

Investigating the Impacts of Digital Elements in Web Information for Socio-Informatics

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Abstract: The Web offers enormous amount of digital information for communication and socializing. The fact that Web has been able to provide users with instant and global access to shared information, this platform gives a powerful medium of communication. When people are free to send and receive information, there is a potential to influence other people or be influenced by others through the use of digital element for its effective presentation. In today's world, there are many cases where people take advantage of these social media to involve in activities that lead to crime cases. Information can be manipulated. Therefore, it is crucial to identify the impact of digital element within the Web information that affects users' minds. In web-based socio-informatics, the conversation of these people take place without any support of physical movement like in face-to-face environment, hence, the strength of digital elements appear to be effective in influencing people's perception.

In this paper, we discuss our study on investigating the impacts of digital elements that include text, two dimensional (2-D) and three dimensional (3-D) graphics, audio and video, which are embedded in Web information. For finding such factors, each type of digital elements is examined in terms of its attributes and usage. Investigations are performed to look into the strength of such digital elements by understanding the existing guidelines, psychological or mental models and theories. It is important to look into such models and theories to justify how digital presentation can relate to the human perception. By identifying the impact factors, information can be constructed using the effective digital elements so that the social media are used in a proper manner with good impacts in strategic communication.

Key-Words:- Web information, impact factors, digital elements, socio-informatics, strategic communication, perception

1 Introduction

Digital elements play important roles in web-based communication. The elements are embedded in Web information for technology-based social contacts that can be part of socio-informatics. Social informatics involves many inter-related domains that can be viewed from different perspectives ranging from social to technology contexts [1]. In the current era of Information Age, networked computers become an important means of communication. People can receive and transfer information in digital form for fast, free and easy. Information can be disseminated freely through electronic social media such as mobile phone, face book, emails and many more. Thus, information can play an important role in influencing one's mind set. A powerful influential medium, the Web has been able to provide users with instant and global access to a massive amount of information.

The internet is capable to attract people regardless of their age group. Furthermore, information can be accessed regardless of time. With the power of

interactive response, some people may spend a lot of their time staying in front of the computer. In addition, people can find and have new virtual friends, discuss favorite issues, play games, do shopping and many more. People are free to send and receive information as well as create communication. Therefore, the context of use in information communication technology (ICT) leads to social shaping [2]. Through the use of a computer as a mediator in communication, it is not only the information that is able to influence the society, but also its presentation by using digital elements has the influential factors. For example, there are many cases where people take advantage of these social media to involve in activities that lead to crime cases. Even though the conversation of these people take place without any support of physical movement like in face to face environment, the strength of using digital elements appear to be so successful in influencing people's perception. There are many factors that contribute to the powerful influence of information and social media. For example, the user interest in the

advancement of computer technology, the physical appearance of the hardware tool, the material presented by the digital information, the content of information and many more. However, the focus of our research is on the presentation of digital elements that affect users.

In this paper, we discuss our study on identifying influential factors in the digital information in terms of text, graphics, audio and video. For finding such factors, each type of these digital elements is examined in terms of its attributes and usage. Analyses are also performed to investigate the strength of such digital elements by understanding the existing guidelines, psychological or mental models and theories. By identifying the influential factors, information with good impacts must be constructed using the best effective ways so that the social media can be used in a proper manner.

This paper is organized as follows; Section 2 discusses the attributes and usage of digital elements. Section 3 describes the strategies and actions on related models and theories, before the discussion and future work in Section 4.

2 Communication and Social Awareness

In networked collaborative virtual environment (NCVE), users interact with each other in dual roles, as senders and also receivers of information. The users are totally depended on the use of digital elements to characterize their presence physically and emotionally. The digital elements; text, 2-D graphics, 3-D graphics, audio and video, must have various attributes to symbolize users' trait in order to support their communication in the virtual environment.

During the virtual communication, with proper usage of digital elements, users are able to portray their gestures and capture visual cues of other users. Study shows that visual cues can be used to dominate others during the communication [3], thus, it asserts impact in strategic communication.

Figure 1 depicts the communication model in NVCE. The dots in the figure represent many users communicate instantaneously regardless of demographic location and form a social group. Since they are not in face-to-face environment, they need to have social awareness in order to enhance their communication. Social awareness has eight types that include awareness of presence, awareness of turn taking, awareness of emotion, awareness of identities, awareness of state, awareness of role, contextual awareness and conversational awareness. In NVCE, social awareness elements are not only embedded in the messages which are passed between senders and receivers, but also in the environment where the communication is taking place.

Studies on awareness of presence show that digital elements play very important role in the users' communication [4].

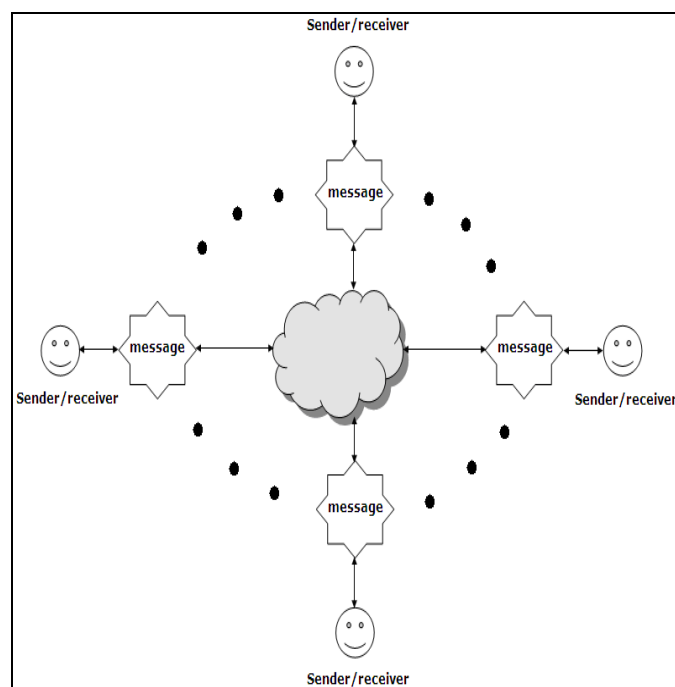


Figure 1. Communication Model in Networked Collaborative Virtual Environment [4]

Communication via social networks can be categorized into two: *personal* and *professional*. The *personal* social network is meant for large and diverse participants. On the other hand, the *professional* social network is for fixed number of participants and they should be recognizable. Social networks post three sociological challenges; to encourage user participation, to foster social interactions, and to promote visibility of people and their activity [5]. Thus, all the challenges are related to the awareness issues which involve the need to use appropriate digital elements during the communication.

2.1 Digital Elements

A digital element can be defined as a computerized unit that represents data or information. It is in a verbal or non-verbal form. The verbal is conveyed in the form of spoken or written words. In contrary, the non-verbal digital element is expressed in various ways except words that include touch, intonation and gestures [6].

In dealing with computer applications, the presentation of digital elements plays an important role in conveying information. The digital elements have many types that include text, graphics, audio and video. Each of them has its own attributes depending on the usage.

2.1.1 The Attributes

Each type of digital elements has its own attributes to present its properties. Table 1 shows some example of attributes for text, graphics, audio and video.

Table 1. Digital elements and some of their attributes

Digital Elements	Attributes
Text	Font, Style, Size, Color, Effect, Background
Graphics	Format, Style, Size, Color, Effect
Audio	Tone, Volume, Wave, Rhythm, Sound Effect
Video	Format, Speed, Size, Color, Motion Effect

2.1.1.1 Text

Text is the first invented digital element. It is commonly used when communicating through the social media since it is the simplest way of presenting information. The communication can be considered as verbal when people use it for chatting and sharing of interest. Text can exist in heterogeneous form that associates with race and culture. For example, Arabic, Chinese, Tamil, Russian and Japanese, have different presentation of text as compared to English. In Chinese transcript, the text usually originated from natural objects, either living things or actions. Reading the text requires top to bottom order. Unlike Chinese, the Arabic has its own meaning for every letter and the reading and writing are from right to left. Figure 2 illustrates some examples of these kinds of text.



Figure 2. Examples of text in Arabic, Chinese, Tamil and Russian

Text must not only attract readers, but they must also be legible that is having the quality of writing (print or handwriting) for easily be read [11]. One of the important attributes in text is font.

The text font is in serif and san-serif. "Serifs" are the small finishing strokes on the end of a character. The serif fonts are fonts are considered as old style which includes the *Times New Roman*. San-serif fonts have a very regular, geometrical shape with no serifs or "tails" at the end of the letter strokes. The examples are *Arial*, *Helvetica* and *Century Gothic*. They are considered as simple, clean, modern font styles that are reliable for the Web. [12,13]. Some considered "Sans serif type is free of visual distractions" [11]. However, through many studies found that there are not much different for the serifs or lack of serifs to have an effect on legibility [14].

The style of text is often used to distinguish some words or matter. For example, the bold style is for showing the importance of word or statement. Similarly, the italic style can be used for the same purpose. When using text, the size is also important to suit the need of applications [15].

Colors play important both in text foreground and its background. When using a color as the text foreground, it is important to consider the background color because the color combination is important in presenting colored text.

Beside colors, there are several effects on text such as shadow, strike, subscript and superscript. In addition to presenting text as in writing or alphabet, text also exists as sketch that uses picture to express the meaning.

2.1.1.2 Graphics

Graphics are usually in the form of shape, picture or graphical images, either in two dimensional (2-D) or three dimensional (3-D) presentations. The simplest graphic representation is a dot [16]. The graphic objects have all the principal texts' attributes (format, style, size, color and effect) except background.

Graphical objects are categorized into two forms; primitive, and advance. Examples of 2-D primitive objects are lines, axes and bars, while primitive 3-D objects are sphere, cylinder, cones and cubes.

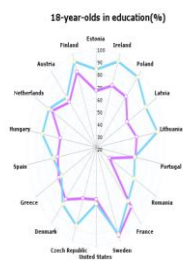
The 2-D and 3-D graphics can be in many colors, shapes and sizes. The 2-D graphics portray an overview of a situation, location or findings. On the other hand, the 3-D presentation aims to imitate the real world for better impacts. In most 3-D networked collaborative games, whenever 3-D human is presented, the object is referred to as avatar. All graphical objects can also have shadow to give an effect on the direction of incoming light.

An instance of graphics can represent a single activity. The description of the activity can be obtained by glancing horizontally across the graphics. However,

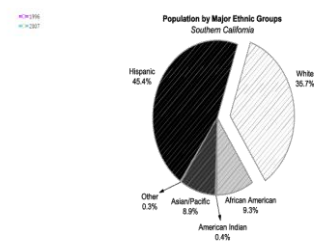
in most cases, graphical objects are grouped together to represent meaningful facts, which can consist of multiple inter-related activities. In addition, the graphics embed information such as scales of measurement, data and spatial coordination [17].

Figure 3(a) to 3(f) shows how 2-D graphical objects are clustered to form facts:

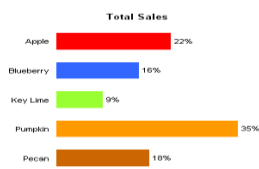
- in 3(a), different color of lines and scattered dots are grouped to form a radar-like graph that shows a comparison of the number of 18-year olds in education for the year 1996 and 2007 between several countries.
- in 3(b), an exploded circle shows population by major ethnic groups in Southern California.
- in 3(c), bars present total sales of several hand phone's brands for a specific company.
- in 3(d), instead of bars, the same information can be presented by using lines with different colors.
- in 3(e), icons represent real-life objects.
- in 3(f), a sketch illustrates a situation in front of a building.



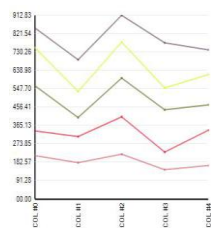
(a) Lines and dots[18]



(b) Pie chart [19]



(c) Bar chart [20]



(d) Line graph[21]



(e) Icons[22]



(f) Sketch[23]

Figure 3. Examples of 2-D graphics

The 3-D graphics offers photorealistic of 3-D real-life objects which enhance users to recognize the images of

the objects easier as compared to symbolic, simplified and flat 2-D graphics [24]. Figure 4(a) to 4(d) shows how 3-D graphical objects are personified and added with scales of measurement and spatial coordination by using the following elements:

- images to portray a real-life scenery 4(a).
- 3-D objects with a perspective view to depict house design 4(b).
- avatars to represent a game scenario 4(c).
- animation to create a movie 4(d).



(a) Image[25]



(b) Object[26]



(c) Avatar[27]



(d) Animation[28]

Figure 4. Examples of 3-D graphics

2.1.1.3 Audio-Video

Audio is always deal with sound. The analog wave is converted into digital form for discrete pattern rather than analog. The important attribute is volume that can also associated with how meaning can be expressed. Audio is usually come together with graphics when they form another digital element; a video. Video contains graphics with motion. The audio and picture must come simultaneously to convey the meaning of the disseminated information.

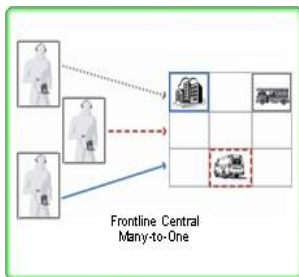
The audio-video is used to support networked collaborative virtual environment between remote and disperse users. The digital elements offer users to collaborate in real world. It is a virtual space where real people engage in real interaction and real working relationship [29]. The virtual space enables users to involve in communication that mimics the features of face-to-face interaction. Users are free to express, interact and attend on each others' personal attributes. According to theories of media richness and social

perspective, audio-video should be well suited for informal communication [30].

In audio-video communication, as users communicate in real-time, they have to present not only themselves in person but also to extend their working space to be seen and shared by other users [29]. Thus, the audio-video broaden the linkage of each user's personality and virtual space at each end of the connection.

Figure 5(a) to 5(d) shows how audio-video communication is envisioned:

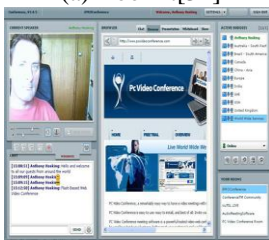
- in 5(a), audio-video communication, many users use wireless and wearable tool-kit that enables one session of audio-video communication takes place without the use of audio-video conferencing system.
- in 5(b), users are able to participate in community discussion where they can see clearly with whom they are interacting with and how many people involve in the discussion.
- in 5(c), users are interacting with multiple windows and multiple users in an audio-video conference.
- In 5(d), users have senses of sharing their places with others as other people could see the background where the audio-video communication is taking place such as their kitchen, living room, office and their personal belongings.



(a) Toolkit[31]



(b) Online discussion[32]



(c) Video conferencing[33]



(d) Extended working space[34]

Figure 5. Examples of audio-video communications

2.1.2 The Usage of Digital Elements in NVCE

The attributes of digital elements influence users in many ways. In interactive networked collaborative environment where people form a group to work together using a virtual workspace, the digital elements help in identifying the invisible users. The digital elements facilitate awareness of users (social awareness), action and activity [35].

In social awareness, there are eight type of awareness that include awareness of present, awareness of state, awareness of role, awareness of turn taking, awareness of emotions, awareness of identities, contextual awareness and conversational awareness. Each digital element is independent from each other in supporting the awareness types. Therefore, there is a need to combine them to give fully support for awareness and enhancing communication among users [36].

2.1.2.1 Text

Text is found to be the most popular element used in networked collaborative applications due to its ability to convey information in a verbal way while details description can be passed easily through message passing [36]. The ease of implementation and control on text attributes allow flexible manipulation for text presentation.

Figure 6 illustrates the use of text in two way communication in a chatting system. By using the chatting system, users can express their emotions through the use of special symbols such as “?”, “!”, “:”, “:.”. In addition, the sequence of words, the use of color on certain words and the word size can also portray users' emotions.

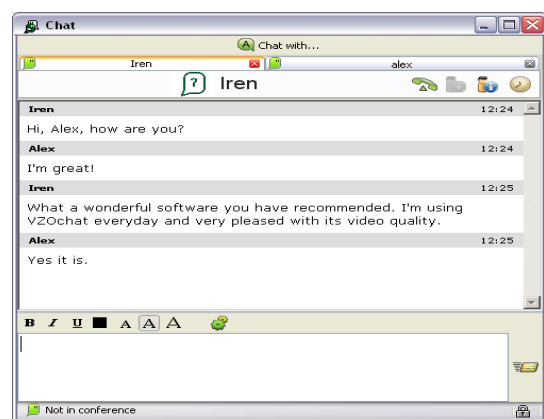


Figure 6: A text chatting system from Vzochat [37]

2.1.2.1 Graphics

In contrast to text, graphics can be considered as difficult to manipulate. Even though “a picture is worth thousand words” [38] and there are lot of images

available, the implementation of graphics using computer programs for flexible manipulation seems hard to achieve.

However, graphical objects offer a wide range of possible combinations [17]. Their graphical attributes allow users to provide spaces in between the objects such as in a map, chart, table or network to show different distance between the objects in real-life situation. Thus, the graphical objects will create different perspectives depending on whether they are clustered or aligned.

2.1.2.3 Audio-Video

In networked virtual collaborative environment, audio and video are usually used through special software tool (e.g. Vzochat [37], Voipcheap [39], Yahoo Messenger [40] or hardware device (e.g. webcam). Figure 6 shows one example of audio-video usage in two-way communication.



Figure 6: A sample of Vzochat [37] window

Most of their drawbacks are on the network delay in transmitting the information. For audio, the delay affects the flow of conversation that sometimes distracts the conversation. As for video, the delays will not only disturbing the voice, but also the quality of picture and the synchronization of audio and graphics. However, in communication, people perceive that audio has lower quality than the video [41]. Figure 7 depicts the lack of people preference towards the use of audio as compared to video in communication.

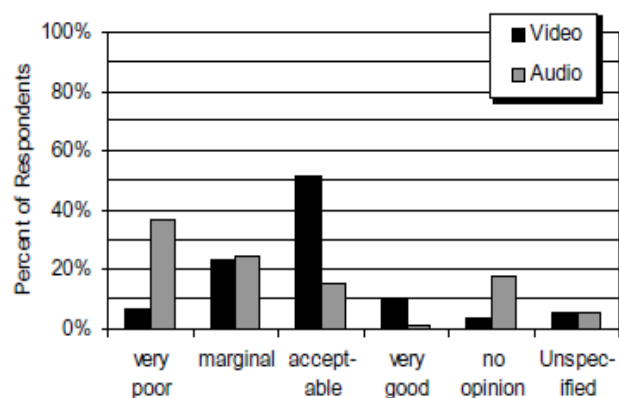


Figure 7: Responses to survey questions about audio-video quality

However, a study shows that the combination usage of audio-video in communication able to pass emotional information such as anger, fear and sadness to others [42]. In addition, the audio-video communication allows users to share their place with others, thus create a sense of belonging between the group members.

3 Strategic and Actions

There are quite a few strategies and actions on using digital elements that influent user. The vast amount of digital elements used in users' communication through networks is in the form of text [35]. According to Bix [15], the presentation of text can influence people's reading styles. Therefore, indirectly, the reading style becomes a habit which affects the people's preferences in communicating text to others [43]. It is important to consider the combination of colors on text and its background. The presentation of colors is capable of controlling the accuracy and speed of information searching and ease of reading. For example, green and red are bad color combination. They can reduce the speed of reading [44]. Blue text and white background can be considered as one of the best color combination that leads to one of best preferred display quality.

According to Timpany [45], the background color of text affects reading speed. For example, blue text on the white background in printed form gives the easiest way to read. However, the similar features of text presentation on a screen give not only the easiest to read, but also the fastest reading speed. In addition, the alignment and spacing of text presentation affects the accuracy of visual search such that the text that is double-spaced and left-aligned could be read and scanned more quickly [46]. Moreover, the length of the displayed text affects the speed of finding information, while fonts have no effect in the performance [47].

As for audio, a case study by Ice [48] that assess both frequency and level of use, reveal that the audio in one way communication is three times more effective than

text-based for conveying nuance. Furthermore, audio feedbacks on students in learning environment are associated with three elements:

- feelings of increased involvement and enhanced learning community interactions
- increased retention of content
- the perception that the instructor cared more about the student.

For example, tone of voice can portray the sound of supportive and caring attitudes [49]. These attitudes will psychologically enhance the feelings of involvement and interaction during the learning process, even though the usage of audio alone is not encouraging in teaching through on-line forum [50]. However, by combining both audio and text, the efficiency in reviewing material can be enhanced.

Unlike audio, the use of video requires interactive mode to promote effective e-learning. Otherwise, the one way video setting does not improve learning [51].

3.1 Theories

Information can be absorbed into human's mind through two distinct parallel ways; visually and verbally [52, 53]. According to the assumption of cognitive load theory (CLT) architecture [54, 55], human can only receive information in a structured manner with a limited storage in the working memory. Then, the processed information is transferred from the working memory into long-term memory that has unlimited storage. Therefore, in presenting information, it is desirable to avoid using excessive attributes of digital elements. It can cause memory overloading and results in misinterpretation of the information. However, the incoming information can be stored directly into the long term effective memory when using schema automation or other cognitive processes [54,55]. Figure 8 illustrates the process of understanding incoming information.

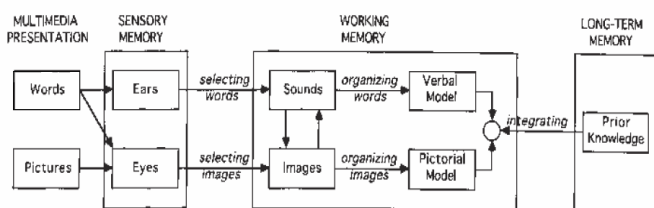


Figure 8. Process of understanding information[56]

Mayer and Moreno [56] suggested that there are six guidelines for absorbing the meaning of information through cognitive theory of multimedia learning (CTML). They are as follows:

- Modality effect – reasonable balance between visual and verbal digital elements.

- Multimedia effect – reasonable combination on digital element's type. Avoid using single type element of digital representation.
- Segmentation effect – Breaking up the information into logically connecting units.
- Signaling effect – Restructure information representation by systematic numbering.
- Temporal contiguity effect – The selected digital elements should be presented concurrently.
- Personalization effect – Information should be presented to the recipients in closely related manner such as using first and second person conversation style.

Referring to Figure 4, words for multimedia presentation can be denoted as text or audio, whereas, pictures are graphics or video in the context of digital elements.

3.2 Impacts

In general, to succeed in digital communication, the user must identify the target audience (viewer) and plan how to deliver the information. According to Rousseau [57], the user must include four steps of interaction between the viewer and the design for successfully and effectively convey its meaning. The steps are as follows:

- noticed
- encoded (decoded)
- comprehended
- complied with by the viewer

Failure at any of these steps diminishes the design's ability to effectively communicate, and therefore, achieve its intended goal. Although graphic designers do not frequently have control over steps three and four of the model, their influence over the success, or failure, of steps one and two is significant. Due to the importance of communication and the vast amount of text presentations (e.g. size, font, color), it is crucial to be selective in order to convey information so that it is noticeable, decodable, comprehensible and compliant to the receivers.

Research shows that color combination has impact towards professionalism. The look may increase readability in communicating the intended message. However, in marketing, color combinations do not have strong influence on purchasing power [58]. Besides color, in graphics presentation, the dimension plays important role to give a richer impression to the user such the 3-D visual is better than 2-D [59].

Among all the social media, web page enables to have all combinations of digital elements. According to Geissler *et al.*[60] who study about web page, there are five factors for influencing user's perception of home page complexity;

- Number of graphics

- Number of links
- Home page length,
- Use of animation
- Amount of text

Thus, these five factors should be considered in disseminating information through digital elements in order to improve users' perception.

In e-learning environment, both audio and text do not have much effect on user's understanding and inspiration [50]. However, the combination of these elements with Braille gives a great impact on visually impaired users [61]. In addition, audio-visual promotes active users' responses due to its capability of presenting visible humanizing cues during the interactive communication [60]. Furthermore, the combination of multiple digital elements such as text, video, audio and graphics promotes positive effects on learning outcome and user's satisfaction [51].

It is possible to detect the degree of dominance from visual cues by using videos. Study by Milovanovic *et al.* [62] on gesture communication is carried out to capture several users who are communicating in face-to-face situations. The dominance factors are composed of four parameters; speaking time (ST), the number of successful interaction (NSI), the number of times the floor is grabbed by a participant (NOF), and the speaker gesticulation degree (SGD). Table 2 shows the results of the study.

Table 2: Dominance classification results [62]

Indicator	Accuracy
Manual ST	100%
Manual NSI	86%
Manual NOF	71%
Manual SGD	71%

Out of the four parameters, both NOF and SGD can be considered as non-deterministic actions whereby the results depended on the users' personality and the shared task.

4 Discussion and Future Work

In this paper, we have presented discussed four types of digital elements which are normally used in social network communication. Each type has its own attributes and usage that have impacts in conveying information. The combinations of different elements' types enhance the impacts. However, human's mind has limited capacity and capability to absorb overloaded information. Overloaded information will tamper human's understanding and perception. Digital information does not only consists of elements in the

form of plain text or image, but also associated with several attributes such as colors, styles, fonts, effect, tone, volume, wave, rhythm, speed, size and motion. Each attribute plays specific role to enrich the overall media presentation.

In socio-informatics, finding the right combination of the digital elements' attributes for presenting any crucial information for strategic communication is very important. It involves disseminating information to a mass population in dispersed location within seconds. Bad combination of the digital elements' attributes may leads to confusion and need to be avoided.

In the future, details investigation on how to measure the impacts of digital elements to humans' perception will be conducted. This involves developing an evaluation model in dissemination of digital information.

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