2005

Designing Medical Legal Exhibits: A Guide to Creating Successful Presentations

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Original thesis proposal

The focus of my thesis is to decide what types of exhibit layouts and design principles are the most successful in conveying anatomical information accurately, efficiently and effectively to the layperson in a jury. In order to ascertain this information, I decided that I needed to go directly to the source: professional medical illustrators who create exhibits for trials.

The inspiration for my thesis topic came from an internship I completed at Anatomical Justice, LLC, located in Nazareth, PA. For the bulk of my research, I plan to interview the medical illustrators in order to obtain their valuable viewpoints of successful design based on their experiences. I will then use the information collected from supplemental research, interviews and my own experience to compile a written guide to defining how exhibits are used, what the impact is on the audience as well as what a medical illustrator in the field could revise in their techniques in order to make their presentations stronger.

Preface

This thesis provides design instruction for medical illustrators, whether they are students interested in the medical legal profession or are current professionals in the field. The information presented encompasses ideas and facts about design, literacy, attention, retention and recall so that medical illustrators can incorporate this knowledge to create persuasive exhibits. My research will show an illustrator how to improve their current graphics and layouts and to understand why they are better suited for juror comprehension.

Although there are many types of demonstrative evidence available for litigation, this paper pertains to the design of large format printed posters containing medical illustrations, as opposed to media that are displayed via computer or television monitor. Advantages of printed exhibits are the ability to refer back to the boards with ease and having the flexibility of being displayed in the deliberation room. Overlays may be included to show progression or to write on.

Each board can show causation, liability, or damages. These goals depend ultimately on what information the attorney wants to convey while communicating to the jury, the judge and opposing counsel. Ultimately, the illustration explains what happened and the consequences. Each type of exhibit is interrelated in the way that they depict an injury and explain the causes of the injury. The specific focus is what differs between the three types of boards. In order to explain the differences of the three exhibit types, consider the example of a
cholecystectomy in which the surgeon clips the wrong duct. This mistake leads to further surgery to reconstruct the damaged biliary system.

In a causation board, the lawyer wants to explain what caused the injury. It could be surgeon error, as in clipping the wrong duct, or many other factors. A liability exhibit shows who is responsible for the injury. In the case of the wrong duct being clipped, the surgeon made the error and deviated from the standards of care. Finally, a damages exhibit depicts the injury and its subsequent repair. In the cholecystectomy example, clipping the wrong duct is the injury and the necessary surgery to repair it demonstrates the damages.

Just as each case is different, the display boards that accompany them to deposition and/or trial are also unique. Though each board is specific to each case, basic design principles of medical legal exhibits remain consistent. We will look in depth at basic design concepts and create design guidelines to convey medical information accurately, efficiently and effectively to the layperson in a jury.

Part I
What is demonstrative evidence?

It is important to understand that there are two types of evidence used in courts: substantive and demonstrative. In order to comprehend demonstrative evidence, the types of substantive, or physical evidence must be introduced.

Evidence is substantive when it is: a witness communicating with a trier of fact (jurors or the judge), the evidence is a hard copy, or is physically palpable (Brain and Broderick 1994). Substantive evidence can be accepted easily into a courtroom because it is admitted to prove a fact and is most often difficult to make objections against.

Demonstrative evidence does not have the same physical characteristics, but it supports substantive evidence. According to Brain and Broderick (1994, 74), demonstrative evidence is defined by its purpose, which is to “explain or illustrate other previously admitted pieces of substantive evidence.” Demonstrative exhibits are used to supplement the testimony of expert witnesses, who in the medical legal spectrum are usually physicians, and to clarify anatomy and type of injury to laypersons in juries. When difficult medical techniques are distilled so that a layperson can understand the issues, the impact is far greater because the terms are easier to comprehend.
The true purpose of demonstrative exhibits is to illustrate points that may not be accurately conveyed using *only monologue* from the attorney to the jury. The difficulty with verbal testimony is that "the bare written or spoken word, even if organized, explicit and built logically commands little attention and has little impact on a passive audience, such as a jury" (Gass 1992, 4). This is especially true when an expert witness is giving testimony about complex surgical techniques and human anatomy. The witness may speak about the subject matter in medical terms, rather than in layman's terms. This is where demonstrative evidence can be extremely beneficial in reminding the expert witness to refer to the imagery and use common names for anatomy as well as to simplify complex terminology. "An expert should be able to explain, teach and articulate his or her knowledge to a trier of fact in a persuasive and effective manner with the ability to make abstract concepts concrete and simplify the complex" (Caroselli 2004, 42). This is not only the job of the expert witness, but of the medical illustrator as well.

Medical illustrations are the foundation for demonstrative evidence in medical legal cases, whether the exhibit is created for the defense or for the prosecution. This is especially true since, "demonstrative exhibits are more likely to catch the jury's attention than any other piece of evidence" (Brain and Broderick 1994, 75). Exhibits are more informative to a layperson that has been conditioned to getting information visually, from things like road signs or television. Although these examples may seem trivial, a medical illustration in an exhibit, "when confirmed as realistic by the treating physician, may help substantiate the victim's reasonable fears that he or she might have died from the wound" (Turley 1989, 63). Since the physician deems an exhibit accurate, "it creates an additional sense of credibility and authority to the exhibit since the expert will be testifying from the exhibit" (Ziegler 1993, 5). The heightened sense of credibility is beneficial for either litigator in the case because "jurors identify and relate to people who help them understand" (Solomon and Seidler 1992, 21). Jurors comprehend the information more effectively and are more likely to trust an expert's testimony.

In any situation when communicating medical information, the illustration cannot be sensational and/or gruesome due to admissibility issues (Buso, Carney, and Samson 2002). With substantive evidence, admissibility is not in question. However, with demonstrative evidence, matters of admissibility are complicated. This type of evidence is only meant to communicate an idea or concept and there is opportunity for misinterpretation.
In order to determine if a demonstrative exhibit is admissible, it must satisfy basic requirements of relevancy and materiality (Turley 1989). The exhibit must clearly and accurately depict the evidence and corresponding to the testifying expert's description and proving that the information is not misleading. Demonstrative evidence cannot be considered cumulative, or a summary of substantive evidence. It must explain the issue, add to the testimony and aid in the description of an injury (Gardner 1996). Ultimately, demonstrative evidence must not "mislead, confuse or unfairly prejudice the jury" (Turley 1989, 67). Possessing the ability to mislead is the most obvious objection that can be made against a demonstrative exhibit.

The illustrator and attorney must be careful with the admissibility of vividly colored anatomical exhibits. "It is absolutely imperative that the artwork produced is 100% accurate. A case can so easily fail, should the defense counsel be able to demonstrate any inaccuracies" (Oliver 1994, 13). In some instances, the court may find that the evidence does relate directly to the issue of the client’s disabilities (Gardner 1996). This becomes detrimental to the attorney's argument and decreases the amount of damages. In the end, the opinion of the jury is changed and they do not see the attorney, witness or exhibit as credible.

Psychology of visual aids in the courtroom

In order to design courtroom exhibits, attorneys and medical illustrators need to understand the preferences of their audience. This can be extremely difficult because the composition of a jury can be complex. It is best to make design decisions on the basis of what is known about the preferences of the majority of the population combined with knowledge of how people learn.

Studies have shown that some people are right-brain, or visual learners and some people are primarily left-brain, or auditory learners. Although learning styles vary and people have more than one style, "visual communication cuts across every major learning style" (Gripp 2002b). For a medical illustrator wanting to communicate complex medical information to a layperson, visuals are the obvious medium to utilize. Neurophysiologists believe that one-third of the human brain is devoted to visual memory (Kuehn 1999). Not only is a majority of our brain reserved for visual stimuli, but also, American culture has trained people to look for information visually. For example, many people receive information from a television. At graduation, the average high school student has received approximately 11,000 hours of classroom education and has viewed...
an estimated 15,000 hours of television (Kuehn 1999). It is not difficult to see that visual media will be successful in portraying information under any circumstance.

Although it is obvious that visuals are a successful way to communicate, how is it known that the information being presented to a jury is being retained? In order to put this into perspective, it is necessary to understand how information is received from our environment. 1% of information is received by taste, 1.5% by touch, 3.5% by smell, 11% by hearing and 83% by sight (D’Arcy 1998). The Wharton School takes a step further and researched the effect of visuals on learning. The research showed that 75% of what is learned is acquired through our eyes (Solomon and Seidler 1992). From this study, the message is clear. The majority of sensory perception is devoted to vision.

The Wharton School observed the retention of information after three days from a presentation without visuals compared to the same presentation with visuals. Retention jumped an astonishing 55% when visuals were added. Another examination of jury retention found that “telling alone produced an audience recall of 70 percent of the material three hours later; only 10 percent after three days. Visuals alone produced 72 percent recall of material after three hours; 20 percent recall three days later. But auditory and visual stimuli together produced 85 percent recall after three hours; 65 percent after three days” (Weiss 1963, 78). Therefore, it is essential to include visuals during testimony because “a picture is the best medium for ensuring that the spoken word is comprehended” (Gripp 2002b).

No matter what the presentation topic may be, the visual communicator’s goal is to have the intended audience retain information. In a trial situation, this means delving into the subconscious of the jurors. “Visual imprinting of ideas and feelings is the most direct path to the sub-conscious and, hence, the critical importance of visual aids during trial” (Solomon and Seidler 1992, 21). The goal is to inform and persuade the jurors to favor their client. It has been documented “jurors base their decisions on their own experiences and beliefs” (Rouda and Bailey 2000, 55). In the end, they can still be persuaded. Demonstrative evidence can help guide their perceptions and aid them in drawing conclusions about the evidence. To understand how this is successful, the two domains of the human brain, which are fact and meaning, must be incited (Heninger 2000). The jurors can be told the facts of a case, but meaning can vary from individual to individual. Demonstrative evidence pinpoints the visual senses and conveys a more meaningful message about the evidence, which can influence the jurors’ decision-making process.
Visuals are also effective for providing jurors with a shift in stimulus. Studies show that concentrating for long periods without a break decreases juror attention. Research proves that segments of uninterrupted information should not exceed 20 minutes (Kuehn 1999). Once 20 minutes is exceeded, the focus of the jury begins to diminish. With the use of interesting visuals, the jury can be persuaded to focus on the case. The exhibits can add variety and clarity as well as holding attention.

Visual aids make great communication tools due to the ease at which they can be processed and understood. With verbal communication, thinking is sequential. With visuals, a sequence is not seen, but rather imagery or concepts are taken in at once (Gass 1992). Visuals are processed up to 400,000 times more quickly than text (Alley 2003). For a courtroom scenario, visuals are ideal. The discussions and testimony could be shorter and can reduce overall testimony length by 28% (Gass 1992). In relation to a jury decision, a trial without visuals results in a consensus of 58%. When visuals are obtained, consensus increases to 79%, even though most juries reach a consensus (Gass 1992). A hung jury is a rare event, so all trials end with a decision, but visuals aid the process of consensus formation.

Processing visuals is faster than comprehending text. This is true simply by the nature of how imagery is perceived versus textual information. The condition of literacy rates of adults in the United States is another, more controllable factor attributing to inadequate text comprehension. Research shows that about half of the population surveyed has some level of difficulty in understanding large amounts of text. From the Executive Summary of Adult Literacy in America (Kirsch 1992), over 26,000 adults were surveyed and placed into 5 different literacy skill levels: Level 1 and 2 being the lowest and Level 4 and 5 showing the highest level of prose. Level 3 is intermediate and includes those who had less difficulty than those placed in Level 1 or 2 with performing tasks that included integrating information from complex or lengthy texts. The results were then calculated to correspond to the 191 million adults residing in the United States. The results showed that 51% of the adult population nationwide belonged in Level 1 or 2. In other words, 94 million adults in America have difficulty with prose and comprehending complex texts and therefore have a literacy skill below average. With this information, medical legal art is an unquestionable means to convey ideas, anatomy and medical techniques. The results of examining literacy are particularly important for anyone in a communication field so content can be focused is such a manner that it can be easily interpreted. In design, this is achieved by decreasing the amount of text, making it subordinate. Visuals are the major focus.
In some states, slightly more than 50% of the population graduates from high school (Kantor 1999). Given the literacy statistics, this does not seem surprising. Americans do not take advantage of printed media, which may account for the literacy rates. Americans do, however, watch approximately 25 hours of television per week and are less likely than those of other cultures, to read print media, like newspapers. This finding is reason enough to recognize the overwhelming importance of visuals in American culture.

Given these statistics, one can see how a layperson in a jury may become frustrated and lose interest if complex information is not broken down and conveyed in an intelligible manner. The importance of medical illustrations as demonstrative evidence cannot be overlooked. With the inclusion of interesting trial visuals, the jury’s attention can be sustained and retention can be increased.

**The role of the medical illustrator**

The attorney’s task is to “heighten jurors’ perceptions and illustrate the facts of the case” (Heninger 1994, 65). He/she does this verbally, with the aid of witnesses, substantive and demonstrative evidence. Medical illustrators accomplish it visually. “The medical artist has a growing role in clarifying often obscure details of medical cases, which may contribute to the early solution of such legal disputes” (Oliver 1994, 14). As discussed previously, the use of visuals can shorten the length of meetings as well as deliberations. These exhibits, created by a medical illustrator, are invaluable resources for conveying information adequately and accurately.

A medical illustrator needs to be aware of whom they are working for and for what purpose. The illustrator’s client “is the attorney, expert or paralegal who is directing the graphics” (Kantor 1999, 5). The ultimate use for the artwork is to explain information in a courtroom. Therefore, the audience is the “trier of fact: a jury in a jury trial, or a judge in a bench trial” (Kantor 1999, 5).

The production of demonstrative evidence is a complex process. The illustrator relies on medical records, radiological films, physician’s input, the attorney, medical experts and their own training in order to complete an exhibit. “If demonstrative evidence is simple, accurate and relevant, its potential is unlimited” (Christy 1994, 70). Extravagance is not the goal of a medical illustrator, but they are the ones “who carry the responsibility for ensuring that the presenter’s story is told in language that is appropriate to that medium” (Johns 1998, 17). The attorney relies on the illustrator to properly portray the injury and damages so that they
can do their part in the courtroom. The illustrator must follow basic design principles so that exhibits are cohesive and appealing yet still relay the proper information.

**General Design Theory**

In order to appreciate specific design decisions made in medical legal art, basic design principles must first be understood. Then the considerations made by the illustrator to create an exhibit for the layman may be appreciated. There are many details and elements that must be accounted for in any type of visual media. Since the goal of any media is to create an impact, artists learn how to manipulate various aspects of their work in order to incite the reaction they desire.

There must be a relationship of the elements within a layout so there is a “plan of organization that determines the way in which the elements must be combined to accomplish a particular effect” (Graves 1951, 17). The effect the creator wishes to portray varies from project to project and can be influenced by such criteria as medium, size and presentation. Since there are many decisions an illustrator must make, there are guidelines for creating successful visuals.

Illustrations provide visual impact and create interest that attracts the viewer. Clarity of the imagery holds the attention of the audience because the viewer does not get confused or discouraged by the display. If clarity in imagery and design is compromised, the whole purpose of the design could be overlooked.

Along with imagery, the text that accompanies it must also be organized and displayed in a logical way. There are generic rules of typography. The first principle of successful typography is to choose simple typefaces. There are two kinds of type: serif and sans serif. Serif fonts are those that have finishing strokes at the end of a character (Strizver 2001). Examples of serif typefaces include **Times**, **Baskerville**, and **Caslon**. Sans serif fonts on the other hand, lack the finishing strokes attached to the characters (Strizver 2001). Examples of sans serif fonts include **Helvetica**, **Univers** and **Optima**. Sans serif fonts present a more clean, modern, and functional image (D’Arcy 1998, 133). Serif fonts add more authority, formality and can be easier for continuous reading. As with most elements in design, the choice of a typeface depends on the information being conveyed. This depends on the amount of text and size of the presentation. Long lines of text would require a serif font and a sans serif font would be appropriate for labels. If a lot of text is used, it is customary to limit text to five words per line, four to six lines per visual (D’Arcy 1998, 133). This guideline helps to break up information into manageable sections.
Another typographic principle is to make text legible and visible to the audience (D'Arcy 1998, 133). Many people assume that readability and legibility are interchangeable. According to the Scientific Illustration Committee (1988), readability is the ease with which type can be read and legibility is the speed at which a word can be recognized. Legibility relates to the shape of the letters and words being recognized, or the actual typeface. Readability is how the typeface is set (Strizver 2001). The way in which a typeface is set relates to the leading and kerning of the type. Leading is the vertical spacing between lines of text. It is measured in points, just like the size of a font. Typically, leading is 20 percent of the font size (Strizver 2001). This guideline assures that the spacing is proportional to the size of the text, allowing for less strain on the eyes. Kerning refers to the spacing between characters. The goal of kerning is to optimize readability.

The use of *upper*- versus *lowercase*-type influences legibility. In general, all capitals are harder to read than a mix of *upper* and *lowercase*-type (D'Arcy 1998, 133). When using all capitals, the letters lose their shape relationships and the eye has difficulty distinguishing different letters, reducing legibility and hindering readability. All capitals can be useful when calling attention to a certain part of the text, but it is not recommended to use all capitals for long paragraphs of text. Aspects of readability and legibility relate closely to making proper typeface and emphasis choices.

Text can be emphasized with underlining, *boldface*, color, *italics* or reverse type (D'Arcy 1998, 133). Any of these choices are effective, but should be used sparingly. Of these options, underlining is the least desirable (Strizver 2001). If underlines, also referred to as underscores, are created using a word processing program, they cannot be adjusted for weight and position. This results in distortion of the text by obscuring descenders (Strizver 2001). A descender is the part of a character that falls below the baseline and aids the reader in interpreting the shapes of letters. Bold and italics settings in the formatting palette of any layout program should also be avoided because these options can distort type, rendering it illegible (Strizver 2001). If either option is to be utilized, the best choice is to use the true-drawn bold and italic from the font menu rather than from the formatting palette. When selecting these computer-generated options from the palette, the choice is a "poor imitation of a true-drawn version" (Strizver 2001, 61). True-drawn italic and bold options are created specifically for the font so that the metrics of the typeface are not distorted. Choosing from the font menu will assure typographic integrity. As long as lettering is simple and easy to read, the terms are not ambiguous, and the symbols and abbreviations are familiar to the viewers, the visual will be effective (Weiss 1963).
Composition and layout must also be considered. How will all of the various elements come together to form a cohesive piece? The most important fact to remember for a layout is that “in the Western world, we naturally read from left to right and down the page, and work through columns in succession from left to right. The layout of the poster should follow this convention” (Johns 1998, 15). This is the most intuitive way to view a layout and should be followed to create a visual that is easy to comprehend and follow. Organization following the Western standards is an effective arrangement for rapid perception and comprehension (Weiss 1963).

According to Kress (1996), composition relates the representational and interactive meanings of the picture to each other through three systems: information value, salience and framing. The definitions are as follows:

*Information value:* “The placement of elements endows them with the specific informational values attached to the various zones of the image: left and right, top and bottom, centre and margin” (Kress 1996, 183)

*Salience:* “The elements are made to attract the viewer’s attention to different degrees, as realized by such factors of placement in the foreground or background, relative size, contrasts in tonal value (or color), differences in sharpness, etc.” (Kress 1996, 183)

*Framing:* “The presence or absence of framing devices disconnects or connects elements of the image, signifying that they belong or do not belong together” (Kress 1996, 183)

Elements are categorized by their importance and may be arranged using the above-mentioned systems. Importance of imagery and text is determined by their placement and size relationships. Proper degrees of emphasis should be placed on images and text so that the viewer knows where to focus. Using contrast, size, and placement can create emphasis. For different media (i.e. poster, paper, slide) the size should be legible and labeling should be consistent. When creating visuals to be viewed from a distance, positioning information on the top three-fourths of the layout is essential for distance visibility (D’Arcy 1998, 133). If a visual is not to be viewed from afar, this concept still applies due to visual balance.

In order to make choices to improve visual balance, many designers choose to work from templates. It is an efficient way to organize and unify the elements of the page. “As a general rule, the more components—texture, illustrations, graphic elements, text treatments—that can be included in the original template, the easier is to create interest” (Kantor 1999, 37). If there are designated placements for elements, layouts are easy to create successfully, but use discretion. Inadvertent conflict between the goal and the design is counterproductive. The goal is to have a simple, concise presentation without including components that could lead to distraction and
confusion. Maintaining a consciousness of typography, imagery and layout throughout the whole design process is crucial.

The aforementioned principles on type, imagery and layout pertain to the slides of digital presentations and basic scientific exhibits. Although these guidelines can be very helpful in communication, they are generalized principles. Many of these guidelines do not take into consideration the specificities of medical legal exhibits. Therefore, design guidelines should be correlated to the needs of layouts used for demonstrative evidence. There are specific details a medical illustrator must be concerned with when creating demonstrative exhibit boards. Touched upon already, in a broad sense, is the idea of clarifying complex information and organizing it in an intelligible layout. Many basic design principles apply to medical legal exhibits, but there are additional constraints placed on the medium.
Part II
Designing Medical Legal Exhibits

Medical legal exhibits have their own set of design criteria due to their inherent nature of specificity required for the layouts and because of their large size. Medical illustrators have a duty to gain the attention of the jury as well as deciphering very complex medical ideas about which most laypersons have no knowledge. When considering the composition of 30” x 40” exhibit boards, “established standards for graphics should be regarded as a set of guiding rules to be applied with a good helping of that wonderful ingredient, common sense” (Simmonds 1993, 57). Keep the exhibits as simple and concise as possible, without losing the influence of compelling design.

As mentioned in the general design guidelines, using variety is a way to maintain interest. With medical legal exhibits, a medical illustrator should keep variety to a minimum. There are still ways to create variety in a presentation without breaching limits of proper design. As designers, the goal is to create accurate portrayals of medical issues as well as keeping the exhibit clean and organized so the audience is not distracted by ‘variety.’ In the example on the right in Figure 1, distractions include: excessive typeface usage, cluttered text, overlapping information, inappropriate color usage, inadequate type size and unbalanced imagery.

Figure 1. Demonstrative evidence in the courtroom: Professional vs. Unprofessional. The exhibit example on the left is of professional quality. The example on the right has many flaws, which include: lack of an orientation, mix of typefaces, improper image size, inadequate labeling, inaccurate color, leader lines cross, inappropriate font sizes, unbalanced imagery and inconsistency.
Four vital criteria for successful scientific exhibits are that they be simple, clear, relevant and have impact (Johns 1998). These criteria also pertain to medical legal exhibit boards because the exhibits need clarity and the impact to influence a jury. The criteria can be satisfied by the illustrations and design choices of a medical illustrator. An understanding of how images are used in the courtroom aids in the design decisions. For successful communication exhibits should have “standardized layouts, uniform colors, and a generally integrated look and feel that enable the viewer to concentrate on content rather than style” (Gripp 2003).

**Imagery and communication**

Just like any other art profession, medical illustrators need to know their target audience and be familiar with their wants and needs. Giving a clear message is the goal of imagery. In order to accomplish this, the audience must be addressed appropriately. This is achieved by considering the number of illustrations, the amount of information present, and the level of complexity (Briscoe 1996). If medical illustrations were being presented to a group of physicians, it is imperative for the graphics to be complex. If this same illustration were to be viewed by the general public, the imagery would be simplified. As long as the illustrations support as well as communicate its intended message to the appropriate audience, the message will be clear.

Three types of variables can influence the needs of the intended audience: “learner variables, socio-cultural variables and the picture coding variable” (Hugo 2002, 104). Learner variables include age, gender, media literacy and learning motivation. All of these factors make an impact on how the viewer will interpret and respond to visual information. Associated with learner variables are the socio-cultural variables. These include health-related behavior, values, norms and familiarity with certain media type. These factors can be especially important when considering a jury in a medical legal case. Depending on what their beliefs and experiences are, the reaction that the jurors may have to imagery can be very powerful, or they could be impartial. The third kind of variable is the “picture coding variable” (Hugo 2002, 104). Picture coding variables are the amount of graphic detail and color use involved with the imagery.

Images on exhibit boards are designed with the assumption that the jurors have no knowledge of the subject matter in question. This way, the illustrator is explaining a concept from the ground level, rather than being concerned with what the audience may already understand. This is an instance when picture coding variables can be applied. Too much detail can confuse the jury and abstract colors can distract from the true purpose of the exhibit. Understanding how people learn is very beneficial to designing demonstrative evidence.
It is pertinent to consider learner variables and socio-cultural variables in conjunction with picture coding variables. When all three categories of variables are given equal attention, the result is a balanced design (Hugo 2002).

In order to create images for the layperson, extraneous details are excluded. There are various ways in which this can be accomplished. For example, include an orientation view of the body allowing the viewer to make the connection between the injury and location of said injury. Size is very important to the design concept dealing with medical legal imagery. The size of a graphic element should be determined by its relative importance (Parker 1990); therefore, the illustrations will be the largest elements on 30" x 40" boards.

Not only do the images have to be sufficient in size, they also have to be clear. When composing and rendering the images “drawings and charts may be so fancy, colorful, and detailed that they prevent jurors from clearly focusing on an important concept” (Turley 1989, 67). Keeping illustrations concise and catered toward the layman only enhances their meaning.

Examples of imagery used in medical legal art include MRI interpretations, X-ray colorizations, interpretations, surgical steps, or storyboards. MRI colorizations include the actual MRI image placed directly next to a colorized version that highlights the pertinent information to a layperson (Figure 2). MRI interpretations are similar, with the exception that the MRI is illustrated, not colorized (Figure 3). X-ray colorizations/interpretations have the same basic principles as MRI colorizations and interpretations, combining the X-ray with an explanatory image. The illustration can be schematic and shaded with color as it is with a colorization, or, bone and other tissue structures are rendered realistically, as it is for interpretations (Figures 3, 4, 5 and 8). Another type of imagery includes the surgical techniques that involve storyboard-like illustrations of the correction of damages or injuries (Figures 3 and 8). These types of boards can be composed of multiple views or a single step in the procedure. They can also be combined with
MRI or X-ray film renditions to enhance juror comprehension (Figure 3). No matter which type of imagery is being used on a board, they all have equal importance when being viewed by a jury.

Color

Color can be a very influential component to a demonstrative exhibit. This is why medical illustrators have to be conscious when using certain colors. “You must learn the language of colors, exactly as you have to learn any language” (Fabri 1967, 21). The language of the medical legal art palette is learned through experience within the courtroom. Illustrations containing exaggerated color have the potential to be unacceptable at a trial. Using too much color “makes an exhibit look cluttered and can confuse the jurors, because they do not know where to focus their attention” (Kuehn 1999). The goal of a medical illustrator is to have the information stand out and be noticed. In medical legal exhibits, “effective use of color enhances acceptance of the information” (Kuehn 1999). Effective, in the sense, that balance is found between blatant colorization and the pitfalls of meager contrast and unpersuasive tonal ranges. A medical illustrator is faced with the difficult task of using color in a manner that attracts attention, yet is not so saturated that it abstracts the message.

“Color is an essential part of visual presentation. Visuals in color are over twice as persuasive than those in black and white” (Gass 1992, 7). This proves how influential colors can be, especially on the intended audience. When designing an exhibit using color, no choice should be arbitrary (Gripp 2002a). This is where color theory is applied. If the symbolism involved is understood and the emotions invoked by certain colors are recognized, illustrators can use colors to their advantage.

Colors and the variance of tonal ranges can aid in clarifying anatomy and calling attention to certain parts of an exhibit. “Tones and colours must never be used just as decoration but to add information not otherwise communicable” (Simmonds 1993, 59). An obvious example in medical illustration is using blue for veins and red for arteries. This example of color choice relates to a general theory in medical art, symbolism.
Medical illustrators use artistic license and utilize the idea of symbolism to convey structure. The use of symbolic colors is critical since the medical illustrator’s goal is to communicate. These symbolic colors are those that “have been adopted for reasons of information and clarity and are now accepted universally in place of actual living colors” (Mascaro 1984). If true anatomical coloring were used in medical legal imagery, the structures would be obscured. Assigning generalized colors to anatomical structures aids in the ability to distinguish between them. In Figure 3, the muscle, ligament, fat, bone, nerve roots and intervertebral discs all have a symbolic color assignment so that they can be distinguished from one another. This is evident in the sagittal view as well as the surgical step included within the exhibit. Though they are different views, consistency in color makes it easy to relate the structures to each other. In Figure 2, the color assignments are consistent, with the spinal cord being represented as a darker yellow, the generalized color for nerves. Red is most often the color of arteries, but variations of red can be used to indicate inflammation and injury as seen in Figures 2, 3, 4, 5 and 8, calling attention to a bulging disc, a herniated disc and even a broken bone. All of these color choices reflect the idea of using symbolic color.

The priority in medical legal illustration is to clarify anatomy to those who are unfamiliar with it. Since jurors may have been exposed to the symbolic colors, it is obvious that medical illustrators should use them consistently, in order to communicate effectively. In general, “color is used to identify, unify, separate, emphasize, hide, and prioritize content” (Gripp 2002a). This must never be overlooked when creating an illustration for demonstrative evidence. Smart color choices are reflected in juror attention, comprehension and retention.

Not only can symbolic colors be used to define anatomical structure, they also have dual meanings related to emotions. Primary colors are the most recognized and are used in our culture for many things because
they are good signal colors (Gripp 2002a). They include red, yellow and blue. Red has a strong emotional impact and is usually used in American culture to represent danger and to stop. Yellow is a color that is used for emphasis. Think of the typical fluorescent yellow highlighter used to indicate an important line within text. Blue has the strongest positive connotation. Think of the feelings associated with a cloudless, sunny day, revealing the bright blue sky.

It has been proven that most people have the same reactions to colors (Graves 1951). It is logical to determine certain colors represent certain emotional responses, which can be utilized to simplify communication. It is very important to understand color connotation when designing for courtroom illustrations. Symbolic representations are important and their emotional implications create impact.

When deciding on what local colors to use in describing objects, their values and contrast relationships with other elements within the illustration as well as other parts of the overall layout should be considered. Contrast in colors and varying tonal ranges is a very important element in imagery because it aids the eye in seeing relationships. Contrast is “obtained by comparing two tones or colors that are notably different from each other” (Parramón 1993, 66). Contrast is necessary because “the eye focuses most sharply on objects that have different colors and brightness” (Kuehn 1999). Contrast aids in the clarity of an illustration, but it is also important to have contrast between illustrations and other elements of the exhibit. Color and tonal contrast may also be used to distinguish the illustration from the background of the exhibit, which increases readability.

Backgrounds with color were introduced for use in demonstrative exhibits in the mid 1980’s and became more affordable to produce using a large format printer (Gripp 2002a). Backgrounds should be light or dark, nothing in between. Stark contrast is the most effective and can provide differentiation from foreground elements. The preference of dark versus light background depends on the tonal range of the illustrations. If the

Figure 5. Pre-Op vs. Post-Op Conditions of the Leg. X-ray interpretation.
imagery is lighter. A dark background can create impact (Figures 4, 5 and 8). Supporters of the dark background said it "brought enhanced sophistication and authority to an exhibit" (Gripp 2002a). Although this is true, some imagery warrants a lighter background because the illustrations are involved. They may have various parts and have details that may be overlooked on a dark background. In Figures 2 and 3, a dark background would compete with the imagery. Although contrast provides dynamic interest, the design choice ultimately depends on the tonal ranges of the illustrations being placed on the board (Parker 1990).

One issue that many illustrators overlook is that about 10% of the population has a color vision problem (Simmonds 1993). If there is concern about designing for those with color vision problems, be aware of contrast. If red or green is used predominately in an exhibit, vary the contrast and luminance (Gripp 2002c). This guarantees that those who are colorblind can notice the differences.

**Typography**

When considering type in medical legal art, the medical illustrator is concerned with titles and labeling components of an exhibit. Although imagery is the most influential element of medical legal art, all content within an exhibit receives equal design consideration. The design of text and imagery is an issue of form versus function, where the function of printed text is "communication, emphasis (word value), and the logical sequence of content" (Tschichold 1995, 66). Medical illustrators should be concerned with the arrangement of text and that it is visible to a jury that may be up to 15 feet away from the exhibit board.

To begin to understand how to use type it is important to know that type is measured in points. A point is about 1/72 of an inch (Alley 2003). In order for text to be seen from a distance, it needs to be large. Consider this: the type on this page is 10 point type. Imagine trying to view this from 4 feet away. The point size is chosen by the relationship of the exhibit dimensions and the distance it will be viewed from. Correct lettering sizes for scientific posters have been suggested as follows (Simmonds 1993):

- Text lettering readable at 1.5 meters (approximately 5 feet), is a minimum of 30 point type
- Headings, or subtitles should be 48 point type
- Poster titles should be readable at 5 meters (approximately 16 feet), is a minimum of 144 point type

If an exhibit is designed as an 7 ½" x 10” document layout, 24 point type is sufficient for the title, 20 point type for a subtitle and 12 point type for labels. When this layout is enlarged from a 7 ½" x 10” document
to a 30" x 40", the point sizes increase by a ratio of 4 times, which results in 96 point type for titles, 80 point type for subtitles and 48 point type for labels. Therefore, if the designing is completed directly in the 30" x 40" format, the larger font sizes mentioned may be used. It has been documented that “lettering of 72 to 84 points will be easily legible from up to 20 feet” (Johns 1998, 15).

In addition to knowing how to design for jurors, medical illustrators need to be aware of designing for the venue. Lighting in the courtroom is one factor that may be overlooked. Lighting in the courtroom can be very poor and attorneys rarely have much control over the lighting situation. Medical illustrators should design with this in mind. In an ill-lit area, effects and details are lost. In general, it is best to keep details to a minimum and create the composition with adequate space and contrast.

The final layout of text should be readable and legible. Recall that readability is the ease at which type can be read and legibility is the speed at which a word can be recognized. To ensure that text is legible under various circumstances, use the legibility formula. To use this formula, find the distance of the audience from the display and the lighting conditions of the room, whether it is well-lit or ill-lit. Given good conditions, divide the distance in millimeters by 150. This results in the optimum cap height, or point size for the type. For poor lighting, divide the distance by 100 and if conditions are really poor, divide by 75 (Simmonds 1993, 60). Given a typical demonstrative exhibit, the average distance from the jury is around 10 feet, or 3000 millimeters. Assuming extremely poor lighting conditions, divide 3000 millimeters by 75. The result is a point size of 40, which is a sufficient size for labeling. Titles and subheads should be larger. By following this formula, type size will be sufficient in relation to distance and room conditions.

As for the type of font to choose for a medical legal exhibit, recall that there are two choices: serif and sans serif. Since there is not a lot of text used in a medical legal board, a sans serif font is typically used. Sans serif fonts are preferred because they are clean and easy to read. They are referred to as simple lettering, which are “not distorted, condensed, expanded or sloping” (Simmonds 1994, 59). This deems them as legible font styles and when viewed from a sharp angle, which may occur in the courtroom setting, sans serif type is easier to read than serif type (Alley 2003). In general, sans serif fonts have the sharpest definition for use in poster size documents (Tschichold 1995). Sans serif fonts are also easier on the eyes because they are proportionately spaced, meaning some letters are closer together (Briscoe 1996). Sans serif lettering is a good choice and Figures 2, 3, 4, 5, and 8 all contain the san serif font, Univers.
When emphasizing text, all capitals, bold and italics are usually the best to use. “Never use capitals as general text” because people can’t recognize the shapes of letters; therefore, it takes more time to read (Simmonds 1993, 59). All capitals also take up about 35% more space more than a mix of upper and lower case (Alley 2003). Since text in medical legal exhibits is limited, the space saving quality of lower case lettering is not important. More important is calling attention, so the mixture of upper and lower case lettering is not a priority in medical legal typography.

In medical legal exhibits, general bodies of text are not used, but there are titles, captions and labels. All capitals may be used for emphasis and for titles. All capitals are also easier to read in a sans serif font because the serifs that decrease readability of all capitals are not present (Strizver 2001). Sans serif fonts are more forgiving when adding type treatments. Since the characters lack the finishing strokes, treatments used for emphasis do not interfere with or distort the shapes of letters.

Another common text treatment is the underline. This generally is not used in body copy or for multiple lines, just like the all capitals treatment. Underlining undermines readability, but is usable for short lengths of text and phrases (Parker 1990). Underlining is also more of a concern with serif fonts because the underline runs into the serifs of the letters. This is not a concern with sans serif fonts, so underlining is a sufficient means of emphasis if a sans serif font is being used. Figures 2, 3, 4, 5 and 8 maintain consistent type treatments. The title/name is in all capitals, with the subtitle being a mix of upper and lower case letters. The subheadings are underlined and labels have no extra treatment.

To create a successful exhibit, use restraints in type choices in order to maintain simplicity and consistency. One typeface choice is sufficient, but do not use more than two typefaces. One may be serif and the sans serif, but reserve one style for titles and headings and use the other for labeling. Avoid mixing too many fonts, font sizes, colors and treatments.

Line art - Labels and leader lines

In medical legal exhibit boards, labels are secondary to the imagery (Briscoe 1996). It is important that they communicate what a structure is, but they should not be the main focus. They should be salient and simple cues that are employed so jurors can identify the focus. There are very basic rules for using leader lines.
When considering the relationship of labels and lines to the imagery, labels and their lines shouldn't be too close to the illustration, but still provide a visual connection (Scientific Illustration Committee 1988). This is accomplished by considering the style of line used as well as the font and font size.

Typically, in medical legal exhibit boards it is customary to use a solid black line with a white highlight when working on a light background (Figure 6). Highlights on leaders are placed to reflect the imaginary light source at top left (Scientific Illustration Committee 1988). The subtle highlight creates structure for the line and defines it from the illustration it interacts with. If the exhibit has dark background, as in Figure 7, leader lines are white with a black shadow. The addition of the shadow separates the line from the imagery while directing a juror's eye.

Leader lines should not be broken because it interrupts where the line is pointing. Straight, solid lines are used for quick viewing. Sometimes, at the end of a line, there can be a small dot or even an arrow to clarify the structure that is being referred to. The size of the dot or arrow should be small in comparison to the thickness of the line. The weight, or thickness of a leader line is thin, but not too thin. An 8 pixel, or 2 point width is average for a leader line on a 7 ½” x 10” layout. On the enlarged 30” x 40” exhibit, the line would be 32 pixels, or an 8 point line. If the line were thicker than 2 points at the original size, it would obscure the imagery. When enlarged, the lines would be even more of a distraction. Larger lines and arrows are reserved to denote direction (Figure 8).

One important rule is that the lines should never cross each other because it causes confusion. They should never cross a large part of an illustration because it detracts from the drawing (Scientific Illustration Committee 1988). Leader lines should be organized so that they are contributing to the clarity of the exhibit, not taking away from it. In the placing leader lines and labels, keep in mind that the attorney and expert witness will be discussing the information and that labels should remain concise.

When considering the font type to use for labeling, maintaining consistency with the rest of the document is suggested. This means staying with a serif or sans serif font, depending on which was chosen for
the title and subheadings. However, mentioned previously, mixing a serif font with a sans serif is acceptable as long as one style is reserved for labels. The size of the labels should not be distracting and therefore should be an adequate size for legibility and readability. Choosing 10 point type for a 7 1/2" x 10" layout that will be enlarged to 40 point type on a 30" x 40" exhibit is sufficient and proportionate to an 8 point line. The size of the labels should not be so large that they are obtrusive.

Keeping the placement of lines to the labels consistent is simple. First, the placements of the lines are considered. Are they on the left or right of the illustration? If the line is on the left, the label precedes it. Since the label is to the left, the line is placed at 2/3 the height of the last letter of the first line. If the label is on the right, the line goes to 2/3 of the way up the first letter on the first line (Scientific Illustration Committee 1988). This rule of placement is pleasing to the eye and adds consistency to the exhibit.

Consider the color of the font in comparison to the background color. If there is a dark background, lighter text should be used. For example, a black background with white text (Figures 4, 5, 8). When a lighter background has been chosen, a dark text color should be used (Figure 3). If finding adequate space on the background is an issue, text can also be superimposed within boxes with a white background and black text (Figures 2 and 6). The line around the box should be the same weight as the leader line. These can then overlap the images in unimportant areas, yet still call attention to the structures. In general, the text should contrast with the background to increase readability.

The grid—balance, unity and flow

Grids are elements a medical illustrator may create in the computer program used to layout the exhibit’s composition. Grids consist of lines created in a layout program that form a system of horizontal and
vertical lines. They are imaginary guides and do not print on the final exhibit. These guides help divide the document layout into equal, balanced parts that aid in the creation of an eye-pleasing composition. Figure 9 is an example of grid lines on a horizontal canvas. Figure 10 is an example of a vertical page with grid lines and an image being placed in the upper right of the document. Both images are snapshots from Adobe Photoshop.

Each grid includes lines for the margins and the main areas of the page. These guides help compose elements such as a logo, and other repetitive imagery that may be included on each exhibit so they are in the same place every time.

The use of grids keeps exhibits consistent with an integrated style. They influence the flow of elements on the page.

There are two types of flow associated within an exhibit. They are visual flow and verbal flow.

Visual flow is the order in which the viewer looks at the images on the page. Verbal flow is the order in which the viewer reads the text on the page (Graham 2002). Visual flow and verbal flow should relate to one another in such a way that the text associated with a certain image is close in proximity to that image. The best designs seamlessly integrate the two. Follow the convention that Westerners read from left to right and top to bottom. An exhibit should be organized in way that people expect and find comfortable. Using an underlying grid aids the illustrator in maintaining this convention while remaining consistent.

Grids "establish the overall structure of a page by specifying the placement of text, related type and artwork" (Parker 1990, 25). Balance is an important consideration of an exhibit because if illustrations and text are unbalanced, it may cause distraction. The balance
issue is remedied by using the grid to utilize the space available. "Space is as much of design element as data or pictures, and good design uses space to show the content to its best advantage" (Johns 1998, 15). Using a grid ensures that the distribution of elements are clear. The exhibit will not be cluttered or unpleasing to the eye.

When placing elements, consider the size of the margins. These are the imaginary lines that a designer does not want to cross. They define the border of the exhibit and restrict the information to the printable area of the document. Notice in Figure 10, the bounding box of the illustration meets the edge of the margin, but the image remains within the constraints of the grid lines. It is essential to place the illustrations first, since they are the most important element to the exhibit. Text is subordinate to the imagery. Text should never be enlarged simply to fill empty space because "changing the size of text changes it importance" (Johns 1998, 15).

Maintaining size consistency of the text elements throughout the exhibit is necessary. Titles, subheads and labels have designated sizes and should remain the same from exhibit to exhibit. The use of the grid system is beneficial for maintaining uniformity. Use of a grid avoids irregular placement and size of the various elements. Be sure that the illustrations are the focal point and the text is readable as well as legible.

Production

Production of medical legal exhibits involves creating artwork, finalizing a layout, printing and laminating. The medium of the medical legal exhibit boards in Figures 2, 3, 4, 5 and 8 are computer generated illustrations and layouts using Adobe Photoshop. Each illustration is created in a separate file. When the imagery is complete, they are placed into a 7 1/2" x 10" layout. To ensure sufficient print quality, the illustrations are created with a resolution of 300 dpi and document dimensions no larger than 7 1/2" x 10." Using a large file size is vital to maintaining print quality. When placing the illustrations in the layout, they should be reduced to fit the page so the quality of the image is maintained. Creating the illustrations at a high resolution with large dimensions ensures the integrity of the image will remain when the 7 1/2" x 10" document is printed at 30" x 40." The 300 dpi resolution becomes 75 dpi. If the idea of working small and enlarging is not appealing, illustrations may also be created and arranged directly as a 30" x 40" exhibit. The resolution of the document would be lower, such as 72 dpi.

Depending on the imagery involved, a vertical or horizontal composition is chosen based on how easily the elements can be balanced within the proportional constraints. After all elements are arranged in the layout, the layout must be sent to the attorney or paralegal, and approved before the final print is made.
The large exhibits are printed on a large format ink jet printer. When ready for printing, the 7 ½" x 10" layouts are increased to a 30" x 40" exhibit, which makes their resolution approximately 75 dpi. If the exhibit is created at the actual size, there is no need to enlarge the document any further and can be printed at 72 dpi. To some, this resolution may seem low for such a large output. With medical legal boards, an illustrator can afford to work at a lower resolution because when printed on the inkjet, the ink bleeds slightly. This blends adjacent pixels with one another and therefore, the colors mix. Also, since the exhibits are viewed from a distance, whatever pixels may be seen at two feet, the eyes naturally blend the colors together at 12 feet. It is not necessary to work in a high resolution, unless the original layout is on the 7 ½" x 10" layout.

After an approved exhibit is printed, the board is laminated, usually with a matte finish. The use of a matte laminate reduces glare from lights, enhances the print and above all, protects it. The attorney may write on the laminated board with a dry erase marker. The marks wipe off clean. After lamination, the board(s) is/are mailed to the client for use in the courtroom.

Conclusion

The creation of medical legal exhibits is an extremely involved process. It begins with receiving an inquiry from a client/attorney who needs demonstrative evidence for their case. A proposal must be made and sent to the attorney. Once the attorney accepts, the illustrator must receive medical files relating to the case in order to begin the process of creating imagery.

The design process is complex and involves first choosing what needs to be illustrated. The images must be rendered and then composed with text in a layout. Medical illustrators need to remember to design for an audience of laypersons. The jurors are learners who need to understand anatomy and the injury that occurred to the patient. Medical illustrators use their creative abilities to keep the jurors interested and paying attention to the exhibit. Illustrators use knowledge of design theory and their own discretion when creating a demonstrative exhibit board. It has been said that a "magical balance" exists when creating a display. This balance is between creative design and contextual design and can be summarized as follows, "creative design ensures an inviting vitality in learning materials, but at the same time remains invisible. Contextualized design adds appropriateness" (Hugo 2002, 104).

It is a true gift of a medical illustrator to be able to convey complex information in an exciting way while still retaining accuracy. A jury is a difficult audience to design for because diversity will exist among
those chosen. If a specific demographic were being designed for, their learning needs and preferences could easily be targeted. With an assorted group, like a jury, design must compensate for all types of learning styles, educational levels and backgrounds. As a medical illustrator in the medical legal field, an appreciation of teaching and clarifying information to the general public is gained. Through imagery, a medical illustrator explains and influences others. In the words of Max Fisch (Tsafrir and Ohry 2001, 108):

"The picture is itself a statement... the picture says something... which cannot be said with words; so that it does not merely fix the meanings of the words... but makes a contribution all its own to a total meaning which the words could not convey alone. This relation between words and pictures is mutual... together they convey an integral meaning."

Demonstrative exhibits are an example of imagery that helps to convey what the attorney wants to say. The testimony of an expert witness and the statements of the attorney are integrated into exhibits created by medical illustrators. Without our expertise in visual communication and understanding of medical concepts, attorneys as well as jurors would be lacking an indispensable means of which to prove and explain a case.
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