Driving Past the Jargon: Designing Multimedia Devices to Clarify Transportation Engineering Concepts

By

Angela Anne Rogge

A PROJECT

Submitted to

Oregon State University

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The educational environment is filled with different types of students, all with diverse learning styles. The Meyers-Briggs Type Indicator and Kolb's Theory of Experiential Learning are generally accepted methods for determining and assessing a person's preferred method of information processing. There has been research that suggests learning styles are specific to academic disciplines. Furthermore, learning styles have a tendency to be gender specific. How people process and discern information is the basis for their learning style. Understanding how individuals learn is an integral aspect of developing teaching strategies. The use of multimedia is appealing to most all types of learners, and may be tailored to specific topics and classroom settings. Multimedia has the ability to simplify concepts and present information in a way that is more conducive to various learning styles. Specifically in transportation engineering, the dilemma and decision zones are confusing concepts that may be clarified through the use of animation.

Key Words: Dilemma Zone, Decision Zone, Learning Styles, Multimedia

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I understand that my project will become part of the permanent collection of Oregon State University, University Honors College. My signature below authorizes release of my project to any reader upon request.

Angela Anne Rogge, Author

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Introduction

The academic environment strives to accommodate various types of people with drastically different learning styles. In college classrooms, the lectures are usually presented in a large group setting where the learning environment is far from ideal. It becomes even harder to teach to the various learning styles when the material is explicit and full of technical jargon. It is common for instructors to employ the use of slide shows, which are a useful multimedia tool, but have the potential for further development. Multimedia technology can provide an interactive and visually stimulating approach to teaching, as well as accommodate a variety of learning styles.

The environment that surrounds engineering academia is technical and process oriented. The material is often presented in the form of text and static diagrams. These teaching methods are not conducive to the dynamic nature of the field of transportation and traffic engineering. It may be difficult for students to visualize an active, real-life traffic situation without an animation to accompany the textual or narrative explanation.

Research has shown that learning styles are not only discipline specific, but gender specific as well (Jones, Reichard and Mokhtari 2003). This means that in order to fairly instruct a classroom of engineering students, there must be consideration for all types of learners. Fortunately, one of the advantages of multimedia presentations in an educational environment is that men and women both learn better from it. Additionally, research has shown that overall comprehension is increased while instruction time is decreased when utilizing multimedia presentations (Najjar 1996).

The purpose of this thesis is to better understand learning styles of engineering students in order to create animations of transportation engineering concepts to be used as a teaching tool in a lecture setting. The thesis itself is a project, accompanied by a research review that further investigates learning and teaching styles, as well as the success of multimedia as an instructional tool.

Two visual aids in the form of a computer animation have been generated to demonstrate the concepts discussed in this thesis. The separate animations may be used to illustrate two confusing transportation engineering concepts, the decision zone and the dilemma zone. Accompanying the animations is a discussion of the subject matter and an explanation of how and why the animations were made. The animations may be used independently of each other as an instructional tool, or they may be used together. When used simultaneously, the difference between the two becomes more obvious.

LEARNING STYLES

Different types of people process information in different ways. More specifically, people with different learning styles tend to succeed in disciplines and academic learning environments that accommodate their methods of learning (Jones, Mokhatari and Reichard 2003). However, even within specific disciplines, such as engineering, there still is a broad spectrum of individuals with various ways in which they perceive the world, process, and receive information. Special attention must be given to presenting information in a way that is conducive to all learning types.

In order to understand what exactly is meant by learning, common assessment tools of learning styles will be explored. Both the Meyers-Briggs Type Indicator (MBTI) and Kolb's Experiential Learning Cycle are generally accepted methods of determining a person's preferred method of information processing. In fact, both are based on different Jungian principles, his theory of personality and concept of experiential learning, respectively (Wyrick 2003).

Engineering

The field of engineering contains endless possibilities and countless amounts of job descriptions. With such a large variety of opportunities, all types of learning styles are likely to succeed in some form of engineering. However, there is less variation in the scholastic environment and the more common instructional approaches benefit some learning styles better than others, making it harder to excel (Felder, Felder and Dietz 2002).

Meyers-Briggs Type Indicator

The MBTI uses Jung's theory of personality as a basis for measuring personality types. The MBTI classifies people into four different dimensions: Sensing-Intuition (S-N), Thinking-Feeling (T-F), Extraversion-Introversion (E-I), and Judging-Perceiving (J-P) (Wyrick 2003). Table 1 includes a summary of these personality types.

Table 1 - Psychological Types

Psychological Type	Description
Sensors (S)	Practical, detail-oriented, immediate, real, focus on facts and procedures
Intuitors (N)	Imaginative, concept-oriented, focus on possibilities and relationships
Thinkers (T)	Skeptical, tend to make judgments or decisions objectively and impersonally
Feelers (F)	Appreciative, tend to make judgments subjectively and personally
Extraverts (E)	Try things out, interest flowing mainly to the outer world of actions, objects and persons
Introverts (I)	Thinking things through, interest flowing mainly to the inner world of concepts and ideas
Judgers (J)	Set and follow agendas, seek closure, tending to live in a planned and decisive way
Perceivers (P)	Adapt to changing circumstances, resist closure to obtain more data, tending to live in a spontaneous and flexible way
Preferred by engineers	

Certain psychological types are more common to engineering students. In most instances, engineers rely more on their intuition (N), thinking (T), and judging (J).

Furthermore, the stereotype that engineers are sometimes withdrawn and socially inept is only reinforced by the fact that engineering students tend to be more introverted (I) (Wyrick 2003). There is speculation that this varies from discipline to discipline, but will not be discussed further in this paper. It is not hard to see why engineering students chose to pursue a technical field; it is what fits their personality.

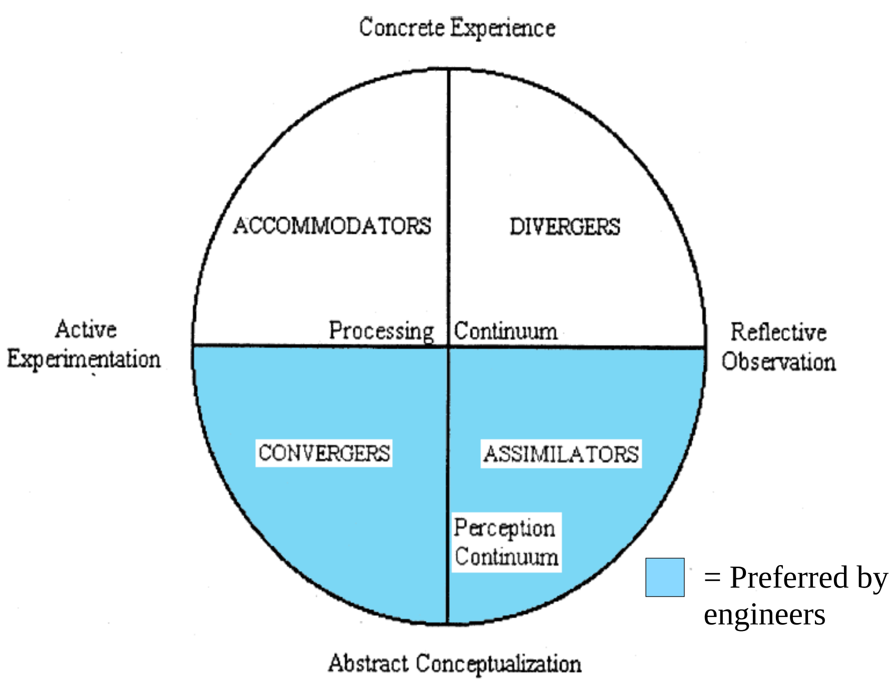
Kolb's Theory of Experiential Learning

David Kolb (1976) used the Jungian concept of adult development to explain how learning is a process. This is not specific to the educational setting, but applicable to how people process information in their day-to-day life. There are four learning modes in the cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Initially, the person experiences something concrete, from which point they examine what has happened via reflective observation. In turn, the observation triggers the individual to determine an explanation or theory, at which point he or she might attempt to apply the theory. The cycle does not necessarily have a finite beginning. A new theory may be heard, and then active experimentation may occur before any concrete experience is had (Wyrick 2003). As seen in Figure 1, the cycle is further developed separating the cycle by processing and perceiving. These axes create four distinct quadrants of learning style types: accommodators, divergers, convergers, and assimilators.

The qualities of each learning style are discerned by where they are in relation to the learning modes. Accommodators take concrete experiences and use active experimentation to create a hands-on experience. Divergers learn by using concrete experience and reflective observation to look at a situation from many different perspectives. Assimilators learn best by making abstract concepts logical through reflective observation. Finally, convergers are best known for their ability to solve problems by experimenting with abstract ideas.

From Kolb's research, it is apparent "that various disciplines are localized in different learning style quadrants" (Jones, Mokhatari and Reichard 2003). With regards to engineering, it makes sense that the majority of the students are convergers or assimilators (Jones, Mokhatari and Reichard 2003). Both of these quadrants are more apt for problem solving and logic. It is also common for individuals to have the ability to switch between two learning styles.

Figure 1 - Kolb's Learning Styles (after Jones, Reichard and Mokhtari, 2003)



People can switch from their preferred learning style if that learning style is not advantageous to their current learning environment. This means that students understand that different learning styles are required for different situations. Though students are able to adapt, it is unusual for a person to be strong in all four learning style quadrants; these are called hub learners. Hub learners are extremely flexible and do not have one specific learning style preference that they would revert to in a high stress situation (Wyrick 2003).

Gender Differences

Many studies have illustrated that males and females learn differently (Keri 2002). It is not enough to understand the basic learning styles specific to an educational discipline. It is also necessary to understand that men and women within the discipline absorb information in a different way. Although there is normally a difference in learning styles between genders, it is not an absolute science. Regardless, these differences validate the argument for a need to expand instructional techniques.

Male

Males are normally more prone to using day to day life experiences as a basis of learning. This means that they thrive in teaching environments and disciplines that involve hands on activities and practice. When observing the Kolb's model of learning styles, it is apparent that males more often fit into the assimilator learning style quadrant. Maybe not so surprising, engineers fit best in this learning style quadrant as well (Jones, Mokhatari and Reichard 2003). Further investigation into how males relate to others in the classroom showed findings that men "seek relationships and enhanced individuation and separation from others through social competition" (Keri 2002).

Specific types of disabilities are obviously going to affect a student's ability to process course content. When creating visual teaching representations, it is important to remember that some males may be colorblind. Though color blindness can affect females too, it is much more prominent in males. The most common type of color-blindness is red-green, in which case the difference between reds, oranges, yellows and greens is difficult to discern. This is important to realize when creating animations. Dark outlines may need to be used to differentiate between colors, or if possible, accompany the change in color with text (Gordon 1998).

Female

Females have a tendency to learn conceptually. Women are apt to be more organized, and prefer abstract learning styles. With respect to the academic environment, females learn best through copious reading assignments and a well organized and knowledgeable instructor. Furthermore, independent of course content, women tend to thrive in environments that reduce hierarchal systems in the classroom. This is not to say that women are timid, but often women are conscious of preserving their self image in order to protect self worth (Keri 2002). This relates to engineering because it is known as a male-dominated field. Women are underrepresented in both students and faculty groups, and the competition creates stress that men are more likely to thrive on. To equalize the classroom, teaching tools should complement the learning styles of both genders.

MULTIMEDIA

Though it is apparent that learning styles change in different disciplines, and even men and women have fundamentally different ways of processing information, there are consistencies in how a person is able to succeed academically. All types of learners excel in a learning environment that provides motivation and promotes interaction, while continuing to engage the student (Jones, Mokhatari and Reichard 2003). We define multimedia as "the use of text, graphics, animation, pictures, video, and sound to present information" (Najjar 1996).

First, a discussion of how students learn and excel academically will supply background to the advantages of multimedia in the classroom. In order to explain the decisions behind the animations created for the purpose of this thesis, a review of suggested techniques and the appropriate situations for multimedia as a teaching tool is presented.

Successful Learning

People learn and retain information more easily when they are actively engaged in the learning. Actively engaged means that a student is cognitively stimulated (Oliver and Herrington 1995). Not only is a student taking in the information, but he or she is consciously making sense of what the information means. Normally a person perceives "actively engaged" to mean that the individual is physically responding to the instruction (i.e. asking questions). However, with various types of personalities and learning styles, not everyone has the desire or opportunity to vocalize this knowledge. If a person does not ask a question out loud, it is still entirely possible that he or she is internally processing and applying the new knowledge to unique personal experiences.

Advantages of Multimedia

One of the ways multimedia works is that it allows new information to be related to existing knowledge by way of establishing links and connections (Oliver and Herrington 1995). In a university setting, introductory classes to topics tend to cover a vast amount of information as an overview because the time allotted is minimal. There is not much time to develop and go into detail in general classes. For example, CE 392 and CE 491 at Oregon State University cover design and traffic planning, respectively. The students in these classes have low or no prior knowledge of the course material. Situations such as these are ideal for multimedia use in the classroom; there is little prior information for the student to connect to the new knowledge, and graphics and animation make key points more obvious (Najjar 1996). And though multimedia is less helpful for students with a high domain of knowledge, it can still be useful. In the university setting, where the goal is to develop advanced knowledge and skills, these connections can build upon prior understanding of a topic to increase comprehension development. There are many aspects of multimedia that make it an appealing and worthwhile teaching tool.

Color

The use of color is visually appealing and also can be an integral part of how multimedia is designed. Color may be used to link logically related elements to highlight their relationship. Color is also very useful in emphasizing key points by making them different from the rest of the presentation (Oliver and Herrington 1995).

Movement

Animation allows the information to be logically presented in a dynamic sequence. Animation is especially useful in explaining cause and effect relationships. There is also a visual appeal to animation that captures the attention of the audience. There may be problems if text in the animation is not large enough, but the main points should be obvious from the graphics. Immediate feedback is an additional benefit to multimedia; animations solicit a quick reaction since they are usually summaries of long, textual descriptions (Oliver and Herrington 1995).

Variety

Utilizing different channels for how people receive information increases retention, and is one of the strongest benefits of multimedia as a teaching tool. More cognitive paths are created when text, audio and visual are combined to create a presentation (Najjar 1996). Learners are able to connect the graphics to the words and audio, and processing the information becomes easier (Oliver and Herrington 1995).

How to Use Multimedia

Multimedia has the potential to be a great instructional tool, but also can fall short if not utilized appropriately (Oliver and Herrington 1995). It is important to avoid distracting the student by overloading his or her senses with cluttered information. The beauty of animations is that their simplicity can be the reason for the clarification of concepts.

When using multimedia in the academic setting, simple animations are best for individuals with low prior knowledge. It needs to be made clear that the appeal of multimedia is its novelty, and overusing it can reduce the amount of stimulation for the student. It works well to increase recognition and teach problem solving, and spatial information. See Table 2 for suggested media, given the information to be learned. Problem-Solving information is more applicable to engineering concepts. Animation makes word problems and real-life situations more concrete (Najjar 1996).

Table 2 - Suggested Media (after Najjar, 1996)

Information to be Learned	Suggested Presentation Media
Procedural Information	Explanatory text with a diagram or animation
Problem Solving	Animation with explanatory verbal narration
Recognition Information	Pictures
Spatial Information	Pictures
Assembly Instructions	Text with supportive pictures

ANIMATION OF CONCEPTS

I have created two separate animations to illustrate both the decision zone and the dilemma zone. It should be noted that by presenting the two animations together, the differences between the two are unmistakable. This limits the confusion that accompanies the two concepts. From the discussion of the effectiveness of multimedia as a teaching tool, we can increase the learning by having the instructor narrate the animation while it plays. That way, two separate cognitive channels are used and learning is increased. However, before further discussion can begin on decision and dilemma zones, it is important to understand some basic transportation terminology. Perception-reaction time (PRT), stopping sight distance (SSD), clearing distance, the change interval and clearance interval are all pertinent concepts.

The reaction time is the amount of time a driver takes to process that they have seen an object or experienced a condition of concern, in this case, a light changing from green to amber. Stopping sight distance is the distance needed for a vehicle to come to a complete stop, based on the assumed driver PRT. The clearing distance is the distance the car will travel at its current speed for the duration of the amber phase plus the width of the intersection. If a vehicle is one SSD from the STOP line and the light changes from green to amber, the change interval is long enough to allow the vehicle to enter the intersection legally on yellow without the driver increasing their approach speed. To accommodate vehicles entering the intersection during the amber phase, the intersection should have a clearance interval, also known as all-red. The clearance interval provides sufficient time for a vehicle to travel through the intersection with its back bumper clear through the far crosswalk line before the opposing traffic is given a green light. It is crucial to note that clearing the intersection means the vehicle's rear bumper is completely clear of vehicular and/or pedestrian paths (Roess, Prassas and McShane 2004).

Decision Zone

The decision zone is the zone approaching an intersection in which the driver of a vehicle can choose to stop or go safely during the amber phase. Ideally, this zone is present at all intersection approaches. The stopping sight distance and the clearing distance are representative of the decision zone (Sheffi and Mahmassani 1981). For the purposes of this presentation, it is legal for a vehicle to enter an intersection on yellow.

Animation – The Decision Zone

The primary purpose of this animation is to show that the decision zone allows the driver to consciously make a choice to either stop or go. The animation is divided into three sections to clarify the pieces that make up the decision zone. First, a vehicle is shown traveling towards an intersection behind the point in which it could stop safely if the light turned to the amber phase. When the light turns red, the vehicle is safely stopped before the crosswalk (see Figure 2). Second, a vehicle is traveling through a section in which it could safely clear the intersection if the green light were withdrawn to show amber. Again, when the light turns red, the car is safe, albeit through the intersection and beyond the crosswalk (see Figure 3).

Finally, the main point is illustrated in the final scene. The first two scenes are essentially overlapped, and the decision zone becomes visible in the form of a green rectangle. To further drive home the concept, two different vehicles enter the decision zone during the amber phase (see Figure 4). Each vehicle freely makes their own decision, one to clear the intersection, the other to safely stop before the light transitions to red (see Figure 5).

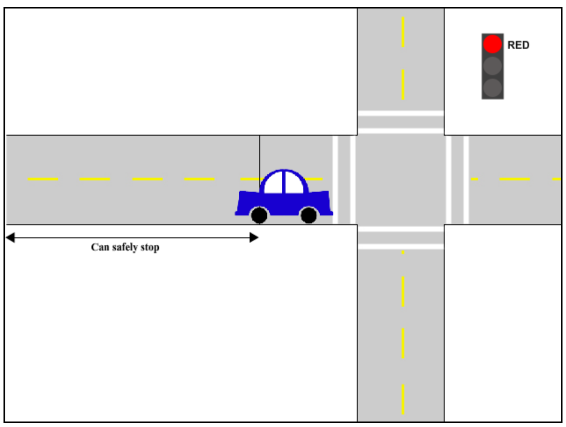


Figure 2 - Decision Zone: Stop

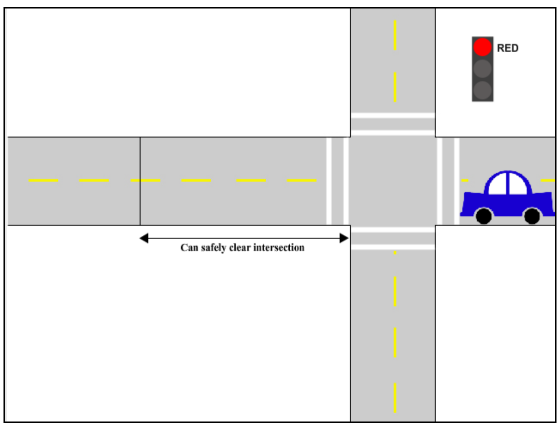


Figure 3 - Decision Zone: Proceed

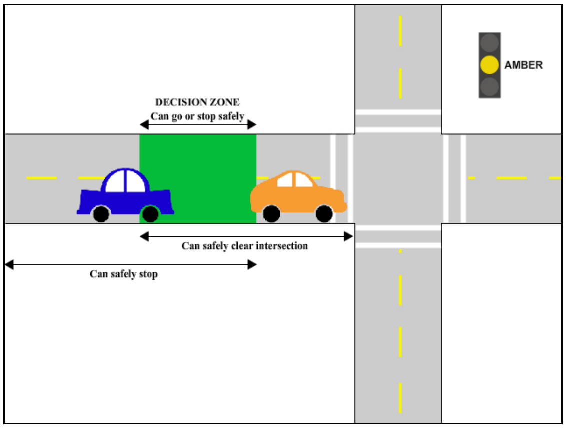


Figure 4 - Decision Zone Presentation

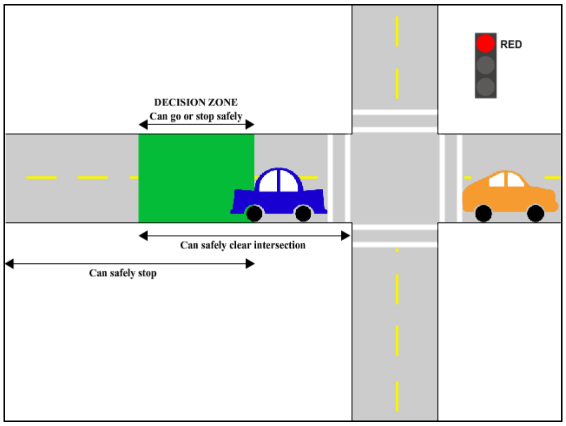


Figure 5 - Decision Zone: Choices

Dilemma Zone

The dilemma zone occurs if there is a region before an intersection in which the driver can neither come to a safe stop nor proceed through the intersection before the end of the amber phase (Sheffi and Mahmassani 1981). This is a direct result of yellow (amber) plus all-red intervals being too short. This zone has the potential to be dangerous for the driver and should be avoided when establishing phase times. The boundaries of this zone may be calculated given some basic parameters; the intersection width, approach speed, and perception reaction time. From this information, the stopping sight distance and clear distance may be calculated, and from that information, the dilemma zone is the difference between the two. The dilemma zone is not just an arbitrary zone; it is relational to the intersection. If the vehicle is closer than the stopping sight distance and also farther than the clearing distance, then that is the location of the dilemma zone. The dilemma zone may be fixed by increasing the amber or all red phase (Pant and Cheng 2001).

The dilemma zone described above is calculable and is dependent on signal timing. Another type of dilemma zone is more subjective and based on driver behavior. This dilemma zone is sometimes referred to as the “indecision zone” or “option zone” and is the region in which more than 10 percent and less than 90 percent of all drivers would stop when the light turns amber (Urbanik and Koonce 2007). When creating the animation for the dilemma zone, the non behavioral type was used.

Animation – The Dilemma Zone

The information stressed in this animation demonstrates the consequences of the presence of a dilemma zone when approaching an intersection. It is also instrumental in expressing what the dilemma zone looks like in relation to the vehicle and the intersection. The primary concern for engineers is the safety of the public. The dilemma zone clearly puts vehicles and their passengers in danger and needs to be avoided in design.

Similar to the decision zone animation, in order to clarify how the dilemma zone is created, the animation begins by showing the location in which the amber phase begins and the vehicle can stop safely (see Figure 6). This means that before the light turns red, the car is safely stopped behind the crosswalk. Next, the vehicle is shown passing the point where it can clear the intersection safely. When the entire vehicle has traveled through the intersection, the light turns red (see Figure 7).

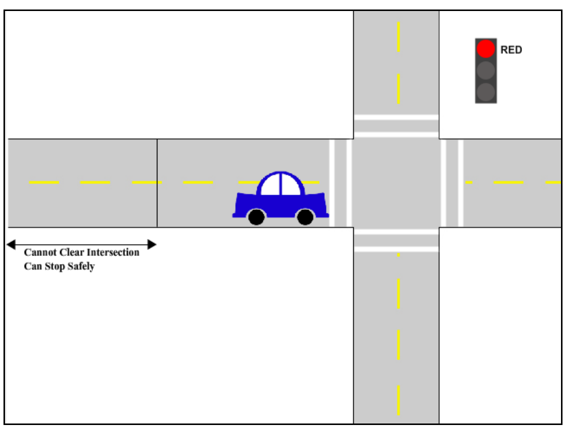


Figure 6 - Dilemma Zone: Stop

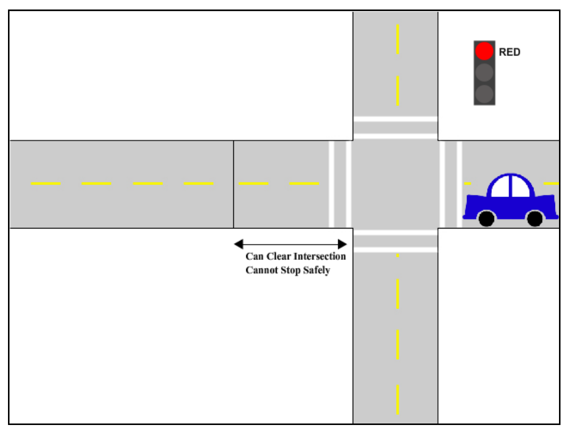


Figure 7 - Dilemma Zone: Proceed

Finally, the two animations are combined to create a visual description of the dilemma zone. The location of the dilemma zone is made obvious by highlighting the section in red. To further illustrate the potential danger, the vehicle enters the dilemma zone during the amber phase (see Figure 8) and attempts to clear the intersection, when it is struck by another vehicle traveling perpendicularly (see Figure 9).

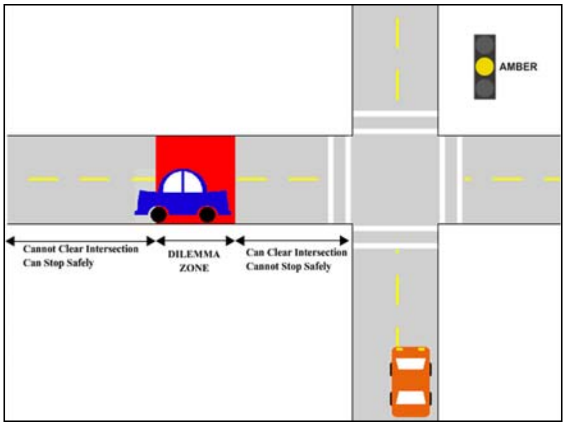


Figure 8 - Dilemma Zone Presentation

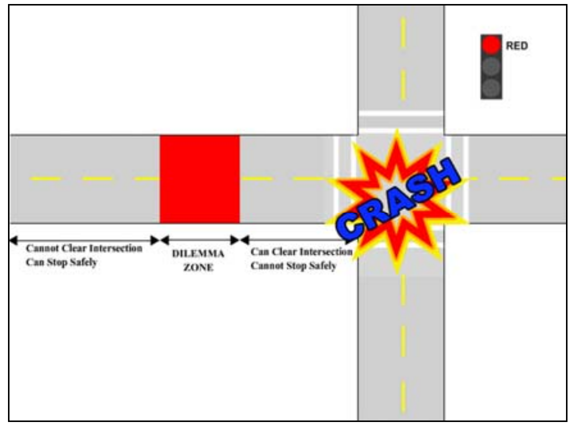


Figure 9 - Dilemma Zone Collision

CONCLUSION

It is apparent from research and various studies that the educational setting is full of varying types of learners, even within the same discipline. The commonality between the learning styles is that visual representation of concepts is acknowledged as a preferred depiction of ideas by all. Traditional lecture may benefit some learning styles, but does not engage the student in a way to facilitate learning.

There is not a reasonable way to abandon the basic lecture setting. Unless class sizes suddenly become smaller, and the need for higher education is lost, lecture is still going to be the prominent form of instruction. However, incorporating visual aids and understanding how to accommodate varying learning styles can improve the academic setting. Comprehension and retention will be increased, and students will be more engaged. The disadvantages to multimedia should also be considered. There is a possibility of cluttering the information, poorly organizing ideas, and not being aware of people with disabilities (i.e. color blindness).

With respect to engineering academia, especially in transportation engineering, multimedia can be extremely useful in illustrating concepts. Transportation involves studying the way things move and respond to changes in environment. When trying to look at static diagrams and figures, an integral aspect of the concept is lost. Animations allow for real-life problems to be illustrated in a way that can show the cause and effect; increasing the understanding and retention of the topic.

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