Incorporating Visual Design into Information Systems Courses: A Practical Primer *Reshaping the Human, Computer Interface Design Curriculum*

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INTRODUCTION

As the new millennium approaches, thoughts everywhere turn to the rhetorical question, "What does the future hold?" It is a question of great magnitude and one that is not really answerable in full. In part, we can speculate on the state of the economy, the ecological impact current technologies will have on the earth and what if, what if...? But what does the future hold for the computer industry? What new advances will present themselves in the year 2000, 2001 and beyond?

The advances in hardware and other gadgetry generally take the lead story in the news. But what if there was a revolution in the way humans interacted with computers? The revolution has begun, but how can we as educators of programmers and interface designers, more directly shape the changes to come?

Many CIS educators have indicated a need to include some visual communications experience in their classes or in the curriculum, but have also indicated that current curriculums don't really allow for the necessary exposure to visual design that their students absolutely need.

With the advent and ease of Web technology, more and more of the interaction with computers is being performed via a browser and the traditional operating system becomes a staid backdrop against which dynamic human, computer interface takes place. This is too be expected since even Windows '98 and MacOS 8 are a little long in the tooth, having been birthed and remained relatively unchanged since the mid-1970's. The current "Office" metaphor was in the original Xerox Palo Alto Research Center's vision for human Computer interface design. Atari and Amiga both used an incarnation of the current interface for their systems in the early '80s.

Certainly, Super Bowl 1984 and Apple's release of the Macintosh marks the popular introduction of the desktop/office metaphor complete with icons and a trash can. Microsoft's idea of "Web Page Navigation" for your desktop is just a different way of looking at the same old interface. What's new about that?

The visual front end to the Web was the next revolution in the current wave of interaction with a computer using the point and click idea. (Certainly voice communication will be a wonderful addition to the human, computer interface options, but even the best voice recognition engines are hard to train and not yet really mass marketable. The days of computer performing like the system that controls the Starship Enterprise are still in a galaxy...far away.) Transforming from a primarily science based, text based resource to a visually interactive one, was awesome. What it also has done is reduce our need to rely on Windows 3.1/95/98 or the MacOS and to experience individualized interfaces created by unique individuals for the multitudes. This is the future of point and click interface.

This freedom, exciting on the one hand, is disconcerting on the other. It goes away from the strict standards imposed by Microsoft and Apple (and others, but for clarity sake I will only mention these popular mass marketed operating systems). Though HTML imposes other limitations on the interfaces people create, they allow for much more access to interface creation for the common man than either Microsoft or Apple. One cannot easily say, "I think I want to interact with my desktop computer in a different way, today.", and easily whip up whatever their visual heart desires. The Web and HTML allows just that idea to come to fruition. Just ask any high school kid with his or her own Web page.

This hodge podge of visual information is becoming tedious. The next generation will bring a cleansing and visual clarity to the web, that will make it a wonderful place to spend time and interact with computers. How can we assist our students, who will be called upon to design these interfaces, make the leap to this next generation?

A COURSE OF ACTION

As has been pointed out in Incorporating Visual Design into Programming Courses [1] and Visual Design Every Web Programmer Should Know [2], the best option would be to require one or two semesters of traditional fine arts fundamentals for computer programmers. There is a trend in this direction, with some Computer Science curriculums adding a computer graphics track to their majors. Indiana University Southeast, New Albany, IN, has an interesting interdisciplinary approach in that their computer Science track in Computer Graphics will include Fine Arts courses. In addition, Computer Graphics Courses will be taught by the Purdue University School of Technology Computer Graphics department (located on their campus) and then the traditional computer science courses will be taught by the CS department of IUS. The interesting advantage to that is that the art department's digital art track can also take advantage of this idea and arm their artists with some programming experience.

The artists recognized early that the web was a place for them and that the computer side of it was not unmasterable. So they jumped on the Web design bandwagon early. It is time for the technologists and computer people to play catch up.

Being that it is not always possible to alter curriculums to accommodate in depth study into a totally, seemingly unrelated

field, the second suggestion is to incorporate the traditional fine art fundamental exploration into the computer programming curriculum.

Although, possibly an extravagant investment in time, the devotion of the first four full weeks of a computer programming, web course or interface design course to the exploration of visual design concepts is absolutely necessary in this day and age of visual communication. The following theories and related exercises or problems are constructed to allow the student to discover the visual vocabulary of visual design. The student is encouraged to explore visual communication concepts and the principles of design. This approach allows personal expression in the solving of complex communication problems of interface and web design.

This approach to interface and/or web design allows intuitive conceptual ways of problem solving to be developed. There are no clear right ways of solving the problems, but the involving of the student in the solving of the problem at hand leads to this development.

The study of information perception is best summed up by the work of Gestalt Psychologists principally Max Wertheimer. The study of how humans perceive and group information by assigning it value relative to other information presented in the same filed of view is extremely important to programmers responsible for interface and/or web page/site design. We are familiar with some of the following illustrations, but others will underscore the importance of understanding these building blocks for the presentation of visual information.

Additionally, in a two dimensional world, which is primarily what the computer screen allows, the matrix of the visual field contains two axis: the x and the y. Visual information, even 3 dimensional representations, can be placed on the field of view only in the x and y directions. With interfaces, there is the addition of a third pseudo axis (z), which contains the idea of action/reaction and consequence. Once the aesthetic (x and y placement) has been satisfied, the information regarding a visual elements function needs to then be considered, but we are jumping ahead to interactive/interface design issues.

GESTALT GROUPING PRINCIPLES- Building A Vocabulary

The Gestalt Psychologists broke presentation and perception of 2 dimensional information down into what they called Grouping Principles. The grouping principles help artists and designers understand how humans perceive the visual field of view. Though each principle looks at the parts of an image, the overriding idea is that the whole is greater than the sum of the parts. The patterns that are formed by the parts take precedence over the individual parts. (Figure 1).

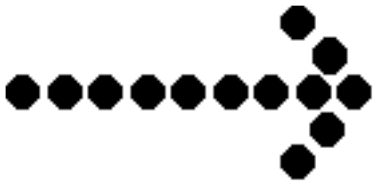

Figure 1-Pattern formed by parts takes precedence over each individual part

Figure and ***ground*** (sometimes called ***field***) - two inseparable ideas in visual design. Referred to as ***framal reference*** by Wong [6], this is the reference to the arbitrary frame that exists around everything in order to provide a context for the perception to focus on. The figure below is a classic one that demonstrates a figure/ground relation ship in equilibrium that creates an ambiguous focus. We cannot see both figures at the same time, but we switch between them. The other figure/ground illustration shows a more useful concept and includes the idea of interruption.

Interruption - the perception that something within the frame needs our attention. Dialog boxes and system warnings certainly are interruptions in the framal reference. This principle can also be utilized in describing the arrangement of elements on the screen.

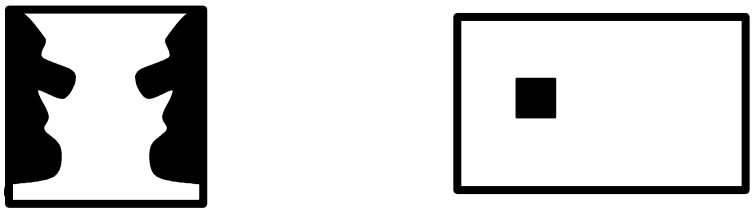

Figure 2-Equal figure ground (ambiguous) and interrupted figure ground.

The major grouping principles of ***proximity, similarity, continuation*** and ***closure*** as explained by Larkin are key ideas in the organization of visual elements and their relative importance to each other and the user. There is a hierarchy of perception to these grouping principles [Larkin]. Greater importance is perceived in objects that are in close proximity to each other. The converse is also true in that we tend to diminish the importance of the relationship between two objects as they recede from each other. Viewers have a tendency to assign greater importance to objects that are similar. Similarity is given greater weight than proximity. Items that are in close proximity but also form a continuation or the perception of a continuation tends to take precedence over both similarity and proximity.

Proximity-The brain organizes information and visual patterns by grouping. One way in that this occurs is by proximity of elements to each other. They appear to be associated just because they are close to one another. The figures below (figures 3 & 4) from Larkin and Bruce & Green help to illustrate this concept.

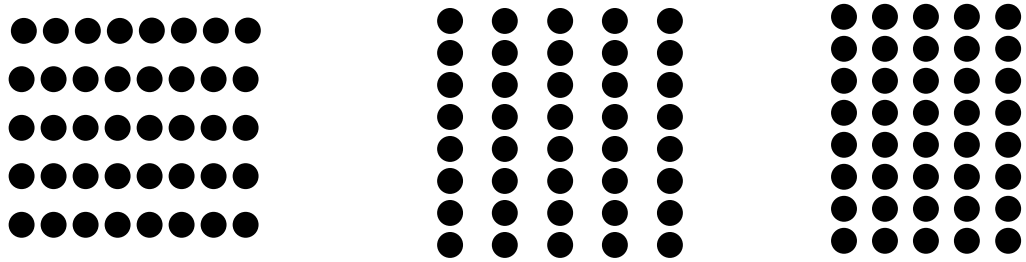

Figure 3-Proximity of dots to form rows, columns and equal distribution. By shifiting the proximities ever so slightly we achieve 2 recognizable patterns and one ambiguous one.

Figure 4-Proximity of objects adds visual weight to a composition giving the group with the greater proximity more importance. **[3]**

Similarity-In the visual field, our brains (through the use of our eyes) can pick out things that are similar to one another even though they share the same proximity as previously illustrated. Items of similar shape, color, texture or other variable attributes seem to belong together just because of looking alike. Figure 5 demonstrates this idea.

Figure 5- Recognition of the similarity of the grey squares to each other and the black squares to each other is perceived as more important than their relative proximity. **[3]**

Continuation-Continuation is the principle of leading the eye to where you want the viewer to focus. It is an instinctive trait of humans to follow a visual path. The path can be literal or imagined. Wucius Wong also call this ***conceptual line***. Literally, objects that points are using the idea of continuation. Our ability to imagine pictures in the stars is an example of our use of continuation.

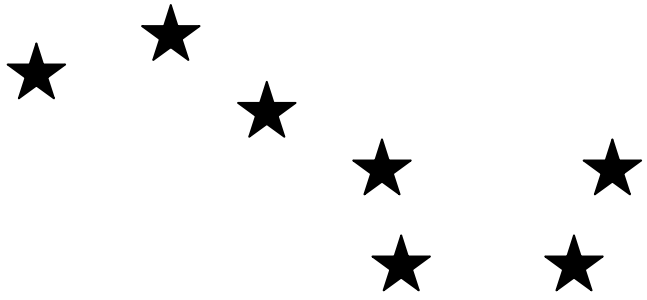

Figure 6-Constellations or pictures in the stars is an example of our use of continuation to organize visual parts. **[6]**

Closure-Humans possess the innate need to close gaps and complete shapes. This is how we read text and view visual information. We make assumptions regarding the finishing of visual input. Visually a closed shape leaves nothing for the mind and imagination to do, but an open shape is much more interesting and leaves exploration to the viewer.

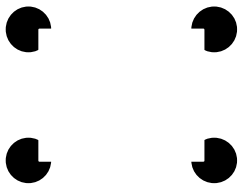

Figure 7-Here the viewer sees the square even though it is only implied bye the position and shapes of the other objects. Our need for closure finishes the picture.

Upright and ***horizontal*** - Viewers are very comfortable with things that are level and plumb. We seem to instinctively know how to deal with the major axis that relate to 90 and 180 degrees and even the major sub divisions of 45 degrees. Humans have a tendency to become uneasy with anything that strays from this expected norm. Deviating from these norms can be disconcerting, but can also be utilized to create an emphasis and focus.

Figure 8-Humans have a strong expectation of upright and level. Everything we see is judged against it. Straying from it can create emphasis. **[3]**

Balance and ***symmetry*** (and conversely ***asymmetry***) are key design principles that most people understand. A clear understanding of the use of these principles and their effect on the user's perception is essential in successful design. Symmetry, although fairly simple for any user

to achieve, can result in a less than exciting design in that it places equal value on all forms within the field. This results in lesser sense of emphasis and importance for key forms. Asymmetry becomes important then in creating the visual road map which the viewer must explore as they interact with the design.

Use of ***positive*** and ***negative space*** is another seemingly minor, yet essential ingredient in visual design. The student must understand that form occupies space (positive space) and that there is space around each form (negative space).

Repetition, rhythm and ***pattern*** are design principles that complement each other, according to Larkin. Repetition is an example of grouping similar forms in an effort to satisfy the user's perceptual need for a sense of order and wholeness. The user recognizes these traits and the eye is drawn to it. Repetition is the most powerful when the variables of size, shape, texture and color are equal.

The use of rhythm is the designer's ability to use sustained repetition to assist in the provision of a sense of order. Pattern is simply the expression of this rhythm over a continuous area.

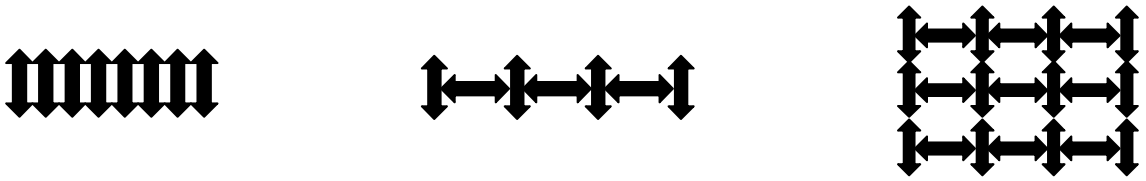

Figure 9-Repetition, Rhythm and Pattern. **[3]**

The concept of ***direction*** addresses the horizontal and vertical alignment of forms in the frame. This is similar but more deliberate than continuation and has to do with established expectations. Direction, when used effectively, can manipulate the viewer's line of sight in order to create emphasis and focus. Direction is effective when used in a logical approach such as the arrangement of forms in a left to right pattern - the way in which most western countries read text. However, breaking the logical directional expectation can also be useful in guiding the user to a particular point in the visual field.

The IS design student should be knowledgeable about the impact of ***color***, ***texture*** and ***contrast***. These tools can be used to create emphasis, focus, hierarchical importance and pure aesthetic appeal. Instruction in the use of these tools could be a course in and of itself.

Value is the lightness or darkness of a form that supports the perception of the user in developing focus and appeal. This concept must be grasped early in the visual design learning process. Greater or lesser value is assigned to an item dependent on its relative value to other items in a group or items in proximity to itself. A common use of this technique is the "graying out" of items that in a particular context are not available or needed.

Information can be organized over an area or on a screen with the use of ***grid systems***. This technique has been employed in graphic design for centuries. The key to using this tool lies in the designer's ability to utilize an underlying and invisible grid to aid in the alignment of visual information. The development of this skill can be exciting and empowering to the student. A related challenge exists in learning how and when to deviate from this grid.

Perspective and the laws of perspective should also be included in any pursuit of visual design. Wucius Wong talks about planar distortion and puts forth the idea that the shape of something will be perceived as changing as the designer manipulates the plane in space.[5] The idea that a flat square when viewed stragiht on will distort as the bottom edge comes up and toward the viewer illustrates this idea.

Figure 10-Using perspective theory to distort a square to achieve a different shape.

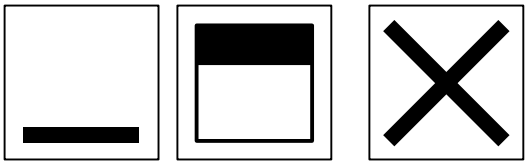

Figure 11-The Microsoft Windows '95 Minimize/maximize and quit buttons

Now with a dynamic visual field, which is what the Human, Computer Interface is, the z-axis comes into play. The arrangement of icons on a screen not only relate visually in terms of size, shape and pictorial description utilizing any and all as described above, the assumption is that they are grouped functionally as well. The hope is that the screen designer really understands the consequence and logic of each action and that the "buttons" or "icons" relate in terms of their tasks as well. I want to point out a possible oversight in the MS Windows '95 environment that will hopefully illustrate this concept.

We are probably all familiar with the Send to Task Bar, Minimize/Maximize, Close All buttons that reside in the upper right hand corner of every MS Windows '95/98 program. (See figure 11). We all understand the functions of each of these buttons. On one hand, in terms of the grouping principles and including the idea of the z-axis and action/consequence, it makes some sense that these 3 buttons are together. On closer examination, the third button, the close all/QUIT the program button has a much higher catastrophic action content than do the other two buttons.

Figure11 shows these buttons and their placement. There has been an attempt to physically and to visually separate the third button from the first two. This as we have experienced doesn't help. Their physical proximity to each other often leads us to QUIT the program instead of either

minimizing, sending to the task bar or just closing the document inside an application (which has a lesser consequence than QUIT). I think if MS designers had fully thought about the grouping of the visual/action information, they would have left the close/quit button out of this group (and separated it as they had in Windows 3.x). The reason we tend to make the same mistake time and again is because we accept the grouping information (proximity and even similarity) regarding these buttons and tend to overlook the disastrous consequence of that third button. (Hopefully, MS will make a change when they are aware of this idea fully and the close/quit button will be separate from anything since its finality is an overriding attribute of that visual icon.) Simply employing a different color would help.

The idea of grouping screen elements by their actions needs to be more fully explored and is often covered in current curriculum. The student needs to be reminded of this idea of consequence of action when assigning actions to objects.

CLASS PROJECTS FOR WEEKS 1 THROUGH 4

Below we have included some projects that are employed to challenge and build a student's visual literacy. Honest work on the students' part is needed in order to make these projects useful and the students should be encouraged at each step. They should know that there are no right or wrong answers or choice, just whatever they think and put forth at the time. Some will rise to the top, but it should be in service of illustrating that sometimes there are more effective solutions and not to discourage attempts on the students' part.

Visual literacy is an important skill to have in this visual world. More and more people are reading less and the information exchange is becoming a cacophony of imagery. The problems in this article are merely the beginning of what should be a life long pursuit of visual literacy, human perception, information exchange and interface design.

Some of the following problems are based on exercises presented in Judith and Richard Wilde's book entitled: *Visual Literacy: A Conceptual Approach to Graphic Problem Solving*[7]. Other exercises are from the authors' own experiences as student s and teachers of visual design, IS and computer graphics. These exercises are to be included in a course after a brief introduction to the concepts explored in Eugene Larkin's book, *Design: The Search for Unity* [3], an exploration of the Gestalt Principles explained earlier and the Wucius Wong materials from his book, *The Principles of Form and Design* [5].

PROBLEM 1-BLACK SQUARE PROBLEM

By using four black squares, initially of the same dimension, create a graphic image to communicate and express the meaning of the following words*: order, increase, bold, congested, tension* and *playful.* The student should make eight preliminary sketches for each word. The student then should select the most effective solution for each word and execute it in a larger area (10 inches by 10 inches).

The exploration here is suited to discovering a visual and geometric idiom relating to the ideas of: framal reference; touching; overlapping and cropping of unit forms; contrast of elements utilizing size, direction, space and position and the dynamics of positive and negative spatial relationships [7].

Using the principles of perspective, the squares can be of differing sizes and change shape as long as perspective dictates the changes. This furthers the range of solutions to explore. By making choices to alter a known shape, rather than just choosing the new shape, engages the student in the thought process more and doesn't allow them to jump to solution without exploration, a common problem of young designers.

The materials used for this exercise are black construction paper, exacto knife, white cover stock and adhesive. Figure 12 shows a sample.

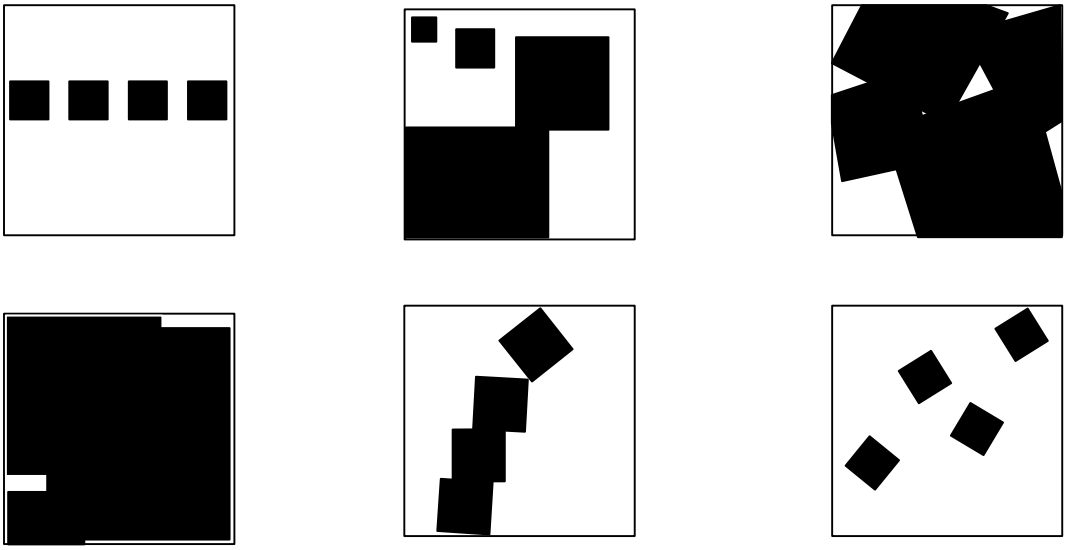

Figure 12-One possible solution to the Black Square Problem. From top left: order, increase, bold, congested, tension & playful.

PROBLEM 2-GRID CREATION

Understanding and using a grid to organize visual information is important. Having the students create grids of their own allows them to experience the grid first hand and to deviate from the traditional horizontal and vertical grid. They should be encouraged to employ geometry and lines other than square (the most common and most stable form) and to let their imaginations go. They should create 4-8 grids using black marker, sketch paper and a straight edge or other tools such as circle template (bowls make good circles, too) or ellipse templates to achieve the shapes.

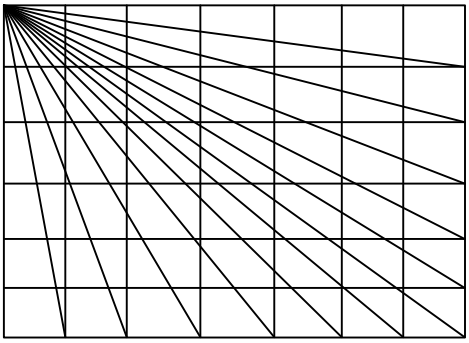

Figure 13-One possible solution to the Grid Creation. Focus should be on non-square grids and the exploration of other shapes.

PROBLEM 3-PICTURE REARRANGEMENT

This project is a direct continuation of the previous one. It involves the student either using a previously constructed grid or a new one (recommended) and overlaying the grid on a picture from a magazine. Then the student rearranges the picture based on a written set of rules. The rules will inform how the pieces, once cut to match the grid, will be rearranged. For example, using the grid from above, the pieces are numbered. Then a list of previously written instructions (like a computer program) determine that piece 1 will move two pieces to the left and that piece 3 will go to piece 5 and so on until all the visual information is in a different place. Emphasis should be placed on pre-creating the instructions once the grid is made and before the picture is chosen. This disallows the students forcing the new composition and allows it to just happen based on their rules.

This project emphasizes risk taking in visual choices, the ability to set and apply some choices with out knowing the outcome and combining techniques (the grid creation with the need to rearrange visual information) to solve a visual problem. So many of our students are concrete cognitive thinkers and they need to know they can think abstractly, too, in order to solve a problem.

PROBLEM 4-JACK AND JILL PROBLEM

The student is to create visual solutions for each line of the nursery rhyme *Jack and Jill* by using a limited symbol vocabulary provided by the instructor. The six lines are as follows:

- Jack and Jill
- Went up the hill
- To fetch a pail of water
- Jack fell down
- And broke his crown
- And Jill came tumbling after

This vocabulary can consist of *dingbats*, *symbols* and *picture fonts* or *typefaces* of the instructor's choosing. Below in Appendix A are samples of what we have used in the past.

The student should be limited to black and white unless there is a compelling reason to use color. Even then it should be limited. The space for each solution should be uniform and no larger than 10 inches x 10

inches and no smaller than 5 inches x 5inches.

The intent of this project is to get the student developing a visual vocabulary that goes beyond the literal. The student should be moved to understand the infinite possibilities within the limited language offered by the symbols. The expansion of the designer's problem solving vocabulary is at the heart of this project. It is also closely related to the developing iconography at the core of interface and web design-allowing freedom to redefine and reshape the language of computer icons on screen.

The problem also touches on the dynamics of composition and scale in relationship to the framal reference [7]. Cropping and overlapping of images are also a factor to be explored. Positive and negative space are strong ideas in this project and the idea that one thing can accurately and succinctly symbolize and communicate something that it is not. The idea of flow from one thing to another is particularly important as the rhyme visually progresses from one frame to the next.

The materials for this project may include the use of a photocopier to reduce or enlarge images, an exacto knife for cutting and adhesive to affix the symbols to white cover stock.

CONCLUSION

Exploration of visual design principles is necessary for today's information systems professional and for the next century's as well. Requiring traditional semester long exploration under the tutelage of a master visual communicator would be best for our students. Partnering and team teaching the visual portion of a programming class would suffice. In lieu of these choices, the teacher of CS/IS and MIS students should familiarize themselves with the information presented here and through additional exploration equip themselves with the necessary visual tools to give their students a leg up in toady's visual information world.

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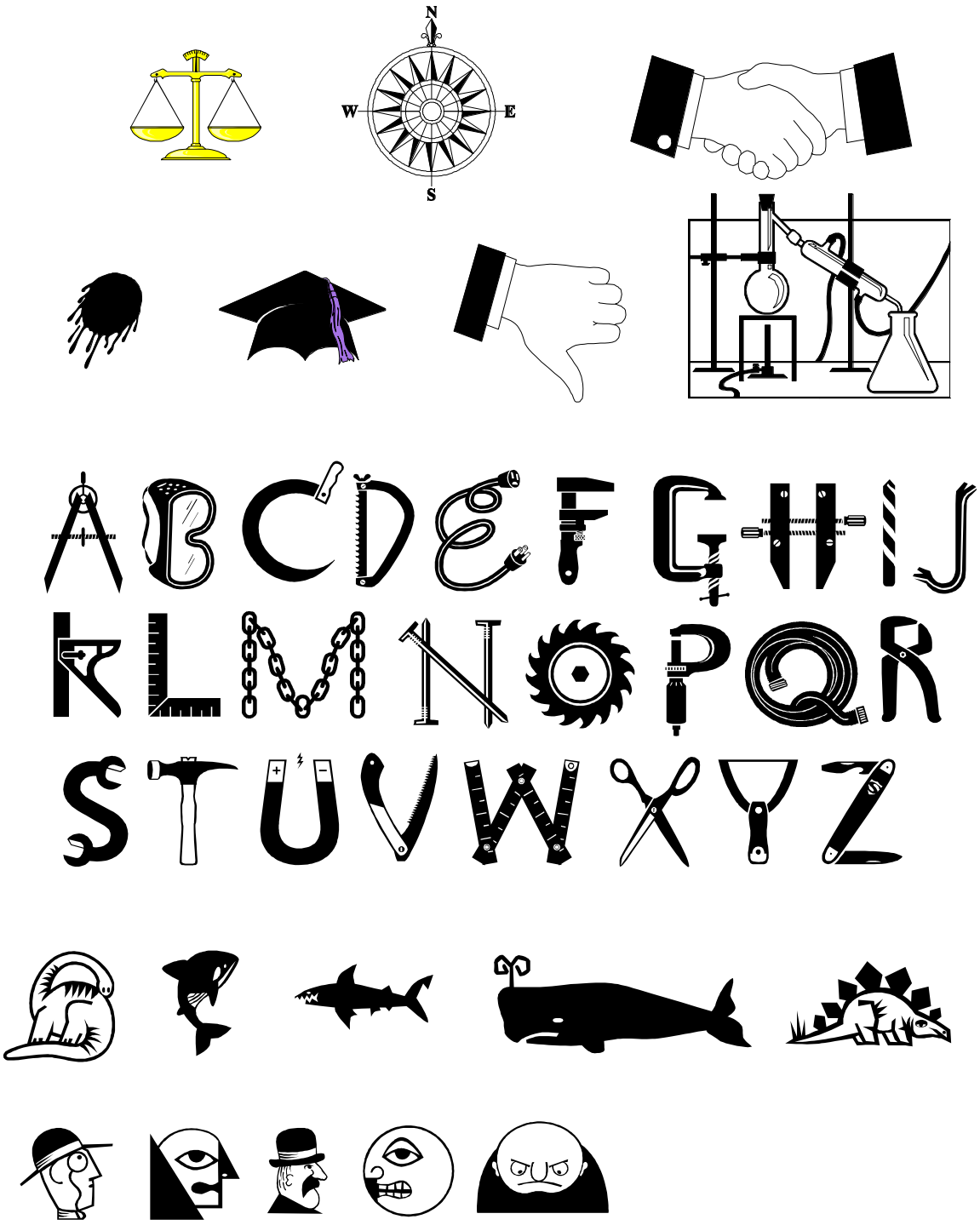
Appendix A-Fonts and Clip Art for the Jack and Jill Problem
Clip Art, Tools Font, Mini Pics & Giddyup Thangs Font

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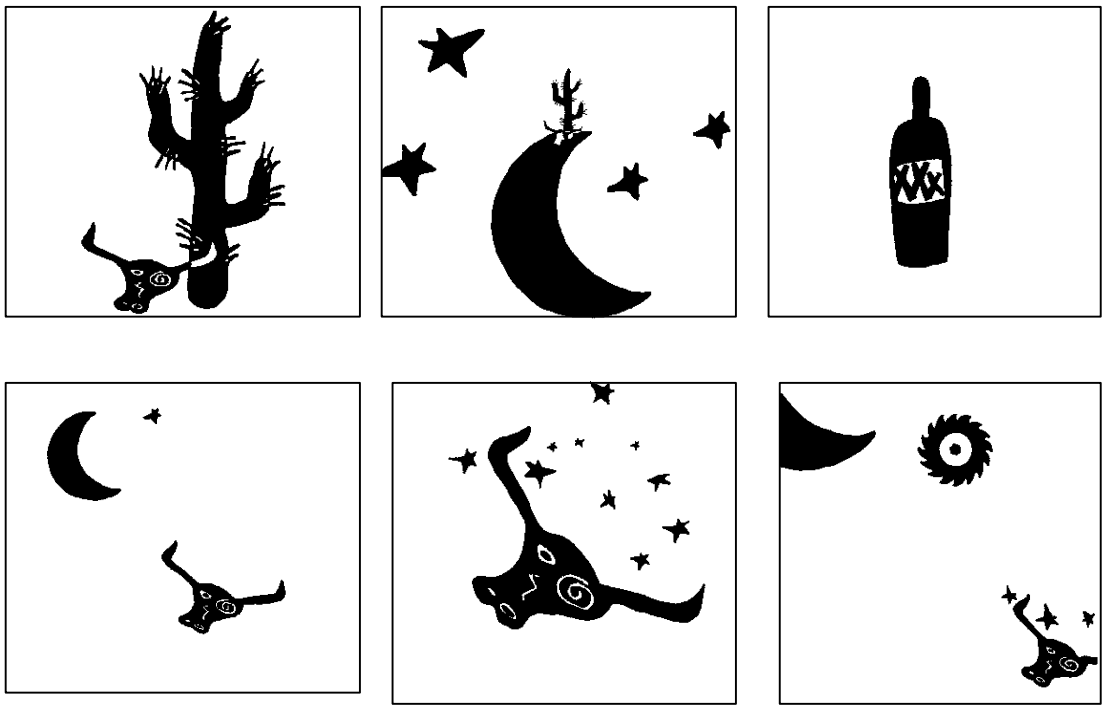
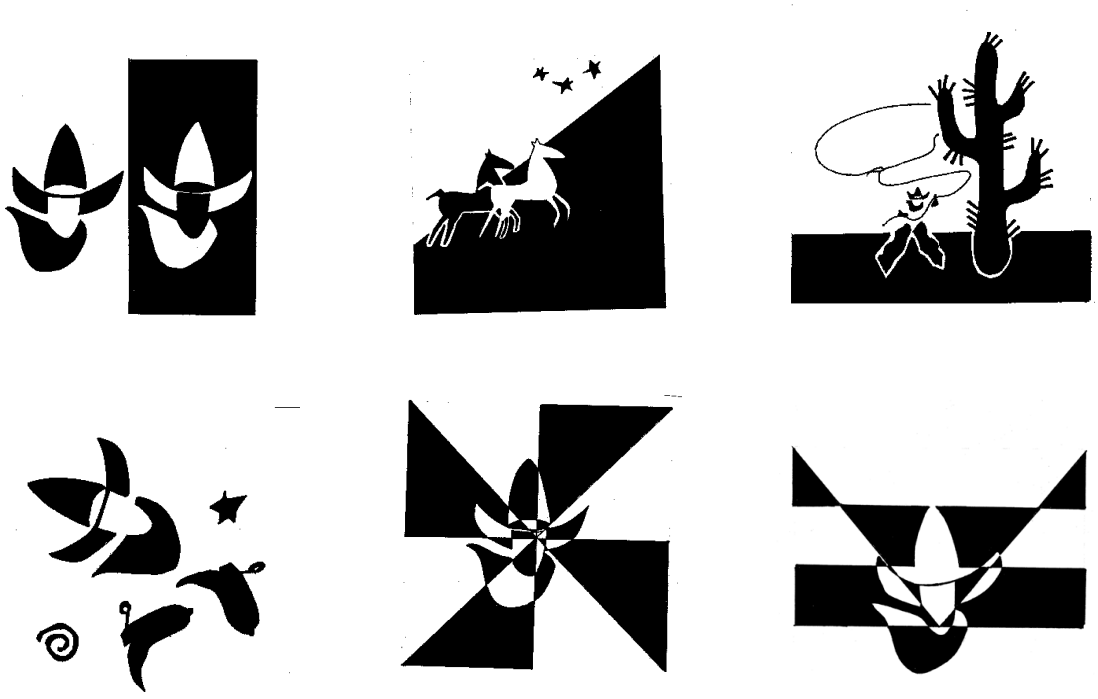
Appendix B-Jack and Jill Solutions

Solution 1



Solution 2



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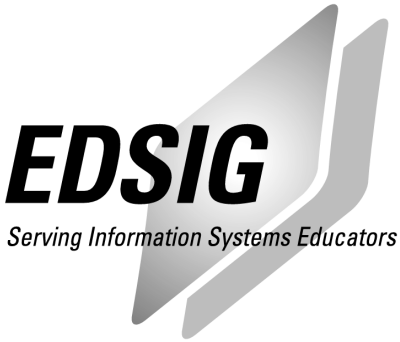

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