Combining the Art, Science and Technology of Multimedia with The Multimedia Creation Circles Paradigm

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1. Introduction

Multimedia **C**reat**i**on **C**irc**le**s (MuCiCle) is a paradigm for correlating existing theories and models from arts, science, and technology knowledge faculties.

There have been such combining efforts in other areas as well. Elam attempts to integrate interdisciplinary knowledge for theater and drama via the study of its semiotics [1]. Swartout and van Lent begin with the premise that, "In game design, the driving force is the user's experience" [3]. From this premise, they explore if "the ideas and development methods that make computer games so successful…(can) also be applied to developing relatively serious-minded applications". They approach the problem from the outer layer, and, as if, peep inside. In the MuCiCle paradigm we begin at the very core, and move outwards.

The core concept for all multimedia systems, serious-minded or game-oriented, is 'story telling'. Storyboarding is commonly used as a technique for multimedia design; imparting some recognition to this concept. This article explores how story telling can help coalesce theories from arts, science, and technology.

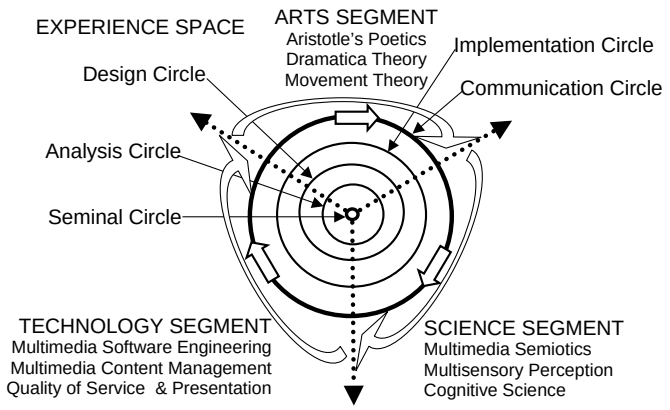

Figure 1: Multimedia Creation Circles

1.1 Multimedia Creation Circles

In the MuCiCle paradigm the process of creating a multimedia experience is depicted by a series of concentric circles (figure 1). Multimedia creation begins at the *Seminal Circle* and moves outwards, traversing the *Analysis Circle*, the *Design Circle*, the *Implementation Circle*, and finally the *Communication Circle*. These *Creation Circles* exist within the user's *Experience Space*: comprising three *Knowledge Segments*, one for each knowledge faculty.

First, we need to find a seminal concept to which we can apply theories from arts, science, and technology as we move through the Creation Circles to generate a yogic (holistic) multimedia experience.

The main thesis of this article is that we can attain this yoga if we view every multimedia system, as if, it's telling a story. We all seem to know what a story is. However, normal stories do not directly relate to all multimedia systems. Thus, some of the questions that arise, and this article attempts to answer, include:

- What do we mean by a story?
- How can we view a multimedia system as a story telling artifact?
- How can we relate theories from arts, science, and technology through story telling?

2. Art Segment

The core purpose of any communication system is to create new meaning [4]. In this section, we explore theories of story to understand the process of creating meaning with multimedia, when viewed as a story telling artifact.

Story telling: The joy of story telling and listening is an integral part of human nature. It began with stories narrated in communal gatherings, and transformed into staged dramas, written epics, and mythological tales. In recent centuries, short stories and novels became popular. Nowadays, television shows and movies tell stories. Because movies embody many aspects of multimedia, we can learn from the current theories of screenplay writing.

There is one significant difference between movies and interactive multimedia. Movies vary in temporal and spatial domains, while multimedia varies in the navigation domain as well. Nonetheless, we can learn many lessons from the process of meaning creation in movies. Especially because, the core function of a movie is story telling; and it is this aspect that we aim to imbibe into our multimedia systems.

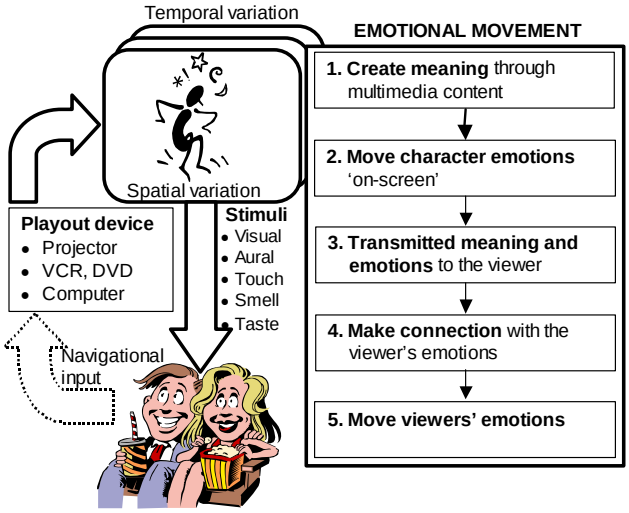

Figure 2: Creating meaning and emotional movement

Figure 2 shows two users watching a movie; however, they represent other multimedia users as well. We use the generic term user to refer to a viewer for a movie, listener for music, and player for a game, etc.

A playout device displays the visual content on a screen accompanied by aural and other sense stimuli. An in-theater movie viewer has no navigational control. VCR, CD and DVD users get some navigational control. Whereas, a game or virtual reality player has significant navigational control.

Emotional Movement: The genesis of any story experience is *Emotional Movement*. Users crave emotional engagement and stimulation. Consequently, systems that manage to achieve this Emotional Movement are successful; and the best way to achieve it is through story telling.

2.1 Theories of story creation

Aristotle wrote Poetics [5] around 330 BC, and applied it to the development of serious stories, called tragedies. Dramatica [6] is a recent theory, that views story creation as a problem solving exercise. In the Movement Theory I have amalgamated important aspects of these theories, and other screenwriting principles.

Story fundamentals: Dictionary meaning of story include, "a short fictional narrative; the plot of a literary work" [10]. These definitions apply to humanistic stories, in which the characters are human beings. In table 1, we extend this concept by defining other story and character types. For example, in an animated story the characters are 'animation beings'.

Table 1: Types of stories and characters

Story type	Character type
Humanistic	Human beings
Animated	Animation beings
Game	Game beings
Education, Lesson	Knowledge elements
Song	Words, metaphors
Music	Notes, movements
Multimedia (MM) Story	Any of the above
Multisensory MM Story	" + Touch, Smell & Taste
Formal Story	Any of the above

Humanistic or animated stories are engrossing when they connect with us, and make our emotions move [8]. Another important aspect of all good stories is their ability to create a sense of immersion. This happens through 'suspension of disbelief' [9]; i.e. the user starts believing in the make-believe world of the story. The story experience is especially poignant if emotions swing incessantly from high to low, and vise-versa.

Creating a multimedia experience akin to a story experience achieves similar emotional connection and movement. Our aim is to apply this concept to other story types given in table 1, including *Multimedia Stories*.

By combining two or more story types, we create an even more moving experience. For example, songs and music enhance the emotional engagement of a drama or a movie; combining educational content with entertainment enhances its impact, for it has a story to tell.

From a technical perspective, multimedia elements include text, audio, still and moving images. From a story perspective, it comprises story characters. A *Multimedia Story* uses character of all types listed above it. A *Multisensory Story* further includes characters of the type touch, smell and taste. The last entry in this table, *Formal Story* will be fully defined with the Movement Theory; however, for the present, note that it can use any character type.

Poetics: Aristotle wrote poetics for crafting tragedies; nonetheless, Tierno [7] shows how to apply it to screenwriting. Many of its aspects are useful for crafting multimedia systems as well. The most important of these is the plot.

Heath paraphrases Aristotle as: "The importance of a coherently structured plot is a crucial element. It consists of a connected series of events: one thing follows on another" [5]. Another imperative for story writing is that every story must have a beginning, middle, and an end

[9]. Movement Theory uses these two concepts for its structural facet.

Dramatica: This novel theory departs from other story creation thoeries, in that, it views story creation as a problem solving exercise. Phillips and Huntley predicate, "…every complete story is a model of the mind's problem solving process. This Story Mind works… holistically. It is the author's argument as to the relative value of (various) considerations in solving a particular problem that gives a story its meaning" [6].

Problem solving: The problem solving model and its variants are used as the design methodology in many computing areas. Task Modeling is one such approach that formally derives the system tasks to solve a problem. However, this approach is but one component of many other aspects of interactive multimedia design, as Mori et al. state, "The field of interactive systems development will benefit considerably if the different theories, models, techniques, and tools can be brought together effectively" [13].

2.2 Movement Theory

The Movement Theory uses story telling to bring together different theories, models, techniques and tools for multimedia development.

Many of the concepts in the Movement Theory have their origins in screenplay writing. Nonetheless, these concepts apply to Multimedia and Multisensory Stories if we cater for multiple navigational paths. It provides a framework for creating multimedia experience by focusing on three facets: *Motivation*, *Exigency* and *Structure*.

Motivation (Why): The motivation facet directs a project by formulating the project concept as a series of problems, or questions. For only if we can ask the right questions, can we find the right answers. It starts with a problem statement, breaks it down into sub-problems and looks for solutions by telling a story that solves these problems.

Exigency (What): The exigency (need) facet asks, 'what is that the user wants'. The generic answer is: to get Emotional Movement. However, the way in which it is produced is different for each story type.

Let us first explore it from a humanistic story perspective. As viewers come out of a good movie, wiping their tears, or laughing, or doing both, they often say, "That was so moving". They are talking of Emotional Movement.

Students coming out of a good lecture may not say that it was moving, however, they have gone through a similar experience. Their experience probably began with anticipation, was followed by discoveries, and ended in a new understanding; making it a moving experience.

The ability to create Emotional Movement in the user is paramount for all multimedia systems. There are five main steps involved in creating Emotional Movement, as shown in figure 2. This process involves: (1) creating meaning that (2) moves the story characters' emotions; (3) these emotions are then transmitted to the user through multimedia or multisensory content. If these (4) story emotions make a connection with the user, they (5) create Emotional Movement.

Now, the challenge is to device a story structure that facilitates the creation of this Emotional Movement.

Structure (How): We view each story as an ensemble of *Story Units*. In addition, each Story Unit has three parts, the *Begin*, *Middle*, and the *End* (BME). The Begin of a Story Unit lays the groundwork. The best beginnings are those that hook the user, imploring to find out more. Middle carries the main story message. Then, for a natural termination, the story requires an End; consequently, any Story Unit that does not have exactly these three parts, is incomplete. Often, the biggest challenge is to find the most appropriate Begin and End.

Let us first look at the screenplay structure and then apply it to multimedia creation. A screenplay consists of three *acts*, which form the BME of the overall story. Each act comprises a number of *sequences*, each sequence is made-up of *scenes*. In the current screenplay writing practice the scene is used as the atomic story element, and it changes whenever there is a sudden change in location or time.

In the Movement Theory, I further divide scenes into Story Movements. The word Movement is used to signify that each of these sub-scenes must move the story. The term movement is used in music as well, where it is "a principle self-contained section of a symphony, sonata etc." [15]. A Story Movement must be self-contained; i.e. it must be a micro-story with BME components.

Hollywood screenwriting guru, Robert McKee, calls such micro-stories *beats* [9]. He defines a beat as, "an exchange of action/reaction in character behavior", exemplifies it with a beat-by-beat analysis of a scene from Casablanca, and demonstrates how these beats move the story forward. However, the word beat also refers to gaps in dialog, as employed by Allan Ball in his Oscar winning screenplay: American Beauty [16]. This usage causes confusion, and Flinn warns against it [17]. Story Movement (henceforth refereed to as Movement) is thus, I believe, the best term for encapsulating the properties of an atomic Story Unit.

While most Movements are sub-scenes, some Movements may comprise more than one scene, especially when presented as a montage.

A story works if its Movements work. And a Movement works if its BME components fulfill their function: Begin creates a sense of anticipation, Middle reveals the main message, and the End gives a sense of

closure. In addition, the End should link to the Begin of the next Movement, wherever possible.

By linking these Movements in a cause and effect relationship we create stories that keep the users glued to their seats. Just as we can create a moving Humanistic Story, we can create a moving story of any other type, including a Formal Story.

Now we can define a Formal Story as 'a connected sequence of Movements with a BME structure'. As per this definition, even this paper is a Formal Story: Introduction is its Begin, Conclusion is its End, and the intervening sections are its Middle; where each paragraph is a Movement.

Presenting multimedia content as a story does not mean that it must be molded into a Humanistic Story. There are times when conveying the message as a Humanistic Story works; however, at times, it obscures the real message.

Story Development: To develop a Multimedia Story, we start by stating its Story Problem. We then proposes a solution by identifying, in broad terms, its BME components. Then we take each component, and break it down into sub-components, each having its own BME structure. We follow this process until we discover the Movements.

Navigation: By breaking the entire story into Movements, it becomes possible to create a structure where the Movements are linked non-linearly. Different navigation paths are then the different solutions to the various sub-problems.

Thus, succinctly, the Movement Theory predicates that we can create Emotional Movement by taking a Story Problem and developing it into a sequence of connected Movements; where each Movement is a complete Story Unit with BME components.

3. Science Segment

Multimedia experience takes place in the mind; the five senses act as transducers that convert various forms of energy – light, sound, pressure, and chemical (for touch, smell and taste) – into electronic signals transmitted to the brain [18]. In this section, we explore scientific theories on how multimedia content combines to create meaning, and how this meaning works in the mind-body continuum.

3.1 Multimedia Semiotics

A scientific study of the semiotics of any domain gives us the means to understand how meaning is created by combining its elemental signifiers [19].

Most studies of multimedia semiotics consider text, graphics, audio, and video as the elemental signifiers [4] [14]. In the Movement Theory we consider Movements as the elemental signifiers from which Multimedia Stories are created. We can call this concept *Movement Oriented* design.

In the Movement Oriented design methodology a Formal Story is created by combining Movements, each Movement is, in turn, created by spatial, temporal and navigational interaction of the story characters. The range of story characters depends upon the story type.

In all multimedia presentations a spatial and temporal connection exists between the various components. As in drama, where "…an important 'bridge' is set up between gesture and speech. …the two are bound to cooperate in the production of theatrical disclosure" [1].

However, the meaning perceived by the user goes beyond simply combining the elements. As Lemke points out, "Meaning-making is always a material process as well as a social semiotic practice; as such it cannot be adequately understood in terms of any one semiotic modality" [4]; i.e. there is always a complex interplay between the meaning-making content, and the user's personal and social interpretation of the same.

Parkin expounds, "Our perception of the world is build up by internal processes which operate on an initial input that is far removed from what our sense organs initially register" [20].

In the following sections we explore two questions.

- How do we make meaning out of multimedia and multisensory experience?
- How does our perception relate to the Movement Oriented design methodology?

3.2 Cognitive Psychology

The two dominant approaches for understanding human cognition are: structural, and Gestalt [20]. The structural approach views our cognition as an ensemble of distinct faculties. Whereas, Gestalt approach predicates our experience as yoga of our sensory inputs, memories, and other experiences, where "the whole can be more than the sum of its parts" [21].

Then, how shall we view a multimedia experience? Movement Theory subscribes to the view that while we consider Movements as structural elements from the designer viewpoint, from the user viewpoint, the entire story is a Gestalt experience; as the famous French film director Jean Renoir said, "A picture is a whole. You cannot say this is the beginning, this is the end, and the middle" [22]. In this statement Renoir takes the viewer perspective. However, the designer has no choice but to put together components. The challenge is to make the story a cohesive whole, rather than something that feel like a collage of disparate multimedia components.

A basic principle of the Gestalt psychology is the 'law of good form', which state that, "if a number of

different organizations (gestalts) of stimuli are possible, it is the most stable or the 'best' that will be preferred" [20]. As a consequence, when a user experiences a story, whatever is not important to the story is missed or ignored' unless it is a complete misfit; and then it distracts the user from the story. Thus, the user should not be able to identify the individual Movements, even though the designer has created it by combining them.

3.3 Multisensory Experience

Should, and could the Movement Theory be applied to multisensory experience? Yes, because a multisensory experience without a meaningful story will be like a massage: therapeutic, but without any new insight.

We are used to audio, visual, and audiovisual stories. Can we have touch, smell and taste stories? Braille provides touch stories to some extent. However, it does not seem possible to create a story based solely on smell and/or taste. Touch, smell, and taste (TST), therefore, remain support senses that can create, or enhance the impact of individual Movements.

One of the aims of a multisensory experience is to 'make the invisible visible'. As Walker put it, "What storytellers in all media share is the need to make the complex understandable while reducing, compressing, and editing to fit space and time restrictions" [23]. Before a designer of interactive and informative art can create a 'compressed' version of reality, there is a need to model the invisible reality. Movement Oriented development helps the artist conceptualize, articulate, enumerate, and develop a multisensory artifact.

Most interactive and informative art uses audio and visual stimuli; whereas, virtual reality systems use more senses. In the future, digital multisensory experience will become prevalent with the development of inexpensive TST transducers. Then, including appropriate and timely sensory experience within a Multimedia Story will become paramount. In a Movement Oriented design, the designer will be able to identify the most appropriate location for TST stimuli by relating it to the story and its Movements.

4. Technology Segment

The technology used for creating, coding, storing and transmitting multimedia content has an important role to play in any multimedia experience. In this section, we explore some of the technological issues related to multimedia software engineering, coding, transmission, and Quality of Service, and their relationship to the Movement Oriented design.

4.1 Multimedia Software Engineering

Multimedia Software Engineering is systematic development of multimedia software. Chang asserts that, "New software process models and paradigms, such as object-oriented approach, are needed in multimedia systems design" [14]. He purports the concept of a Multidirectional Language, in which "the pragmatics can be based upon the patterns of various multimedia structures or sub-structures, such as navigational structures, content-based retrieval structures, etc. Once such structures are identified, they can be used as building blocks in putting together a multimedia application".

The Movement Oriented design methodology provides another vehicle for Multimedia Software Engineer, in which Movements are the 'code' building blocks. The concept of a Formal Story can be developed further, and placed in a formal framework by developing a grammar that caters for combining Movements in spatial, temporal and navigational domains.

4.2 Multimedia Content Management

One aspect of multimedia content management, namely, Computational Media Aesthetics attempts to extract metadata from existing multimedia content [24]. Dorai and Venkatesh suggest, "If we're going to create tools for automatically understanding video, it's usually best to interpret the data from the maker's eye". This poses many challenges as we attempt to extract meta-information. It's not possible to reverse-engineer all meta-information, especially nebulous concepts such as, writer's inspiration, director's vision, or the editor's intention.

However, content management can be facilitated in the Movement Oriented methodology by storing all design processes as meta-information with the finished product, or linked to other files (stored locally or on remote servers) and hyperlinked to the 'code' consisting of Movements.

Adams asserts that for video analysis "…finding boundaries within the data is one of the most fundamental requirements of any Multimedia Content Management-related tasks. Depending upon the domain, structural units can be shots, paragraphs, episodes, and so on." [25]. In the current production process, the shot (uninterrupted camera run) is the atomic element; Adams suggests that the shot is usable as a structural unit for multimedia content management as well. For a story created with the Movement Oriented design methodology, Movement becomes the structural unit for boundary demarcation.

Thus, we can use Movement as the structural element not only for creating new multimedia stories, but also for analyzing, segmenting, annotating, digitizing and storing

existing stories. However, this will require Movement Analyzers (people) working with Movement Analysis Tools (software).

4.3 Quality of Presentation and Service

Any error in the entire multimedia production and presentation chain can lead to artifacts in images, sounds, and the TST stimuli, that can interrupt the sense of immersion, jolting the user out of the experience. Therefore, the Quality of Presentation (QoP) is an important factor for any multimedia system. This problem is more pronounced in Networked Multimedia systems due to delay, jitter, skew, and errors encountered on the transmission media [12]. Consequently, Quality of Service (QoS) plays an important role for all multimedia information transmitted over networks.

Movement based QoS: Providing the desired Quality of Serve (QoS) to non-technical user is a major concern. Holistic QoS models aim to give the user the ability to request the desired QoS with minimal knowledge of the system's technical details [26]. However, most such systems are designed to provide the same QoS over a given session.

If we analyze, say a movie, we realize that its different parts require different QoP; if it is transmitted over a network, then different parts require different QoS as wells. For example, when Jackie Chan is kicking around, some jitter in the picture or the sound may hardly be noticed. However, when, for a change, he goes down on his knees in front of the heroine, we want to hear her answer clearly. If we were watching this movie on a video-on-demand system, and due to some transmission error we could not hear her answer, watching rest of the movie will become an exercise in agony.

In a Movement Oriented design we can assign different exigency (need) levels to different Movements, and use them to decide when to drop some data packets to overcome transmission difficulties.

Movement based compression: Current coding methods relate data bits and bytes in spatial and temporal domains, without any understating of the story and the importance of different Movements to the story. Once we include Movement Oriented meta-information in the presentation 'code' we can use it not only for annotation and QoS issues, but also for developing a new model of compression.

We can develop a new compression technique in which the system is concerned not only with the information entropy but also with the *Story Entropy*. Having allocated different exigency levels to different Movements, it will become possible to eliminate less important Movements from a presentation. Thus, a Story Entropy based compressor will produce shorter versions of the presentation automatically. Rather than just look for spatial and temporal redundancies, it will look for story redundancies also, thereby generating a compressed (abridged) story.

5. Is MuCiCle a New Paradigm?

We began with the assertion that the MuCiCle paradigm can create a yogic multimedia experience. This raises the question if the MuCiCle model represents a paradigm shift, as defined by Kuhn [27].

MuCiCle is not an entirely new paradigm; it is more of a paradigm mix or a paradigm twist, rather than a paradigm shift.

There is some paradigm shift as the development of multimedia 'code' is based on Movement Oriented design, rather than Object Oriented design. However, on the whole, there is a greater emphasis on mixing existing paradigms, models and theories from Arts, Science, and Technology. For example, with Movement Oriented designs, other story telling techniques, such as, plot twists and catharsis also become applicable.

6. Conclusions and Future Work

In this article I have given but an overview of some key issues of the MuCiCle paradigm. Main focus was on expounding the concept of Story Movement, and articulating the Movement Oriented design methodology. This methodology can spawn further research to link it with processes, tools, and techniques used in multimedia systems development.

The aim is to develop a formal theory, linked with a development methodology, as well as techniques and tools for creating Movement Oriented systems, with which we can produce 'code' that contains not only experience-generating content, but also, meta-information that encapsulates the processes used in creating this content. This will facilitate multimedia content management functions that seem extremely challenging with the current content development methodologies.

Others too have recognized the need for new approaches to multimedia design. Davis says that, "For video to become a daily means of communication we need to invent new forms of computational media production that don't merely computerize existing media production tools" [28]. The MuCiCle paradigm does this with the Movement Oriented design methodology.

In his book on Multimedia Software Engineering Chang writes, "There is an ongoing paradigm shift – from business orientation to entertainment orientation" [14]. I wonder if he had thought of story telling as the new paradigm.

7. Example

This example illustrates some of the principles annunciated in the article by developing the 'story' of a multimedia presentation – stage-by-stage – to solve the following problem.

Main Problem: To explain the meaning of electric current to high school students.

STAGE-1

Problem: To explain the meaning of electric current

B1 Importance of Electric Current (EC)
M1 Define and exemplify EC
E1 Link to Ohm's Law. Explain AC & DC

Each of the Stage-1 Story Units, i.e. B1, M1 and E1 are now expanded further. For example, 'B1,B2' in Stage-2 is the Begin of the Story Unit 'B1'.

STAGE –2

Problem: Why is EC important

The importance of Electric Current (EC)

B1,B2 Many people die of electric shock
B1,M2 Understand and respect EC, not be afraid of it.
B1,E2 EC is useful for running appliances

Problem: How is EC defined

Define and exemplify EC

M1,B2 Amperes = Coulombs / second
M1,M2 It's like watching Coulombs go past and counting how many go past in one second.
M1,E2 Demonstrate the effect of EC through multimedia and multisensory experience.

Problem: What determines EC strength

Link to Ohm's Law. AC/DC

E1,B2 Current depends upon voltage and resistance
E1,M2 Ohm's Law: I = V/R
E1,E2 Current can be direct or alternating.

Some of the Story Units at Stage-2 have been expanded further in Stage-3; whereas some of these have been left blank, signifying that Story Units can be instantiated in more ways than one.

STAGE -3

Problem: Why is EC important

The importance of Electric Current (EC)

Problem: What is the effect and cause of shock

Many people die of electric shock

B1,B2,B3 Video clip of a person getting a shock
B1,B2,M3 Explain the reason for the shock
B1,B2,E3 Ask, "So what is electric current?"

Problem: How should we treat EC

Understand and respect EC, not be afraid of it.

B1,M2,B3
B1,M2,M3
B1,M2,E3

Problem: How do we use EC

EC is useful for running appliances

B1,E2,B3
B1,E2,M3
B1,E2,E3

Define, exemplify and inject EC

Problem: What are the units of EC

Amperes = Coulombs / second

M1,B2,B3
M1,B2,M3
M1,B2,E3

Problem: How to visualize EC

Watching Coulombs go past

M1,M2,B3 Animation of Coulombs (blobs) going past.
M1,M2,M3 Update a counter
M1,M2,E3 Update display showing Amperes value rise and fall as Coulombs go past at different rates.

Problem: How does EC feel

Effect of currents, multisensory experience

M1,E2,B3 Ask the user to hold two probes interfaced to a constant low current generator.
M1,E2,M3 Increase current through the circuit. Display current in (mille) Amperes.
M1,E2,E3 Explain the physiological effect of current on the body.

Problem: How do we calculate EC

Link to Ohm's Law. AC/DC

E1,B2 Current depends upon voltage and resistance
E1,M2 Ohm's Law: V = IR
E1,E2 Current can be direct or alternating.

Many of the Story Units at Stage-3 can be expanded further, while some these are already at a level where these are the Movements for the final multimedia presentation. Note that the Movement Oriented development process pin-pointed an appropriate Story Unit for including a sensory experience: 'M1,E2'. The reader can get a better feel for the Movement Oriented design methodology by attempting to :

- Instantiate the un-instantiated Story Units at Stage-3.
- Explore how some of the Story Units can be expanded further into Movements at Stage-4.
- Explore how Movements can be linked nonlinearly.
- Locate more opportunities for user interaction.

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Multimedia technology as an advanced technology in audio-visual education program is applied more and more widely, with the advancement of times and the development of science and technology, such as in college physical education. The effects of multimedia computer assisted instruction on learning the swimming basic skills for physical education students. ("CMMB Vision", Stock Code: 471.HK), has reached agreement with Shanghai Jiaotong University to develop China's next generation of satellite-based mobile multimedia technology standard (the "Standard"), subsequent to