The Pituitary gland: Exploring the use of multimedia for medical science education

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THE PITUITARY GLAND:
Exploring the Use of Multimedia for Medical Science Education

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Interactive multimedia has been commonly associated with computer games and other forms of home electronic entertainment. We have only begun to explore its use in the fields of education and communications. With further technological advancements, the speed and efficiency with which digital information is transmitted will continue to increase. Aided by advanced navigational tools in a multimedia environment, called graphical user interfaces (GUI), digital information will eventually be made accessible from every household. At that point, multimedia interfaces will provide the imaginary environments where the words, sounds, images, and actions of our physical world will translate into machine language and vice versa.

By definition, multimedia is the presentation of information by means of more than one medium at a time. In terms of a computer system, this includes the use of text, graphics, sound, video, and animation. Another word to describe multimedia is hypermedia. Hypermedia is actually a type of multimedia that makes use of hypertext, a non-linear method of accessing information. Instead of reading a document in sequence from beginning to end, the reader can jump from one topic to the next by selecting a highlighted word or phrase. This activates a link to another place in the same

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document, or to another document altogether. The user is, in a sense, transported through information space.

Use of the prefix "hyper" comes from the word hyper-space, which is "a mathematical term used to describe any Euclidean space beyond the third dimension". Hypermedia allows for the representation of physical reality in an imaginary space. The economic benefits of being able to place an imaginary physical world onto CD-ROM or to transmit it through phone lines has made the concept of hypermedia and multimedia very appealing to educational planners. As a result, it has become the mission of a number of private and government organizations to implement and evaluate centers of computer based learning both in the US. and around the world. Among these organizations are those concerned strictly with the use of computer-based learning in medical education. One example of this is IMED, the California Consortium for Informatics in Medical Education and Development. It is "the mission of IMED to provide a forum to promote the development, evaluation, dissemination, and utilization of technology-based medical education."3

In the article, "Hypermedia and Design", Stuart Marlin and Colleagues state, "At the very highest level, advanced media tools are particularly well-suited for two prevalent problems today; complex subjects and too little time."4 Both of these problems are relevant to

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4"Hypermedia and Design," 17.
the student of medicine who is responsible for absorbing an overwhelming amount of information in a relatively short period of time. With this in mind, medical media professionals strive to develop educational materials that can make the learning process as efficient as possible. For the medical illustrator this means creating visual information that reduces the amount of time necessary to clearly teach a particular subject or concept. If the saying is true that a picture is worth a thousand words, than what can be said of a sequence of animation or a quicktime video? These are some of the issues that have been addressed by using the computer as the primary media tool for this thesis project.
SECTION 2
SUBJECT MATERIAL AND TARGET AUDIENCE

Subject Material

Upon making the decision to produce an interactive multimedia teaching software, the first consideration was that of finding a suitable topic, one that would provide a self-contained unit of instruction without being too broad in scope. It was also determined that a good topic would be one that is widely documented, allowing for the opportunity to improve on the existing media with new visualization alternatives. There are many facets to the process of producing multimedia. The goal of this thesis has been to concentrate on two components of this process; illustration and design. These are areas that a medical illustrator is most often involved in.

Why the pituitary gland? For one, it is very relevant to the general study of medicine. It is vital for the student of medicine to learn how such a small component of the human body can produce such varied effects on the development and maintenance of so many fundamental life processes. The power of the pituitary gland comes from its having both neural and endocrine properties. It serves as a conduit between these two systems. Its discussion conveniently brings together many broad issues of medical science, providing the opportunity to touch on a variety subjects that were addressed
during my two years of study at RIT. At the same time, this topic is specific enough to allow for a fairly detailed discussion.

**Target Audience**

The target audience for this project is medical science students at the introductory college level or post graduate level, during the first two years of medical school. Although the scientific base of information regarding endocrinology is vast and still growing, the student of medicine is primarily concerned with learning fundamental principles. He or she spends only two concentrated years learning the basics of medical science before entering clinical clerkships in the third year. For this reason, it is imperative to streamline the learning process in order to allow for the most efficient use of time. It has been a goal of this project to explore the creation of educational media that uses visual information to its fullest potential. At its best it can serve to reduce study time by decreasing the learning curve while increasing the level of user concentration.
SECTION 3
COMPONENTS OF DESIGN

Introduction

The following discussion of design has been divided into three categories: text, graphic design and interface design. These three categories are not mutually exclusive of one another. They intertwine and depend on one another in the same way the field of design depends on both the aesthetic intuition of the artist and the analytic scrutiny of the scientist, programmer or engineer.

Successful design is based upon a framework of logical principles. There are times, however, within the visual arts, when design decisions are based more on aesthetic intuition than on proven facts. In such cases it can be difficult to explain why one choice is better than another. In addition to describing technical processes, the discussion in this paper provides the reasoning that was used in making decisions. The choices that have been made are not proven to be the correct ones for every case. They simply show one individuals use of logic and intuition to describe the process of creative problem solving.

Text

Realizing that visual graphics alone would not be enough to explain every aspect of the subject, a decision had to be made concerning to what extent and in what format text would be used. After all, the point of this project was to explore the potential of
using visual media to communicate ideas. An initial thought was to make an audio tract of someone reading the text aloud, but this was ruled out for several reasons. An audio tract does not require the same level of concentration from the user that reading does. One can passively listen to someone else read without processing anything being said. While the same argument could be made against written text, reading is a much more active process. Secondly, the complex undertaking of sound recording did not fit in with the goal to explore visual media. This is not to imply that sound and music aren't fundamental components of multimedia. (This topic is further discussed in Section 5.)

Upon deciding to use a written format, the next decision was to determine the best way for incorporating text with the visuals. Oftentimes reading large amounts of information from a computer screen can be more difficult than reading from a hard copy. Staring at a screen for long periods of time can cause one's eyes to become dry and irritated. On the other hand, having two separate elements could potentially break the continuity of a program and could render the software unusable if the hard copy were lost.

One idea to compensate for this would be to include a printable text file that could be accessed from within the program. This way the text could never be separated from the rest of the presentation. However, if the program were to be accessible from an Internet site or a university computer station for temporary use, the user may find it inconvenient when required to print text in a hard copy form. After weighing the pros and cons, a decision was made to incorporate
text into the program, but in limited portions relative to the amount of visual information.

Other considerations given to the text were in regards to the choice of type size, color and use of fonts. Generally, sans-serif typefaces are easier to read on a computer screen than serif typefaces. In some cases serif typefaces were used where a text character serves as an icon or a stylistic element. As for size, the two biggest concerns were readability and consistency. The optimal size for screen fonts is generally 14 to 18 points. Keeping this in mind, a 14 point Geneva type font was use throughout most of the program.

A final factor that affects the readability of text is the level of contrast that exists between text and background. A high degree of contrast allows the text to stand out boldly against the background. Opting for light text on a dark background can help to eliminate eye strain that may accompany reading from a bright white screen. It also adds aesthetic appeal for reasons that relate to the classic use of chiaroscuro in painting. Low contrast between text and background may also be of some use in cases where the text is to be de-emphasized.

**Graphic Design**

Multimedia is new enough that there are very few rules dictating a standard method for the layout of graphic elements. The necessity for creating good design is vital for both practical and aesthetic reasons. If a program lacks a unified appearance it can come across as being of lesser quality, regardless of the information that it contains. The presentation of the information is an indication
of the degree of professionalism with which the program has been put together.

One way of achieving a consistent appearance within this type of media is to make use of reappearing geometric elements. An example of this is the rectangular shape that appears in different contexts throughout the program. In one place it is used to frame and display an animation, while in another it serves to focus the viewers' attention to a particular region of an illustration. In a third instance it serves as a border around a field of text. The reappearance of this element helps to create a common visual connection from one screen to the next.

The use of color is another important factor to be considered. Visual consistency may be attained through the use of a limited color pallet. By using the combination of a few well balanced colors, graphic elements can be coordinated with one another to provide a sense of order and unity. In contrast to this, when a specific element requires user attention, the basic color scheme may be purposefully avoided. Studies have shown that bright red attracts attention (i.e. stop signs and fire engines). For this reason, bright red is used to draw attention to the navigational buttons at the beginning and end of each unit that normally appear as pink. The purpose of this is to alert the user that the unit is finished and that there will be a short pause while the next unit becomes activated. At this point the user is able to decide whether to continue on, or to backtrack within the same unit.

Another application of the principles of graphic design can be found in the production of button iconography. It is here that
symbolism is used to imply functionality. Certain buttons, like the "go next" and "go previous" arrows, appear in almost every multimedia program. They commonly reappear because of their ability to express a meaning that is universally understood. It can sometimes be difficult to explain what a button does without spelling it out. An example of this is the "quit" button. A point has been made to clearly express the function of this button by printing the word "quit" onto the face of the button. This helps the user to avoid the frustration of prematurely exiting the program. In other cases, a single text character may effectively represent a button's function. An example of this is the "go to contents" button. It is labeled with the same text character that appears as an icon in the title of the contents screen. This helps the user to establish a connection between the button and what it does.

**Interface Design**

If it is true that people tend to base first impressions on appearance, then secondly based opinions may depend on the ease with which they are able to navigate through the program. If the user is not able to move past the table of contents without running into navigational problems, the presentation is over before it begins.

A successful interface allows the user to intuitively understand how to interact with the program. It is important to clearly mark points of interactivity while avoiding a screen cluttered with buttons. New buttons should only be provided when necessary, and should always appear with regularity in the same area of the screen. This allows the user to focus his or her energy on exploring the contents
of the program rather than on how to move from one screen to the
next. For a program that has a book-like format, at least three
buttons should be used: "go next," "go previous," and "quit." The
"quit" button should be isolated from the other two to avoid its
accidental use. Although some computer games use hidden elements
to create an investigative challenge, it would be counter-productive
to use this in a program that is set up for a straightforward
presentation of information.

To further clarify the intuitive understanding of navigational
controls, buttons that appear only briefly may be anchored to one
spot on the screen. In this program user interactivity has been
designed into almost every new screen. In its early design stages,
each new point of interactivity was marked by a unique button
graphic that when clicked-on would produce an action. While
observing first-time users, it was discovered that these new buttons
would often go unnoticed while inactive portions of the screen were
being probed for hidden function. It appeared as though this
confusion was caused by a lack of consistency with which new
buttons would appear and disappear at different points on the
screen. This conclusion was further supported by the observation
that controls appearing consistently in one region of the screen were
quickly mastered. Making use of this knowledge, a button was
created that appears in the same position, at the bottom of almost
every screen. Its function changes according to the command that
appears on its face. Through its consistent reappearance, this button
serves to anchor transient commands.
SECTION 4
ILLUSTRATIONS AND ANIMATION

This section describes the conceptual and technical steps involved with creating images for multimedia production. Where it may be redundant to describe the process involved in making every piece of artwork throughout the entire program, specific examples have been chosen from each of the five units to serve as representatives of a variety of different techniques that were used.

Unit 1: Introduction

The first illustration of the program is similar in concept to what might be found at the beginning of a series of surgical illustrations. It describes the pituitary gland in relationship to external anatomy. The importance of this is to provide a general point of reference for those who are starting with limited prior knowledge of the subject. In this particular case, at least two views of the head are necessary to show the exact location of the pituitary gland within it. By choosing to take advantage of multimedia, the two fundamental views serve as the beginning and end points of a short animation.

Originally the head was going to appear as transparent wire-frame structure, created from 3D graphics software. Due to the limit of my experience with 3D software at the time of production an alternative method was to capture frames from a live model; in this case, myself. Ideally, one would use a digital camera to accomplish
this. Digital image capture allows for on-the-spot editing while eliminating the cost of film and processing. However, working with limited resources, conventional photography was the next best alternative.

The process involved mounting a camera on a tripod, and swiveling myself to incremental points along the path of rotation while the shutter was released with the use of a trip chord. After having the film processed and printed, the best shots were selected to be scanned and touched up in Adobe Photoshop. To create the flashing gland indicator that serves to focus user attention on the target area of the illustration, a red dot was added to every other frame. The images were saved as pict files and imported into Macromedia Director where the animation was put together. Below are some of the original concept sketches and three of the final images.
Unit 2: Development

In order to clearly explain the unique anatomical and physiological properties that the pituitary gland possesses, it was first necessary to explain how the gland develops from two sources of embryonic tissue. To introduce this topic, one illustration is used to describe the three tissue types, then a cartoonish looking illustration is used to demonstrate the size and shape of the embryo at the stage of pituitary development. This particular illustration is one of the first that was created for the program. Its style fits with the original vision for the program which was to use animation as the primary method for presenting information. This explains why simplified shapes and bold colors dominate certain parts of the program.

It is in this section that an animated sequence is most beneficial in showing how the pituitary initially forms. The first step in producing this animation was to sketch-out the beginning, middle, and final frames in a storyboard fashion. Next, a larger and more polished line-drawing was made for the first frame. It was then scanned into Adobe Photoshop. The sketch then served as a guide for creating the intermediate frames. Using the magic wand and masking tools, areas were selected and filled with color to represent the different embryonic tissues. Each selection was converted into a path and saved separately.

The computer served as a time-saving tool in the remaining steps. By slightly distorting the shape of each path in the direction of movement outlined by the storyboard, individual frames were rapidly created. Going by the rule that animation can be played at
12 frames per second without a significant loss of fluidity, the relative proportion of change for each frame was estimated. Following each new series of changes, paths were converted back to selections and filled with the appropriate color. The same process was carried out for each frame until the final image matched that of the final image on the storyboard sketch.

**Unit 3: Anatomy**

As the project developed, it was determined that animated illustrations would not be practical for every aspect of the program. This is especially true in cases where highly detailed renderings are necessary to show anatomical accuracy. An example of this can found at the beginning of unit 3. The very first illustration in this unit shows a mid-sagital view of the brain, emphasizing where the pituitary gland is located. It serves to familiarize the user with neighboring structures of mid-sagital neuro-anatomy. Determining it was important to give this illustration a realistic appearance, its production began with a detailed pencil drawing. A variety of illustrations and photographs were used as reference material to establish the accuracy and originality of the drawing. Below are two of the original concept sketches followed by a print of the initial pencil drawing and its colorized version on the next page.
The colorization process was initiated by first scanning the pencil drawing into Adobe Photoshop. Next, the smudge tool was used to eliminate unwanted texture and pencil lines. This procedure smoothens the texture of the drawing as though it were rendered in carbon dust. For the next step, the image was converted to RGB, then areas to be colorized were selected using the magic wand and masking tools. When filling each selection with color, opacity was adjusted to allow the form of the pencil drawing to show through. In the final step, brightness, contrast, and hue saturation were adjusted accordingly.

The next illustration to be discussed was produced using a mixture of techniques ranging from sculpture to photography to computer image manipulation. This illustration presents a close-up view of the pituitary gland, consistent with the movement of information from general to specific. It serves to demonstrate how the anterior lobe fuses to the posterior lobe by wrapping itself around the infundibular stalk. It is necessary to show the gland from a number of different perspectives, so once again the use of animation is helpful.

Without the benefit of a live specimen in this case I opted to create a plastic model that closely replicates the appearance of the gland. Using a variety of textbook sources as a reference, a typical pituitary/hypothalamus structure was sculpted in plasticine clay. The finished sculpture was then casted in plaster. To make the model solid, the cast was filled with Bondo™, a polyurethane resin commonly used for auto body repair. The next step was to sand the
model to a smooth plastic finish and paint it with an airbrush. Using the same technique as the rotating head animation, the model was photographed from different perspectives and the prints were scanned and touched up in Adobe Photoshop. The pict files were then imported into Macromedia Director where the animation was produced.

A real advantage to using the computer as an illustration tool becomes evident when images need to be replicated, reduced, enlarged or redone with minor changes. An example of this is the series of illustrations that show the gland in cross-sections. Each illustration was made by painting over a cross-sectional image produced from a photograph of the plastic model.

**Unit 4: Histology**

Unit 4 begins with an animated illustration that demonstrates the axonal flow of neuro-hormones. This composition started from a pencil drawing of a basic neuron. After scanning the drawing into Adobe Photoshop the outline was selected and filled with color. Highlights and shadows were then feathered into the selection using the airbrush tool. By inversing the selection, the background was then filled with black.

The animation demonstrates how neuro-hormones pass down the axon and into the synaptic junction. In order to accomplish this, a section of the previous illustration was magnified to show only the terminal portion of the neuron, where neuro-transmission takes place. Using this illustration as a template, everything was cropped out except the nerve ending, which was enlarged to many times its
original size and saved under a different name. This process is similar to that of enlarging a photograph many times its original size. It becomes very grainy, or pixilated, in the case of computer images. The airbrush tool can be used to soften its appearance.

In order to actually animate the movement of hormone granules, a technique similar to that described for the animation of pituitary development was used. Neuro-hormone granules are represented by circular selections filled with red to attract user attention. The opacity of the dot was adjusted to better show their position inside the neuron. Separate frames were created by moving the selections down the axon in small increments. After each move, a new pict file was saved. Eventually, when the first granule reached the nerve ending, the airbrush tool was used to paint the explosion of hormonal contents through the cell membrane.

Unit 5: Physiology

Society has brought many time constraints to the modern workplace. The image of a medical illustrator, such as Max Brödel, creating original anatomical illustrations from a university cadaver lab, are reminiscent of a bygone era. Tight deadlines and limited access to real specimens are some of the difficulties inhibiting the creation of completely original anatomical renderings. As a result, it has become common practice for medical illustrators to use the work of other artists as a means for observing and referencing correct anatomical form.

According to the ethics of this practice, the work must not have a recognizable connection with its source, in which case, credit
must be given to the original artist. However, if the composition differs to the point where the source of anatomical reference could never be identified, it is common practice to consider the new piece an original. Taking this one step further, in the realm of electronic image production, if a line drawing of a particular piece of anatomy is scanned and manipulated, changing its compositional appearance beyond any recognizable connection to its original source, this too would be an acceptable practice.

In unit 5, illustrations of glands and organs that are targeted by pituitary hormones were created through the manipulation of pre-existing line drawings. The point of discussing this subject is to present a time saving alternative that capitalize on the use of new technology, while adhering to the code of ethics that has been established within the graphic arts industry. Even though each of these images has been altered beyond any obvious connection to its original source, I have listed the source of each illustration in the section titled, Illustrations Cited. The following example serves to illustrate the types of changes that have been made.

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SECTION 5
OTHER PRODUCTION COMPONENTS

The following section discusses some additional considerations that were addressed during the production process.

Opening Sequence

Like the cover of a book, a multimedia program requires an opening sequence to familiarize the user with the content of the program. Depending on the purpose of the program it may be preferable to use a simple title screen with or without the use of graphics. At the other extreme, an elaborate animation set to music would provide a more dramatic beginning. Most arcade games and kiosk displays have what is referred to as a teaser loop. This is a sequence of frames that play over and over in a continuum until the user performs some type of action, such as clicking the mouse or moving the cursor, which serves to break the loop by beginning the program. A teaser loop has two major uses. One, it acts as a screen saver. Two, it attracts attention to the monitor.

A teaser loop would be advantageous for any multimedia program that is to be displayed for public viewing, such as in the case of a museum exhibit, or in my case, the master's thesis show. One idea that I had for this scenario was to animate a wire-frame human head with a pulsating pituitary gland at its center. The head would continue to rotate until someone activates the program by clicking the mouse. However, for the purpose of the final product
this component was not be necessary. As an educational tool, users will normally open the application at home or at an Internet sight on a need-to-use basis.

There are some educational multimedia programs that open with entertaining sounds and animation, projecting a more light-hearted approach to learning. This can be very effective for entertaining small children and instrumental in keeping their attention. However, for an audience of high school or college students it is not as imperative. Furthermore, as one becomes more familiar with the program, a long opening sequence can become redundant.

**Contents Screen**

A multimedia designer is freed from many of the restrictions that are imposed by other forms of media. For example, a book or magazine is usually subject to the established design format that the publishing world and our culture have come to accept. Multimedia has no one standard format, as of yet. However, with freedom comes responsibility. If a program is poorly designed, its user may become lost in a tangle of interactive junctions. Practically any newcomer to the Internet can relate to this, although the development of GUI's for the World Wide Web has changed things dramatically. A well designed educational multimedia program should provide the user with a variety of options for movement within the program, without loosing its structure for presenting information in an orderly manner. For this reason it is necessary to create a central point of reference
where paths and information connect. This is commonly referred to as a home card, home page, or contents screen.

The contents screen and the structure of my program has been modeled after the format of a book. By using this metaphorical relationship, the program is given a virtual structure that the user can relate to. Similar to that of a book, the table of contents lists unit headings in a specific order. This is the order in which information needs to be read, since concepts build on information discussed in previous units. Some interactive games and multimedia presentations work on a different principle in which the user is encouraged to move about randomly, seeking hidden areas of interactivity.

In another effort to help the user, a portion of the contents screen has been designated to describe and define the navigational controls that appear throughout the program. The user can read this information before moving to the body of the program, or access it by clicking on the contents button. Another option would be to script a button or toggle command that allows information to be displayed in a temporary window. This window could be opened or closed without having to move to a different location in the program.

A final comment about the contents screen of the program pertains to the icons that follow each unit heading. It was originally intended to use these icons as buttons throughout the program. By placing the five icons at the bottom of every screen, the user would be able to move back and forth between units without having to refer to the contents screen. This idea was later ruled against in an attempt to avoid screen clutter.
Transitions

A unique quality of multimedia is its ability to present information in a way that engages the user in action. A program that encourages the user to actively participate can also serve to increase the user's concentration. This in turn can serve to increase the level of information comprehension and retention, which is the main objective of an educational program. Visual imagery plays an important role in this process.

Images can be effective in explaining abstract concepts when they tap into visual comprehension. It is generally easier to understand something that can be visualized and it may also be easier to remember things that have been explained in visual terms. In addition, visual imagery can serve to engage the user's imagination. A multimedia designer should always strive to make a program entertaining as well as informative, regardless of the subject. The user is much more likely to remember something when his or her mind is actively engaged.

Applying this idea, an excellent place to make use of creative imagery is in the design of screen transitions. Unlike turning the page of a book, multimedia presents different ways to move from one page or screen to the next. Transitions can range from a dissolving screen to an extensively animated sequence. For example, the animation of pituitary development in unit 2 serves as a screen transition. Two separate screens have illustrations and text that explain the process of pituitary development, showing it both before and after. They are joined by the transitional animation which serves to reinforce the text in visual terms.
Graphs, which are commonly found in scientific text, can provide valuable visual communication. They also provide excellent opportunities to use animation in screen transition. Due to the high degree of interpretation that is required by some graphs, people may choose to overlook them and the information they contain. This may be intensified when graphs are not directly incorporated into the presentation of information. When a graph is animated and used as a screen transition, it becomes the focus of the viewers attention.

**Sound and Hypertext**

The power of multimedia is in its ability to streamline the learning process by coordinating many sources of information from various different media in one common environment. With the focus of this thesis placed on visual information, other important properties of multimedia design need to be mentioned. This section touches on two of the more vital components, sound and hypertext.

**Sound**

A multimedia designer can use sound to stimulate memory, visual images and emotions. Sound effects help to create an illusion of reality. An example of a sound effect that is widely used in multimedia is the "click" that plays when a screen button is pressed. This sound helps the user to imagine the act of pressing a physical button. By simulating commonly heard sounds a graphical user interface becomes more intuitive to use.

Music is another form of sound that can be used to compliment visual imagery and focus user attention. A movie producer uses
music to increase the emotional impact that accompanies a dramatic scene. The same principle can be applied to any visual presentation. Music can be used to focus user attention to a specific action or piece of information, such as an animated sequence or graph.

**Hypertext**

Hypertext has been defined as a non-linear method of accessing information. Instead of reading a document in sequence from beginning to end, the reader can jump from one topic to the next by selecting a highlighted word or phrase. This activates a link to another place in the same document, or to another document altogether. This can serve as a helpful time saver for the user while it is also as a convenient method for the designer to link screens.

Hypertext lends itself nicely to reference programs where words or numbers are linked to definitions or explanations. An example of its application to medical or scientific text would be to link reference numbers with corresponding bibliographic information. Rather than traveling through numerous screens to locate the information, the user could simply click on a number to immediately access its bibliographic source.

Hypertext can also be combined with other forms of media such as sound or video. For example, by clicking on a complex medical term, one could activate audio playback that provides the correct pronunciation of the word.
Medical illustration is strongly based in both art and science. Additionally, it draws on the fields of photography, computer technology, and communications. As an allied health care professional, a medical illustrator can work for a hospital media department where he or she faces many challenging opportunities to help physicians and researchers explain ideas in visual terms. In keeping with the advancements of medical science, today's medical illustrators must be innovative, striving to improve on traditional methods of visual communication.

It is reasonable to say that digital technology will play a pivotal role in the future of medical media. The employee of a hospital medical media department may presently observe how the use of digital technology has grown into all facets of the field. Doctors are using liquid crystal display units to present information that was traditionally projected in a 35 mm slide format. With its potential for saving both time and money, digital photography is replacing conventional photography. Research and patient data is stored in digital format that saves space, increases archival quality, and allows for quick access. As a final example, nonlinear digital video editing is replacing traditional analog capabilities. As a result of this technological change, the roles of the medical illustrator, medical photographer and computer technician are beginning to merge.
In addition to hospital medical media, there are many other opportunities for medical illustrators to use computer technology as a means for improving on traditional teaching and presentation methods. An example of this is anatomical illustration. The tradition of anatomical atlases goes back to Leonardo Da Vinci, Vesalius, and even further to ancient cultures that used pictures to record medical procedures and information. Traditionally, anatomical renderings show a fixed view of a three dimensional form in a two dimensional space. Presently, with the development of 3D computer rendering, atlases no longer need to be limited to a fixed view. A virtual cadaver can be cut and viewed from any perspective just like its physical counterpart.

Animation is another excellent visual teaching medium that has been revolutionized by computer technology. Its power to communicate relies on the use of simplified form in motion. Its quality relies on the imaginative capabilities and technical skills of the animator to simulate physical phenomena in simplified form. Traditionally, animation has been expensive and time consuming to create. Through the use of the computer it is now possible for an individual to accomplish what once required a team of artists and an array of expensive equipment.

Although digital technology has greatly influenced medical media, as we move into the twenty-first century, it will not eliminate the use of traditional media or replace the artist. Basic scientific knowledge remains the same regardless of changing technology. It is often the job of the medical illustrator to interpret the work of others in a way that communicates with greater effectiveness. In lieu of
this, new technology can be used to reformat the superbly crafted, timeless illustrations of past. This exemplifies how medical artists are discovering ways to save time and money by combining the use of traditional and digital media. To the individual who is flexible and creative, with the ability to combine the use of photography, traditional and computer generated art, the future of medical media will provide many new opportunities.
LITERATURE CITED


ILLUSTRATIONS CITED


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page 163; figure 7.37: the thyroid gland; Lorraine Wrzosek.


*Illustrations:*
page 638; figure 40-4: schematic of a nephron and its blood supply; J.W. Nicholson
page 708; figure 45-1: The adrenal glands; Pam Rowles


*Illustrations:*
page 903; figure 44-4: hypothalamic-pituitary-target cell feedback mechanism; Carole Russell Hilmer.


*Illustrations:*
page 986; figure 543: Vertical section of kidney.