Do you think showing the different positions of the arm is necessary? Explain.

  • yes

5 Would you add anything to the diagram that you chose?
  • yes, I would take the saturation out of the arm and show it in its natural state.
  • change shape of dumbbell

Please see Appendix A for additional questionnaires

Implementation

In this next section are the components and images that were implemented into the actual poster that this designer developed, such as the written instructions, the main image and the overlay sketch along with the correct and incorrect images.

Initially this designer thought a handbook would be an effective way to show the exercise instructions, but after researching various fitness centers and watching the way people work out, this designer decided it would be difficult for someone to turn pages and work out at the same time. This designer determined that a large poster would be the best possible way to show the exercise instructions. It could be mounted on the wall in front of weight racks in weight rooms. A poster is the easiest and most immediate way for viewers to look at the exercise and be able to reference the poster at any time during the exercise.

Also in this section are the initial poster layouts varying horizontal and vertical orientation, color and typeface. From these, the final design was developed. The vertical layouts were not pursued past the sketch stage because there didn't seem to be a way to connect the text with imagery without putting too much emphasis on one or the other. The horizontal layout seemed to be the most effective.

Sketch 1
This sketch shows a vertical poster with the instructions on top and the visual diagram below.
The preparation and 'Start' instructions are located side by side above the main diagram.
The correct picture examples are indicated with a green bar on top and the incorrect picture examples are indicated with a red bar on top. The green bar is used to represent the correct way to do the exercise, and the red bar is used to represent the incorrect way to do the exercise. Each correct and incorrect picture is located next to the arm position it represents.

Concentrated Bicep Curl

Exercise Instructions

Preparation
- Sit on the edge of the bench
- Keep knees should width apart
- Keep feet flat on the ground
- Lean forward
- Rest your forearm on the top
  of thigh

Start Exercise
Grasp the dumbbell and place elbow against your inner thigh. Elbow should be about two inches from your knee.

With wrist straight curl barbell up to almost an inch from your chest.

Then curl barbell down toward the floor.

In–correct elbow positioning

Correct elbow positioning

In–correct wrist positioning

Correct wrist positioning

Correct arm positioning

In–correct arm positioning

Correct grip position

Implementation continued

Sketch 2
The correct picture examples are indicated with a green bar on top and the incorrect picture examples are indicated with a red bar on top. Each correct and incorrect picture is located next to the arm position it represents.

Concentrated Bicep Curl

Exercise Instructions

Preparation
- Sit on the edge of the bench
- Keep knees should width apart
- Keep feet flat on the ground
- Lean forward
- Rest your forearm on the top
 of thigh

Start Exercise
Grasp the dumbbell and place elbow against your inner thigh. Elbow should be about two inches from your knee.

With wrist straight curl barbell up to almost an inch from your chest.

Then curl barbell down toward the floor.

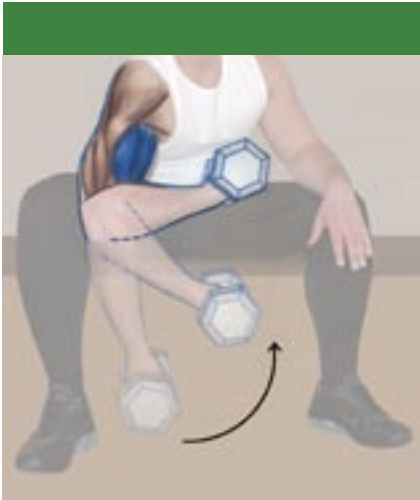In-correct elbow positioning

Correct elbow positioning

In-correct wrist positioning

Correct wrist positioning

Correct arm positioning

In-correct arm positioning

Correct grip position

Sketch 3
A thick green bar highlights the title of the exercise and a thin green bar is located on the
bottom to keep the poster pulled together. The correct picture examples are indicated with a
green bar on top and the incorrect picture examples are indicated with a red bar on top.

Concentrated Bicep Curl

Exercise Instructions

Preparation
• Sit on the edge of the bench
• Keep knees should width apart
• Keep feet flat on the ground
• Lean forward
• Rest your forearm on the top
  of thigh

Start Exercise
Grasp the dumbbell and place
elbow against your inner thigh.
Elbow should be about
two inches from your knee.

With wrist straight
curl barbell up to almost an inch
from your chest.

Then curl barbell down toward
the floor.

In-correct elbow positioning

Correct elbow positioning

In-correct wrist positioning

Correct wrist positioning

Correct arm positioning

In-correct arm positioning

Correct grip position

Implementation continued

Sketch 4
A thick green bar highlights the title of the exercise and a thin green bar
is located on the bottom to keep the poster pulled together. The one thing
different in this sketch from sketch 3 is that the words 'Preparation and Start Exercise'
are directly over the instructions.

Concentrated Bicep Curl

Exercise Instructions

Preparation

• Sit on the edge of the bench
• Keep knees should width apart
• Keep feet flat on the ground
• Lean forward
• Rest your forearm on the top
  of thigh

Start Exercise

Grasp the dumbbell and place
elbow against your inner thigh.
Elbow should be about
two inches from your knee.

With wrist straight
curl barbell up to almost an inch
from your chest.

Then curl barbell down toward
the floor.

In–correct elbow positioning

Correct elbow positioning

Correct arm positioning

In–correct arm positioning

In–correct wrist positioning

Correct wrist positioning

Correct grip position

Implementation continued

Sketch 5 and 6
A thick green or blue bar highlights the title of the exercise and a thin green or blue bar is located on the bottom to keep the posters pulled together. One thing different in these sketches from sketch 4 is that the start exercise instructions are located over the main diagram whereas in sketch 4 they are located over the correct and incorrect pictures.

Concentrated Bicep Curl

Exercise Instructions

Preparation
• Sit on the edge of the bench
• Keep knees should width apart
• Keep feet flat on the ground
• Lean forward
• Rest your forearm on the top
 of thigh

Start Exercise
Grasp the dumbbell and place elbow against your inner thigh. Elbow should be about two inches from your knee.

With wrist straight curl barbell up to almost an inch from your chest.

Then curl barbell down toward the floor.

In-correct elbow positioning

Correct elbow positioning

Correct arm positioning

In-correct arm positioning

In-correct wrist positioning

Correct wrist positioning

Correct grip position

Concentrated Bicep Curl

Exercise Instructions

Preparation
• Sit on the edge of the bench
• Keep knees should width apart
• Keep feet flat on the ground
• Lean forward
• Rest your forearm on the top
 of thigh

Start Exercise
Grasp the dumbbell and place elbow against your inner thigh. Elbow should be about two inches from your knee.

With wrist straight curl barbell up to almost an inch from your chest.

Then curl barbell down toward the floor.

In-correct elbow positioning

Correct elbow positioning

Correct arm positioning

In-correct arm positioning

In-correct wrist positioning

Correct wrist positioning

Correct grip position

Implementation continued

Sketch 7
This sketch shows a horizontal poster with the instructions on the bottom and the visual diagram on top. A thick gray bar highlights the title of the exercise and the title is aligned left with all of the other information in the poster. A gray box is placed on the bottom of the poster to contain the exercise instructions. The correct picture examples are indicated with a green bar on top and the incorrect picture examples are indicated with a red bar on top. The green bar is used to represent the correct way to do the exercise and the red bar is used to represent the incorrect way to do the exercise. Each correct and incorrect picture is located next to the arm position it represents in the main diagram.

Concentrated Bicep Curl

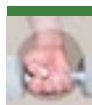In–correct elbow positioning   Correct elbow positioning

Correct arm positioning   In–correct arm positioning

In–correct wrist positioning   Correct wrist positioning

Correct grip position

Exercise Instructions

Preparation
• Sit on the edge of the bench
• Keep knees should width apart
• Keep feet flat on the ground
• Lean forward
• Rest your forearm on the top of thigh

Start Exercise
Grasp the dumbbell and place elbow against your inner thigh. Elbow should be about two inches from your knee.

With wrist straight curl barbell up to almost an inch from your chest.

Then curl barbell down tward the floor.

Implementation continued

Sketch 8
A thick green bar highlights the title of the exercise and, unlike sketch 7,
the title is aligned with the main diagram. A green box is placed on
the bottom of the poster to contain the exercise instructions.

Concentrated Bicep Curl

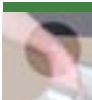In–correct elbow positioning

Correct elbow positioning

Correct arm positioning

In–correct arm positioning

In–correct wrist positioning

Correct wrist positioning

Correct grip position

Exercise Instructions

Preparation
• Sit on the edge of the bench
• Keep knees should width apart
• Keep feet flat on the ground
• Lean forward
• Rest your forearm on the top of thigh

Start Exercise
Grasp the dumbbell and place
elbow against your inner thigh.
Elbow should be about
two inches from your knee.

With wrist straight
curl barbell up to almost an inch
from your chest.

Then curl barbell down toward
the floor.

Implementation continued

Sketch 9
A thick gray bar highlights the title of the exercise. Preparation and Start Exercise are located side by side above the main exercise diagram. The words, Preparation and Start Exercise, are aligned next to the instructions. Each correct and incorrect picture is located next to the arm position it represents. The main difference in this solution from the other vertical sketches is that a rule is placed above the correct and incorrect pictures to separate them from other information.

Concentrated Bicep Curl

Exercise Instructions

Preparation
- Sit on the edge of the bench
- Keep knees should width apart
- Keep feet flat on the ground
- Lean forward
- Rest your forearm
  on the top of thigh.

Start Exercise
Grasp the dumbbell and place elbow against your inner thigh. Elbow should be about two inches from your knee.

With wrist straight curl barbell up to almost an inch from your chest.

Then curl barbell down toward the floor.

Elbow Positioning

In−correct | Correct

Arm Positioning

Correct | In−correct

Wrist Positioning

In−correct | Correct

Grip Positioning

Correct

Implementation continued

Final Poster Application
This designer decided on a horizontal poster with three sections, starting with the left side which shows the correct and incorrect positions. The correct picture examples are indicated with a green bar on top and the incorrect picture examples are indicated with a red bar on top. The green bar is used to represent the correct way to do the exercise and the red bar is used to represent the incorrect way to do the exercise.
The concetrated bicep curl visual diagram is placed between the 'Positioning and Exercising Instruction' sections. The diagram has a green bar on top indicating the correct and accurate way to do the exercise. The exercise instructions text is placed vertically and encased in a medium-value green box.
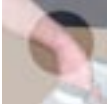
Please see details of the final poster application in Appendix B

Dissemination

Part 1
Bevier Gallery Thesis Show Opening
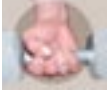This designer showed in-progress thesis panels to the public during Spring quarter 2005. This designer organized the information from exercise instructions, book research and interviews with personal trainers.

This designer then worked with a medical illustrator who drew the concentrated bicep curl illustration with the correct attributes. The illustration was drawn over a combined set of photographs. Four 3 x 4-foot exhibit panels were designed and installed in the Bevier Gallery.

The four in-progress thesis panels consisted of:
1 Thesis description: thesis goals and key resources
2 Visual instruction examples
3 Research: key principles, visual variables, consequences
4 Preliminary application: specific attributes and step-by-step written instructions

The exhibit opened with a reception on Friday, April 1 and closed on Thursday, April 14, 2005.

In the future this author intends to use this prototype to test at local fitness centers. The feedback from the prototype will be used to develop a series of systematic, free weight instruction posters for gyms across New York state. The posters will all have the same attributes and design features. These applications could be published in physical fitness books, magazines and posted in fitness centers.

This designer also intends this thesis to be published within graphic design instruction manuals or journals that will help designers when designing visual diagrams.

This designer anticipates using this thesis as a guideline for graphic designers when they are designing any kind of pictorial instructions.

Dissemination continued

These are the four thesis panels that were hung in the Bevier Gallery Show.
Each panel was 3 feet tall by 4 feet wide. They were mounted flush to the wall.
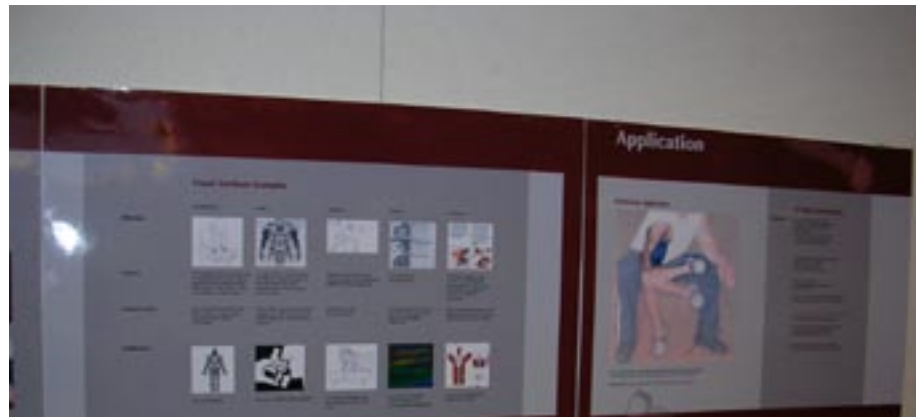
Details of these panels can be seen in Appendix B: Thesis Show Panels

Panel one states the original thesis goals. At this time, most of the example goals and attributes were resolved.
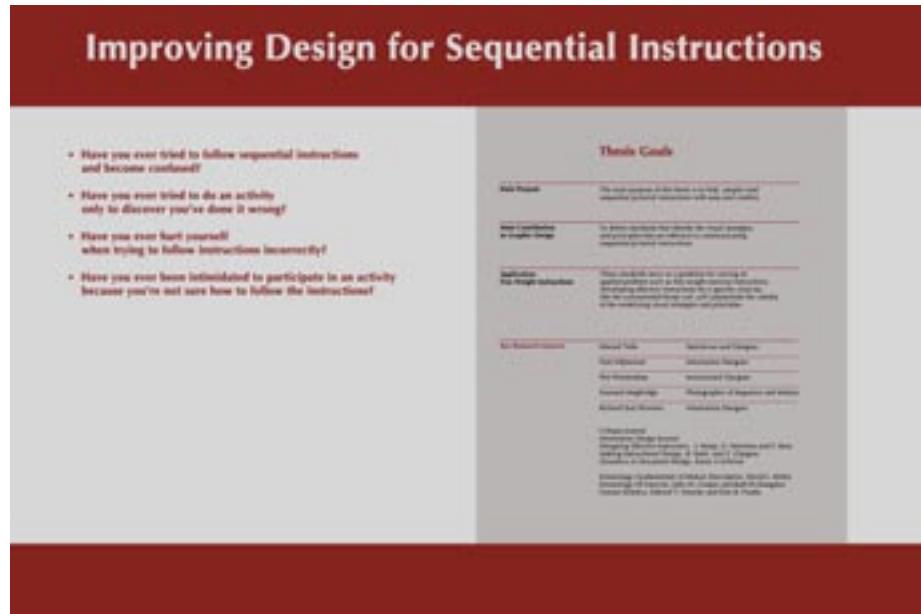
Panel two shows the primary visual variables researched, key principles and consequences. Visual variables were manipulated to improve the understanding of pictorial instructions.
Key Principles lists main attributes this designer collected from research.
Consequences shows the correct and incorrect body positioning examples.
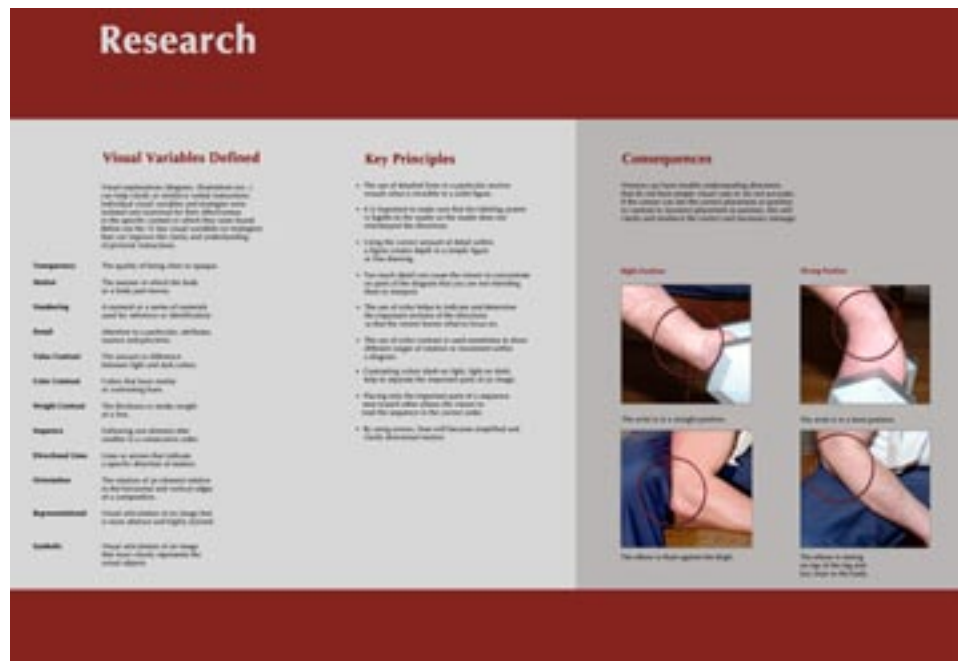
Dissemination continued

Panel three shows examples of existing instructions that illustrate specific effective and ineffective attributes. Guiding principles of transparency, color, sequence, arrows, and numbering were then determined after assessing the effective attributes.
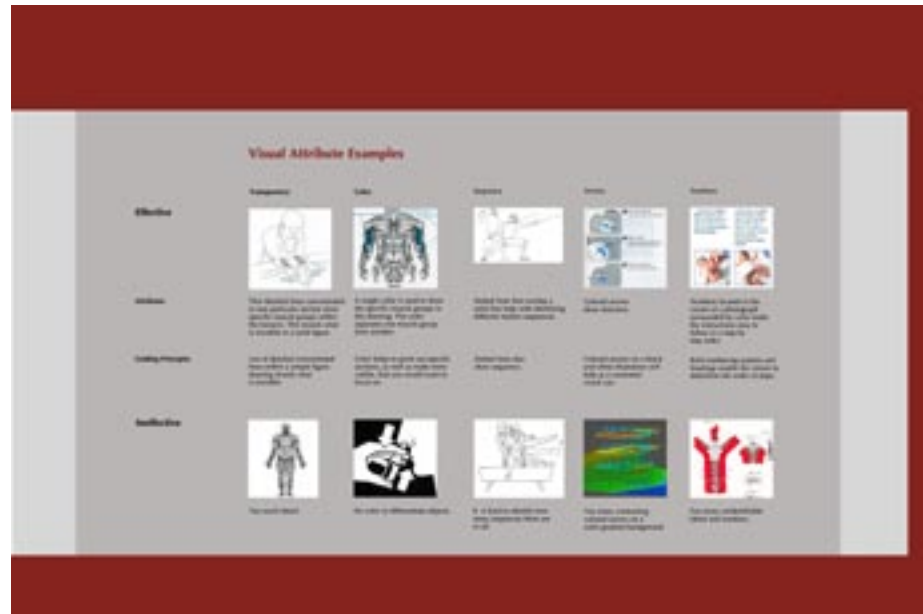
Panel four shows a sketch overlayed on a photograph and step-by-step, written instructions as a preliminary direction for the poster application.
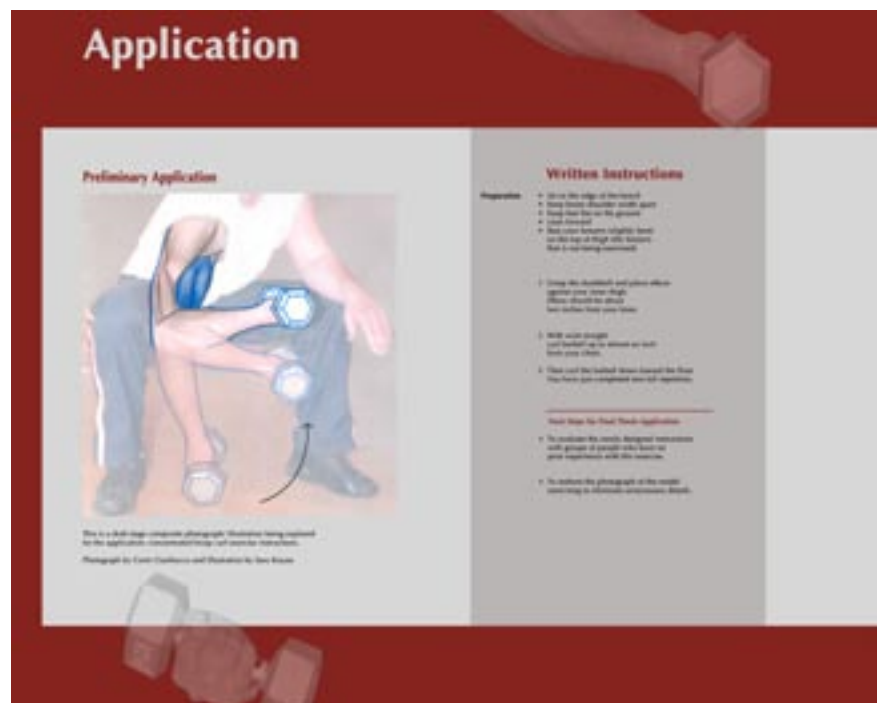
Retrospective Evaluation

Self–Evaluation
This thesis allowed this author to expand her knowledge about
instructional design, and the principles that must be considered
when developing an effective diagrammatic design that is easily read.

This thesis has been a great challenge in developing new critical thinking skills
within graphic design, and developing better research skills.

The free weight diagram was refined through a critical analysis of
approximately fifteen different iterations. This designer believes the problem
of readability within free weight lifting diagrams has been resolved and based
this conclusion on feedback from two groups of students. One group of
ten people who were involved in an Introductory Wellness Class at RIT,
and a second group of ten people who had little knowledge of weight training
were asked to participate in the evaluation. This designer also took into
consideration comments and feedback of the three thesis advisors
and personal trainer with whom the designer was working with. This designer
feels that it was very important to use actual test subjects along with an expert
personal trainer to help determine what symbols, color and images were the
most prominent instructional components to use in the final application.

The following seven guiding principles that helped the designer were value,
sequence, motion, detail, color, numbering, colored arrows/direction. Value was
used to separate elements within the written portion of the step by step procedure
by bolding headlines and value also was used to help identify specific sections in the
drawing of the arm. Transparency was used to draw concentrated lines within the
figure to show muscle over the arm. Which was needed to show the part of
the muscle that was getting used. Sequence was used to show the step by step
directions on how to move the arm in the proper way with out injury. Motion was
used to show different arm orientations within motion, which also helped represent
key positioning and pivoting points within the steps. Line details were drawn
with simple smooth lines and dotted lines were drawn in the arm
to show the different points at which the arm was being moved. This helped to identify
the degree of motion the arm was moving, allowing the drawing to be easily read.
Color helped emphasize specific sections of the arm and was used to separate
the bicep muscle from the other parts of the arm. Color was also used in the final
application poster to show correct and incorrect arm positioning. In the drawing
the actual photo that was taken of the subject was faded, so that the arm could be
drawn over the photo and it could be easily identified. The muscle was colored
using a blue color, so it was easy to identify the muscle that was being used.
An arrow was used to help reinforce and indicate the direction that the arm is
moving. Numbering was used within the written portion of the directions by labeling
the step by step order of the instructions.

The feedback gathered from the tests that were conducted using the guiding
principles confirmed that the seven princples worked when they were incorporated
into the application. When the final application was completed and developed, the seven
guiding principles were proven to be an important and valueable portion to this thesis
investigation. Demonstrating that after testing the principles my hypothesis was right.

Retrospective Evaluation continued

External Evaluation
The final free weight application was shown to, two avid free weight lifters from outside Rochester Institute of Technology. The concentrated bicep curl poster was presented to these two lifters, and they were asked to perform the exercise. The weight lifters agreed that the diagram was easy to follow. They stated that the smaller detailed photographs which show the correct and incorrect way to do a bicep curl can be very helpful, if one is unsure about the positioning of the wrist, arm or elbow. The weight lifters commented that they appreciated seeing the three arm positions and that each arm was in a different tone and highlighted in blue.

The weight lifters also felt the clear and simple written instructions successfully reinforced the diagram. This designer asked the lifters if they thought it was necessary to show written instructions with the diagram. They agreed that both images and text were required for the exercise to be done properly.

During this part of the evaluation this designer learned of the importance of gathering all information and developing the application. It was discovered that it is essential to test your application with the final end user to ensure that the correct content was used.

Conclusion

The goals of this thesis were to improve visual diagrams for instructional design by developing a vehicle that is clear, usable, and visually interesting. Another goal was to integrate existing effective instructional design attributes discovered through research and to develop an application that has never been seen before. This designer believes that these goals were accomplished within the free weight final application. Written text that was gathered from existing concentrated bicep curl exercise instructions were simplified and incorporated into easily read instructions. Existing effective instructional design attributes gathered from research such as transparency, motion, sequence, value, color, line and arrow, were synthesized with the use of a photo overlay illustration to develop a diagram with improved clarity and readability.

Each effective attribute is defined and explained within the research portion of this thesis and within the final application. The most important task this designer completed was to first examine all the discovered attributes that could be included and distill them into the most important attributes of transparency, line, motion, sequence, value, color, and a single line arrow to show direction. From the assessment of selected applications in which these variables were used, a set of guiding principles were developed for each variable. These guiding principles were central to the selected applications deemed most effective in the use of the individual variables.

Distinguishing effective and ineffective instructional design attributes can serve as a useful example to other graphic designers. This designer learned new ways of working on projects along with new research techniques such as conducting interviews, asking questions about how people identify and interpret symbols, colors, and written directions. It was important to gather documented text examples, as well as personal interview comments, each highlighted a different area of the instructions that might need to be studied closer when designing sequential pictorial diagrams.

This author hoped to develop a diagram that could stand alone as free weight lifting instructions. However, author learned after collecting data from the intermediate evaluation questionnaires and then reviewing the external evaluation that written instructions must be included as a tool to reinforce the images. If one part of the diagram is used without the other, neither part can be understood alone, and it is difficult for the user to perform the exercise correctly.

Many graphic design standards already exist within instructional design. This designer believes that this thesis will help clarify how to improve instructional design problems when designing instructions for sequential tasks.

Glossary of Terms

Design Terms

Instructional Design
The visual explanation of a set of instructions or task to perform. Often includes text instructions and accompanying pictorial explanatory images.

Brainstorming
A design process tool used for generating a wide range of ideas without prejudgement.

Sequence of Tasks
A consecutive order of one task following another.

Pictorial Imagery
Illustrated detailed drawings.

Wurman's Hatracks Method
A problem solving tool which helps to categorize a large quantity of information. The Hatracks method uses five ways to organize information, including alphabet, location, time, category, and magnitude. Wurman's Hatracks was developed by Richard Saul Wurman, an architect highly publicized as a proponent of making information understandable through design.

Illustration
A visual representation or artwork that helps make information clear and attractive.

**Physical Fitness
(Free Weights) Terms**

Skeleton
The internal structure composed of bone and cartilage that protects and supports the soft organs, tissues, and other parts of a vertebrate.

Physical Fitness
Being in good health or physical condition, especially as the result of exercise and proper diet.

Repetition
The act of doing or performing again, such as the cyclical continuation of lifting weights.

Sets
How many times a weight lifting procedure is repeated.

Duration
Continuance or persistence in time.

Muscle
A bundle of tissue, which moves a particular bone, part, or substance of the body.

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where the attribute
examples can
be found*

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Yessis, Michael Ph.D. Kinesiology Of Exercise.
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Appendices A
Questionnaires

All questionaries are located in the final bound thesis book.

Appendices B
Details of Thesis Panels

Panel One Details

- **Have you ever tried to follow sequential instructions and become confused?**

- **Have you ever tried to do an activity only to discover you've done it wrong?**

- **Have you ever hurt yourself when trying to follow instructions incorrectly?**

- **Have you ever been intimidated to participate in an activity because you're not sure how to follow the instructions?**

Thesis Goals

Main Purpose	The main purpose of this thesis is to help people read sequential pictorial instructions with ease and comfort.
Main Contribution to Graphic Design	To define standards that identify the visual strategies and principles that are effective in communicating sequential pictorial instructions.
Application: Free Weight Instructions	These standards serve as a guideline for solving an applied problem such as free weight exercise instructions. Developing effective instructions for a specific exercise, like the concentrated bicep curl, will substantiate the validity of the underlying visual strategies and principles.

Key Research Sources		
	Edward Tufte	Statistician and Designer
	Paul Mijksenaar	Information Designer
	Piet Westendorp	Instructional Designer
	Eaweard Mugbridge	Photographer of Sequence and Motion
	Richard Saul Wurman	Information Designer

Critique Journal
Information Design Journal
Designing Effective Instruction, *J. Kemp, G. Morrison and S. Ross*
Making Instructional Design, *B. Seels and Z. Glasgow*
Dynamics in Document Design, *Karen A Schriver*

Kinesiology Fundamentals of Motion Description, *David L. Kelley*
Kinesiology Of Exercise, *John M. Cooper and Ruth B.Glassglow*
Human Kinetics, *Edward T. Howley and Don B. Franks*

Panel Two Details

Visual Variables Defined

Visual explanations (diagram, illustrations ect...) can help clarify or reinforce verbal instructions. Individual visual variables and strategies were isolated and examined for their effectiveness in the specific content in which they were found. Below are the 12 key visual variables (or strategies) that can improve the clarity and understanding of pictorial instructions.

Transparency   The quality of being clear or opaque.

Motion   The manner in which the body or a body part moves.

Numbering   A numeral or a series of numerals used for reference or identification.

Detail   Attention to a particular; attributes, nuance and precision.

Value Contrast   The amount or difference between light and dark colors.

Color Contrast   Colors that have similar or contrasting hues.

Weight Contrast   The thickness or stroke weight of a line.

Sequence   Following one element after another in a consecutive order.

Directional Lines   Lines or arrows that indicate a specific direction of motion.

Orientation   The rotation of an element relative to the horizontal and vertical edges of a composition.

Representational   Visual articulation of an image that is more abstract and highly stylized.

Symbolic   Visual articulation of an image that more clearly represents the actual objects.

Panel Two Details

Key Principles

- The use of detailed lines in a particular section reveals what is invisible in a solid figure.

- It is important to make sure that the labeling system is legible to the reader so the reader does not misinterpret the directions.

- Using the correct amount of detail within a figure creates depth in a simple figure or line drawing.

- Too much detail can cause the viewer to concentrate on parts of the diagram that you are not intending them to interpret.

- The use of color helps to indicate and determine the important sections of the directions so that the viewer knows what to focus on.

- The use of color contrast is used sometimes to show different ranges of rotation or movement within a diagram.

- Contrasting colors (dark on light, light on dark) help to separate the important parts of an image.

- Placing only the important parts of a sequence next to each other allows the viewer to read the sequence in the correct order.

- By using arrows, lines will become simplified and clarify directional motion.

Panel Two Details

Consequences

Viewers can have trouble understanding directions that do not have proper visual cues or are not accurate. If the viewer can see the correct placement or position in contrast to incorrect placement or position, this will clarify and reinforce the correct and necessary message.

Right Position

The wrist is in a straight position.

Wrong Position
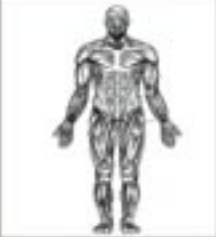

The wrist is in a bent position.

The elbow is flush against the thigh.

The elbow is resting on top of the leg and too close to the body.

Panel Three Details

Visual Attribute Examples

	Transparency	Color
Effective		
Attributes	Thin detailed lines concentrated in one particular section show specific muscle groups within the forearm. This reveals what is invisible in a solid figure.	A single color is used to show the specific muscle groups in this drawing. The color separates one muscle group from another.
Guiding Principles	Use of detailed concentrated lines within a simple figure drawing reveals what is invisible.	Color helps to point out specific sections, as well as make more visible, that you would want to focus on.
Ineffective		
	Too much detail.	No color to differentiate objects.

Panel Three Details

Sequence

Dotted lines that overlap a
solid line help with identifying
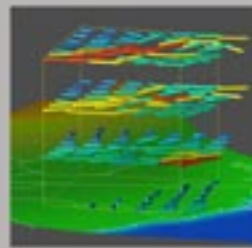different motion sequences.

Dotted lines also
show sequence.

Arrows

Colored arrows
show direction.

Colored arrows on a black
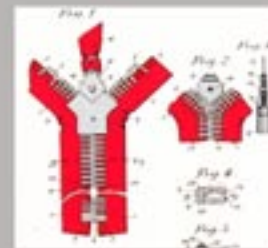and white illustration will
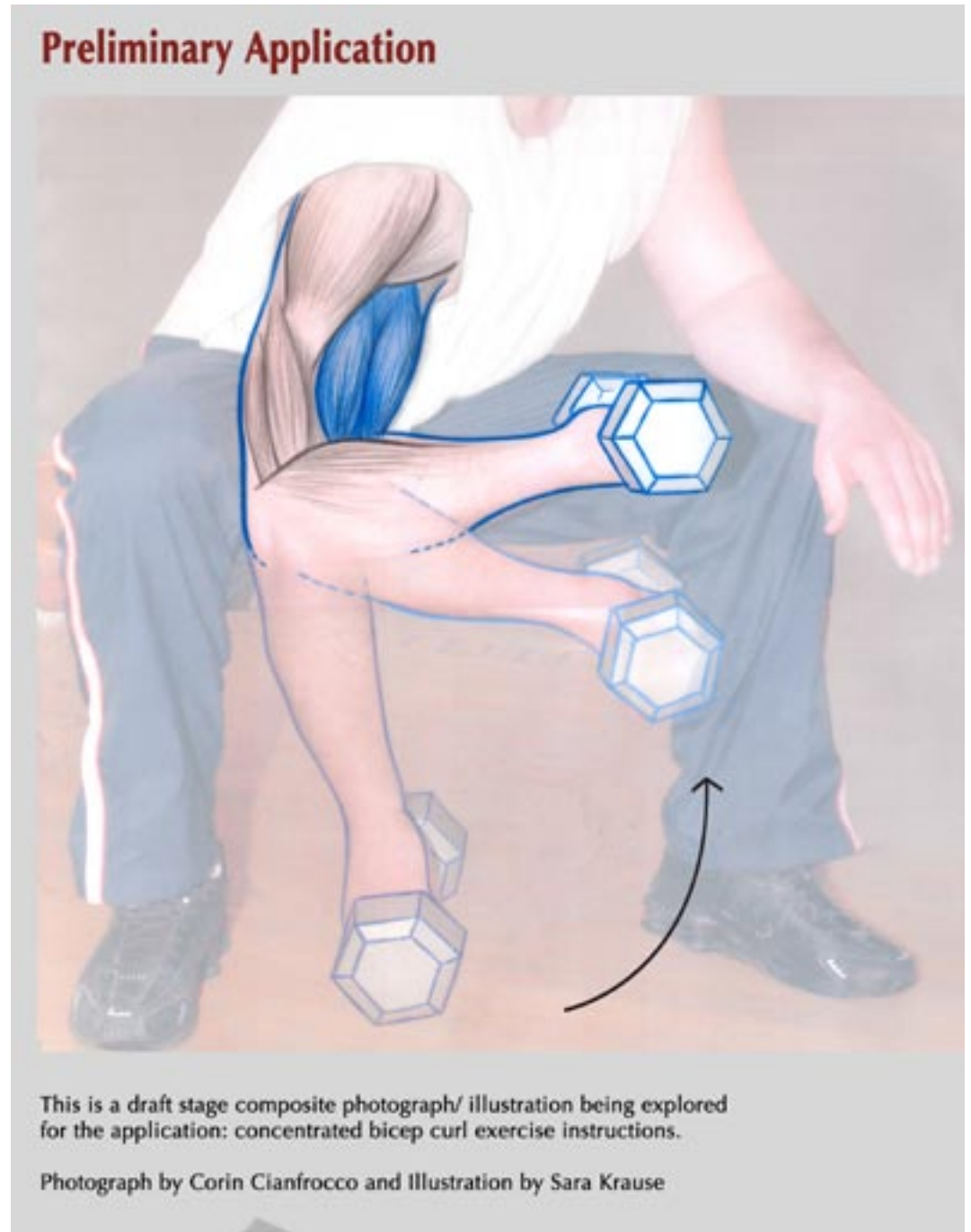help as a consistent
visual cue.

Numbers

Numbers located in the
corner of a photograph
surrounded by color make
the instructions easy to
follow in a step by
step order.

Bold numbering systems and
headings enable the viewer to
determine the order of steps.

It is hard to identify how
many sequences there are
in all.

Too many contrasting
colored arrows on a
color gradiant background.

Too many unidentifiable
labels and numbers.

Panel Four Detail

Preliminary Application

This is a draft stage composite photograph/ illustration being explored for the application: concentrated bicep curl exercise instructions.

Photograph by Corin Cianfrocco and Illustration by Sara Krause

Panel Four Detail

Written Instructions

Preparation

- Sit on the edge of the bench
- Keep knees shoulder width apart
- Keep feet flat on the ground
- Lean forward
- Rest your forearm (slightly bent) on the top of thigh (the forearm that is not being exercised)

1 Grasp the dumbbell and place elbow against your inner thigh. Elbow should be about two inches from your knee.

2 With wrist straight curl barbell up to almost an inch from your chest.

3 Then curl the barbell down toward the floor. You have just completed one full repetition.

Next Steps for Final Thesis Application

- To evaluate the newly designed instructions with groups of people who have no prior experience with this exercise.

- To reshoot the photograph of the model exercising to eliminate unnecessary details.

Appendices C
Final Application

-Poster is located in actual thesis book