The SSF Model: Structuring the Functions of the Sound Attribute

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Abstract: Prescribing instruction that utilizes the specific attributes of educational technologies has met with criticism and limited success. A contributing factor may be an insufficient depth of understanding of the attributes themselves. Given the current state of affairs, it seems reasonable to expect more negative criticism and poor results when designing instruction for the sound attribute. A better understanding of the sound attribute may be gained and a subsequent improvement of the educational materials realized when the functions and structure of the sound attribute are prescribed for sound-image sequences. The purpose of this paper is to present the perceived problem and offer the Structured Sound Functions (SSF) Model as a possible conceptual solution.

Resume: l'enseignement utilisant les technologies pédagogiques et leurs attributs précis a fait face à une critique et un succès limité. Une compréhension insuffisante des attributs eux-mêmes est un facteur qui contribue à cette critique. Les choses étant ce qu'elles sont, on peut s'attendre encore à des critiques négatives et des résultats médiocres quant a l'enseignement utilisant l'attribut du son. Une meilleure compréhension du son peut être atteint et une amélioration du materiel éducatif peut etre realisée lorsque la structure et les fonctions de l'attribut sont considerées dans la conception de séquences audio-visuelles. La résolution d'un probleme à l'aide du modèle Structured Sound Functions (SSF) est presente dans cet article.

BACKGROUND

Educational technologies (e.g., hypermedia, desktop and conventional video) can be made to possess attributes (e.g., interactivity, multiple windowing, zooming, sound) that may differentially affect learning (Greenfield, 1984; Clark, 1983; Salomon & Gardner, 1986). Matching these attributes with assessed needs, learning objectives and instructional strategies have enabled instructional message and user interface designers to prescribe instruction that utilizes the particular attributes of the technology required to achieve objectives (Reiser & Gagne, 1983; Richey, 1986). However, simply prescribing instruction that merely utilizes particular attributes of a technology has met with criticism and limited success, including: Video zooming (Salomon, 1979);

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interactivity and differentiated presentations (Hannafin, 1989); learner control (Merrill, 1988); CAI (Dede & Swigger, 1988) and LOGO combinatorial and knowledge-transfer attributes (Pea & Kurland, 1984); hypermedia (Conklin, 1987); and the attribute of embedding generative fact- and concept-level cognitive strategies (Barba & Merchant, 1990), to mention a few. It appears that an insufficient depth of understanding of some of these attributes may be at least partly responsible for ineffective or inefficient instructional communication (Clark, 1983; Hartson & Mix, 1990; Lepper, 1985; Salomon & Clark, 1977; Salomon & Gardner, 1986).

Given the current state of affairs, it seems reasonable to expect more negative criticism and poor results when designing instruction for the sound attribute. The purpose of this paper is to address the non-use and mis-use of the sound attribute and present the Structured Sound Functions (SSF) Model (Mann, 1990) to improve sound attribute research and scriptwriting guidelines in educational technology.

VISUAL PREFERENCE

Owing to a preponderence of visually-minded theoreticians and practitioners, designing instructional sound for simulations video and desktopvideo has often been slighted in both practice and research (Buxton, 1987; Doane, 1980; Gorbman, 1976; Nickerson, 1986; Seidman, 1986). For example, only three of the 100 software development contracts tendered for Ontario's Grant Eligible Microcomputer System (G.E.M.S.) made extensive use of the sound function (Gaudino, 1986). Moreover, complex instructional messaging has caused confusion in some important computer interfaces, the most serious instance occurring at the Three Mile Island plant where over sixty different warning systems were activated (Buxton, 1987; Nickerson, 1986). One explanation for the proliferation of silent courseware has been that younger children may not understand sound-image relationships (Greenfield, 1984). Another explanation was that it just doesn't seem 'right' for users to have to listen to their computers speak to them (Mel et al, 1988). In these instances and others, opportunites may have been missed because the sound attribute was not included in the message design of the user interface.

Semiology

Some theorists and practitioners (Bordwell & Thompson, 1979; Doane, 1980; Gorbman, 1976; Prendergast, 1977; Seidman, 1986; Spottiswoode, 1950) have suggested that semiological frameworks should organize content. Although there are obvious physical differences between video, CAL and multimedia technologies, they share several psychological and physical characteristics (Lepper, 1985; Salomon & Gardner, 1986). Among their psychological characteristics, educational and informational messages can be encoded in symbolic forms which subsequently require skill for their decoding (Salomon,

1979; Smith, 1988). Moreover, multimedia may expand the number of symbol systems to represent meaning, bringing to bear a wider range of semiotic functions that may influence how a reader acquires meaning from text (Havelock, 1988; Olson, 1988; Beinking, 1987) or from graphics (Marcus, 1987). In this light, the analogies of research on the cognitive and social effects of conventional video to those of CAL and hypermedia have been useful (Lepper, 1985; Salomon & Gardner, 1986). On their own, however, combined, chained, arranged and organized symbol schemes are too descriptive and too complex for most sound analysis and production users (Gianetti, 1985).

Formative Research in ETV

Coldevin's (1981) several content organization categories were meant to improve learningusingmediabystructuringtheeducationalcontent throughout the production. But they do not attend to sound in sound-image relationships. Similarly, the story-spine has been considered by some (Goldman, 1983; Field, 1982; Boot, 1979) to be an indispensable instrument for theatrical and made-for-TV scriptwriting. But its usefulness in treating the story using sound has been left unspecified.

The Children's Television Workshop used instructional goal-areas as a method for structuring visual and verbal content (Palmer, 1969; Lesser, 1972; Mielke, 1968; Schramm, 1972). Their methodology, however, neglects to consider procedures for selecting and combining their sound strategies (goal-areas) with the purposes or functions (Point of View POV], character's past, etc.) for the sound in the image-sound relationships.

The idea that television acts more like an ear than an eye and that its participation is aural not visual (M. McLuhan, 1967; S. McLuhan, 1978), carries the correct attitude for approaching the visual preference or bias problem in educational technology. However, this notion was only part of his larger vision of post-literacy in a futuristic global village, and is not readily adaptable to designing sound for television. Even Aristotle (see the ***Poetica*** in McKeon, 1941) alluded to theatrical structure but ignored sound per se in his discussion of plot development using sound (i.e., the structure, dialogue, and music).

Image Decoration

Some design guidelines for the conventional technologies appear to be dependent on visual cues rather than story structure; or only allude to the psychological components of sound. Zettl (1973) replaced Pudovkin's (1960) synchronistic-asynchronistic dichotomy with the more literal source connected-disconnected film categories. Millerson (1979) presented four types of audio-visual relationships and is generally correct in stating that 'the trick is to use sound selectively if you want the scene to carry conviction, rather than try to include all typical background noises" (p. 367, Millerson, 1979). He has suggested that the image's impact in video and film may be due to its accompanying audio, the effect of image and sound can be cumulative, and the sound

and image together may imply a further idea. But like many others, these re-orientations of sound in technology can be attributed to a camera-oriented dominance in the terminology (Doane, 1980; Seidman, 1986).

Some theorists (Daiute, 1985; Malone, 1981) have suggested that captivating computer-sound must somehow decorate, enhance, create fantasy, reward, or represent that which would have otherwise been leas effectively communicated as text or numbers, Others (Alkin, 1973; Rosenbaum, 1978; Gorbman, 1976) have stated that captivating images cannot hold learners' attention for long if the aural sense is not suitably stimulated. Finally, there are those (Buxton, 1987; Paine, 1981; Ragsdale, 1988) who believe that learners who are regularly bombarded by ever-deepening visual information (hi-res graphics, video capture), may need heightened sound effects in their instructional messages if only to perceive them at all. In all these cases, supporting the image is presumed because the overall design of the program or production is purposeless or structureless and will, as it usually goes, require some measure of redundancy from the audio channel to impact on a weak informational or emotional message.

Redundancy

Audio visual redundancy, however, can be boring (Brown, 1985), distracting (Gecsei, 1986) or both (Field, 1982; Goldman, 1983). While it is apparent that the redundancy of information (Schoderbek, Schoderbek & Kefelas, 1985) may contribute to message retention, and that auditory and visual modality design may increase human capacity over either mode separately (Craik, 1979), the increase is often evident only when the bimodal information is related, not redundant (Fleming, 1987; Grimes, 1990). So, although reaction seems to be growing against the exinclusion of sound in educational technologies, the prevailing attitude of many message designers still seems to be that sound is the poor relation in the sound-image relationship and should only be permitted as much consideration, effort and facilities as can be spared after the visual requirements of the production are satisfied (Altman, 1980; Blattner et al, 1989; Buxton, 1987; Buxton et al, 1989). This 'poor relation' attitude is evident in conventional video technology, where the problem of achieving high quality sound has been avoided by suggesting that either the image supplied most of the information, or that the presence of the image makes the sound less critical (Alkin, 1973; Altman, 1980; Zettl, 1973). Without sufficient attention to the function or purpose and the structure of the sound attribute, there's little reason to expect that results of encoding and decoding educational messages from the sound attribute of these educational technologies will be any more successful than they have been for other attributes

In situations where it is assumed that text, graphics and video samples supply most of the information or that the presence of the image makes the sound less critical, it seems that unifunctional sound or unstructured sound has been the norm, not the exception, and unstructured sound is considered to be undesirable because its primary purpose is only to support

the image. A deeper understanding of sound design may be gained and a subsequent improvement of educational audio-visual materials realized when the functions and structure of the sound attribute are prescribed for sound-image sequences.

THE SSF MODEL: STRUCTURING THE FUNCTIONS OF THE SOUND ATTRIBUTE

The Structured Sound Functions (SSF) Model is a generic educational message design tool for structuring sound in sound-image sequences. Several functions can be structured offering a more equitable treatment of the sound attribute. Three activities seem to be implicit in structuring sound functions into a sound-image relationship: Creating functions, structuring the functions and scriptwriting. First, sound functions must be chosen for each sound-image relationship.

Creating Functions for the Sound Attribute

The function of the sound attribute is a characteristic that prescribes or describes its purpose within the sound-image relationship (Alten, 1981; Gorbman, 1976; Zuckerman, 1949). Evidently, functional aesthetic distinctions are rarely drawn between meanings inherent in the stated and implied message in the image, and in the stated and implied sound.

Unifunctional sound tends to demonstrate a lack of creativity and innovativeness in the courseware design. The two most common types of unifunctional sound are conditioned reflex sound and hackneyed sound. Conditioned reflex sound relies on stimulus-response (S-R) associations and S-R chains. The S-R associations and chains provide networks of associations to support generalizations beyond the immediate control of individual stimuli (Hannafm & Rieber, 1990). Reinforcement schedules can have differential effects on both how associations are made and how behaviour is shaped as well as on the durability of conditioned responses (Reynolds, 1968). Hackneyed sound is a corollary of the conditioned reflex design. Hackneyed sound is the application of another designer's sound idea to one's own program or production; colloquially referred to as a spin-off or sound bite (Brown, 1985; Goldman, 1983) depending on how heavily the user borrows from the original idea.

Creating sound functions for a sound-image sequence means writing one or more sound functions on the function sheet (Figure 1). In this case, it also means the additional task of encoding utterances that represent one or more sound functions into the sequence. Together, the implied sound functions can prescribe what the sound should imply within a sound-image relationship.

Analyzing or creating functions of sound for a sound-image sequence means writing a description or prescription for what the sound does or should

Figure 1.
The Functions of Sound.

The Functions of Sound (Speech, Sfx, Music)
For Segment: _____

Step 1: *What do the* images Show (e.g., Point moving along a line.. .)

Step 2: *What does the Sound State* (e.g., Silent)

Step 3: *What do the* images imply (e.g., Something will happen to the point or line)

THEN: ***What the SOUND SHOULD /MPLY about the Atmosphere, Feeling,*** or ***Mood (e.g.,*** Video-game style sfx, music)

OR: ***What the SOUND SHOULD IMPLY about the Point(s) of View (e.g.,*** Objective POV – a situation analysis; Performer POV – focus favours the point Subjective POV – usually contrast to other POVs)

OR: ***What the SOUND SHOULD IMPLY about Future or Past Events*** (Temporal Speech Coding – e.g., "Meanwhile the position of point Q has changed" Or – "Don't forget to.. .l' Or – OK, now watch for.. .")

OR: ***What the SOUND SHOULD IMPLY about the Locale(s)*** (e.g., A congested situation – multiple voices; becomes clearer – one grows dominant)

OR: ***What the SOUND SHOULD IMPLY about the Character's Past*** (e.g., Character's Personal Past/Private Past/Public Past-Or, just back story on the present visual situation -why it looks this way and where it was before)

OR: ***What the SOUND SHOULD IMPLY about the Character IN the Character*** (The exceptions to this behaviour. Quirky, paradoxical and unpredictable conditions. In simulations – why it looks this way and where it was before)

imply about an atmosphere, a feeling, or the mood; one of three points of view a future or past event; a locale; a character's past; or a character's personality. These functions may be conceptualized as possible prescriptions for character, place, time or subject matter in a sound-image relationship.

Atmosphere / Feelings / Mood

The Atmosphere/Feeling/Mood Sound Function (Alten, 1981; Seidman, 1986; Zuckerman, 1949), traditionally has been the most overused function of sound. When an ***Atmosphere/Feeling/Mood Sound Function*** is created, it must imply either more or something else about the referent other than what has already been stated or implied about atmosphere, a feeling, or mood by the image.

Point Of View (POV) Sound Function

Informational Sound Functions (Alten, 1981; Zuckerman, 1949) can add new concepts, ideas or facts to the program or production. ***Objective, Subjective or Performer POV Sound Functions*** (Lee & Misiorowski, 1978) can be prescribed as a function of character. A ***Subjective POV Sound Function*** may use a character voice-over. An ***Objective POV Sound Function*** may use a narrator voice-over, and a ***Performer POV Sound Function*** may use some combination of subjective and objective sounds. When an ***Objective, Subjective or Performer POV Sound Function*** is created, it must imply another point of view or more about the point of view than what has already been stated or implied about the referent by the image.

Temporal (Future/ Past Events) Sound Function

The Temporal Sound Function (Brown, 1985; Gecsei, 1986; Gianetti, 1985; Field, 1982; Lee & Misiorowski, 1978; Root, 1979; Samuels, 1984) may be conceptualized as the visual equivalent of a scriptwriter's "gimmick." When a ***Temporal Sound Function*** is created, then it must imply more or something other about the referent than what has already been stated or implied about the future or past in the image. Unlike the ***Character's Post Sound Function,*** the ***Temporal Sound Function*** informs the learner about a past event unrelated to the history associated with the Character or gimmick (e.g., a metaphorical occurrence as in a dream).

Locale Sound Function

The Locale Sound Function (Alten, 1981; Zuckerman, 1949) seems to play one of the most necessary informational roles in a sound-image relationship. Most often, the ***Locale Sound Function*** is used realistically as appropriate background speech, music, or sound effect. Typically, familiar sounds are produced to establish a place for a referent. When the Locale Sound Function is created, then it must imply more or something else about the referent than what has already been stated or implied about it in the image or sound.

Character's Personal, Private, or Public Past/Future Sound Function

Three types of sound function related to a Character's Past or future are presented: Personal, private and public. When the ***Character's Professional Past or Future Sound Function*** (Brown, 1985; Gecsei, 1986; Gianetti, 1985; Field, 1982; Lee & Misiorowski, 1978; Root, 1979; Samuels, 1984) is created for

a referent, then the character's professional past implies (without overtly stating it) what the character has been doing for a living; his roles in the corporation, history of relationships with co-workers, and so forth. When the ***Character's Personal Past or Future Sound Function*** is created, then the character's personal past or future implies (without overtly stating it) the nature of his/her marital history, history of educational background, job, and socioeconomic history. When the ***Character's Private Past or Future Sound Function*** is created, then the character's private past or future propels the character through the story. The private past implies the need for fame, money, stability of the marriage, peculiar tendencies, and flaws of character or personality.

When the ***Character's Personal, Private or Public Past/Future Sound Function*** is created, then it must imply more or something other about the referent than what has already been stated or implied about his/her past in the image. Unlike the ***Character-In-The-Character Sound Function*** (Goldman, 1983; Root, 1979; Zuckerman, 1949), this function does not plumb the depths of the character's psyche. This function tries to answer specific questions in relation to the message design or plot.

Character-In-The-Character Sound Function

The Character-In-The-Character Sound Function refers to the subtext, story spine or tragic flaw in the character. The ***Character-In-The-Character*** sound should be used to depict a certain recurring aspect of the character's behaviour, certain aspects of the character's (moral) character or his or her peculiar personality (mask) is intentionally prescribed ambiguously (e.g., self-effacing music that presents a multi-faceted personality of the character). When the ***Character-In-The-Character Sound Function*** is prescribed, the person's character (i.e., his or her habits) or their persona (i.e., his or her worldly mask) is created. This character or persona must imply more or something other about the referent than what has already been stated or implied about him/her in the image.

Specific questions in relation to the subtext of the plot are best answered by implication using ***Character-In-The-Character Sound Function:*** What does he really want? Who/what's really stopping him/her from getting what she or she wants? The intention behind prescibing this sound function is to generate a controversy with the other sound functions (i.e., ***POV, Locale, Character's Past,*** etc.) working in the sound design.

In conclusion, unstructured sound is undesirable because it is often distracting (Gecsei, 1986), boring (Brown, 1985) or both (Field, 1982; Goldman, 1983). In education, boredom can be a formidable problem often treated with improved motivational messaging (Fleming, 1987; Keller, 1983; Malone, 1981) or with procedural facilitations (Scardamalia et al, 1989); while distraction is anathema to the learning process, and may be prevented with attention-focusing events of instruction (Gagne & Briggs, 1979; Hannafin, 1989). Six functions of the sound attribute can provide a subtext or within

sound-image sequences. However, these sound functions still require a structure to prescribe the duration of the function in the sound-image relationship. Structuring sound substrategies is a second activity in structuring sound functions into a sound-image relationship.

Structuring The Functions Of The Sound Attribute

A sound structure is a combination of strategies working together with one or more functions. A "strategy" is a schema for mediating an intended message or expression. The strategies that comprise a sound structure refers to the plot (McKeon, 1941), the content organization category (Coldevin, 1981), the goal-area (Palmer, 1969; Lesser, 1972; Mielke, 1968; Schramm, 1972), the code (Salomon, 1979; Smith, 1988), or the story-spine (Goldman, 1983; Field, 1982; Root, 1979). Sound strategies and substrategies help the designer or script-writer to prescribe where, how, and for which function exactly each component of the message fits into or "works" in the overall scheme of each scene or sequence of scenes. Structures place appropriate sound functions next to every image sequence to create the preferred symbol scheme for a referent. Figure 2 (page 54) shows the six sound strategies and fifteen substrategies that can be used to produce or evaluate the structure of the sound in a sound-image sequence.

In this context, structuring the sound functions for a sound-image sequence means writing the sound strategies on the Structured Function Sheet for each created function. Structuring sound functions means describing or prescribing from among six levels of informational intervention with the image; from either of two roles for an emotional strategy; from a flexible pacing strategy, a continuous or discontinuous rhythm strategy; a spaced, massed, or summarized review strategy; and a convergent or divergent delivery strategy

The Informational Sound Strategy

Four substrategies comprise the ***Informational Sound Strategies*** (Alten, 1981; Brown, 1985; Buxton, 1987; Field, 1982; Gaver, 1989; Gecsei, 1986; Goldman, 1983; Zuckerman, 1949). ***Cueing, Counterpointing, Dominating,*** and ***Undermining*** can be placed along a relationship-to-image continuum. All four substrategies may be used throughout the sound design in combination with other substrategies. A fifth substrategy is not considered here and not included in the SSF Model. It prescribes sound information that supports or merely accompanies the image, making that information unnecessarily redundant, and subsequently promoting the visual preference or bias.

Audio segues, headliners, flashforwards or gimmicks are some examples of the ***Cueing Informational Sound Substrategy*** where the chosen sound function foreshadows the visual action. The ***Countepointing Informational Sound Substrategy*** has been used to create a visual cast-against-type characters by providing aesthetic meaning. The ***Dominating Informational Sound***

Figure 2.
Sheet for Structuring Sound Functions.

Structuring the Sound Functions (Speech, Sfx, Music) for Segment:

The Informational Strategy:

☐ **Cues The Image**
How? _____
How Often? _____
Where? _____

☐ **Dominates the Image**
How? _____
How Often? _____
Where? _____

☐ **Counterpoints The Image**
How? _____
How Often? _____
Where? _____

☐ **Undermines the Image**
How? _____
How Often? _____
Where? _____

The Emotional Strategy:

☐ **Punctuates an Emotional Highlight**
How? _____
How Often? _____
Where? _____

☐ **Defines Intensity of Action**
How? _____
How Often? _____
Where? _____

The Pacing Strategy:

☐ **Slow-Paced**
How? _____
How Often? _____
Where? _____

☐ **Fast Paced**
How? _____
How Often? _____
Where? _____

The Rhythm Strategy:

☐ **Discontinuous Rhythm**
How? _____
How Often? _____
Where? _____

☐ **Continuous Rhythm**
How? _____
How Often? _____
Where? _____

The Review Strategy:

☐ **Massed Review**
How? _____
How Often? _____
Where? _____

☐ **Spaced Review**
How? _____
How Often? _____
Where? _____

☐ **Summarized Review**
How? _____
How Often? _____
Where? _____

The Delivery Strategy:

☐ **Divergent Delivery**
How? _____
How Often? _____
Where? _____

☐ **Convergent Delivery**
How? _____
How Often? _____
Where? _____

Substrategy rarely appears in video simulations and multimedia. If it did occur more often it may alleviate the current audio-visual redundancy affecting educational courseware (i.e., identical informational and emotional strategies using verbal, visual and graphic organizers). However, at its rare best, this substrategy untypifies a predictable or hackneyed emotional interlude (e.g., injects silence where music would bridge two scenes or where the attention to image is lost briefly). The *Undermining Informational Sound Substrategy* is considered to be an ironic or sarcastic use of informational sound in that its effect "sends up" the meaning in the image.

The Emotional Sound Strategy

The sound attribute is often prescribed with either ***of*** two ***Emotional Sound Strategies*** (Alten, 1981; Brown, 1985; Field, 1982; Gecsei, 1986; Goldman, 1983; Lapper, 1985; Seidman, 1986; Zuckerman, 1949). Invideoand computer application, the visual action may be a gimmick. Strategically placed, ***Defining Visual Action Intensity Sound Substrategy*** prescribes how, where, and how often the chosen sound function should punctuate the visual action. A sound or its absence may create depth by creating suspense or interest in the sound-image relationship. Restraint through the sparing use of silence or room noise may imply suspense or interest in the story or message. ***Punctuating an Emotional Highlight Sound Substrategy*** may create depth by implying suspense or interest with two or more sound functions in a sound-image relationship (e.g., electroacoustically-produced sound designs may create deeper-felt emotions in the learner).

The Pacing Strategy

Since the 1930's, pacing has been used effectively in many conventional applications of sound to image (i.e., in artistic, education, and entertainment environments). Motion picture writers and editors have operationalized the importance of "the dialogue cutting point" for making smooth, unnoticeable cuts when cuttingfrom onespeaker to another in a scene (Salt, 1976). The two ***Pacing Sound Substrategies*** (Coldevin, 1981; Lesser, 1972; Mielke, 1968; Palmer, 1969; Salomon, 1979; Schramm, 1972) prescribe how fast, where, and how often the chosen sound function occurs in the production. Sound pacing can be placed along the designer's continuum Fast or Slow occurring in contrast to one another.

The Rhythm Strategy

Two Rhythm Sound Strategies (Brown, 1985; Coldevin, 1981; Field, 1982; Palmer, 1969; Root, 1979; Salomon, 1979; Schramm, 1972) prescribe the periodicity for each chosen sound function in a script or sound mix. A Continuous Rhythm Substrategy places uninterrupted sound ***Review*** or ***Summarized Review)*** or interrupted sound at regular intervals (Spaced Review) throughout the sound design. A ***Discontinuous Rhythm Substrategy*** places uninterrupted sound or interrupted sound at regular intervals throughout the program or production.

Review Sound Strategy

When one or more of the ***Review Strategies*** (Coldevin, 1981; Palmer, 1969; Salomon, 1979; Schramm, 1972) have been chosen for a particular sound function, then each strategy should show the size and the extent to which the designer or learner wants to manipulate the reality suggested by the image by writing how, where or how often each sound function will be ***Massed, Spaced,*** or ***Summarized*** (Coldevin, 1981; Palmer, 1969; Salomon, 1979; Schramm, 1972). The three review substrategies prescribe the nature of a particular function's recurrence in a sound-image relationship.

Corporate video productions tend to use a Summarized Review Substrategy to reinforce behaviour modification role modelling techniques. Similarly, most "Sesame Street" episodes often repeat "this program has been brought to you by the letter M"; broadcast TV news programmes utilize a Summarized Review Substrategy in recapping the main news stories. Exemplary software using sound as a reviewing technique tend to mass the speech or music into "sound bites."

The Delivery Sound Strategy

Convergent or Divergent Delivery Substrategies (Davis, Alexander & Yellon, 1981) are usually considered to fall along a continuum. Their visual counterparts have been implemented in education to prescribe instructional events or learning activites. The application of convergent or divergent delivery methods to sound designing is most appropriate when applied in this context.

In a Convergent Delivery Substrategy (Coldevin, 1981) the designer or learner presents the questions and supplies the answers; favouring one side over another. Brown (1985) states that in a dramatic script with a convergent delivery, catharsis is reached through the ultimate confrontation of two opposing forces. In a Divergent Delivery Substrategy (Coldevin, 1981) the designer or learner supplies their own answers to controversial questions presented by the medium. Two or more diverging points of view emerge but are presented equally for scrutiny. It is important to retain this dichotomous or scholastic presentation format, wherein no attempt is made to editorialize nor to show favour.

In summation, structuring skills are relatively common dramatic devices that, in many cases, are learned in many creative writing and production courses under various synonyms. Structuring the sound functions for a sound-image sequence means writing the sound strategies on the Structured Function Sheet for each created function. Together, the implied sound substratgeies can prescribe how, where, and how often the speech act should be placed within a sound-image relationship. Implicit in this task is an ability to choose from among fifteen possible substrategies, as well as the ability to decide how, where, and how often each substrategy should be applied in the sound-image relationship. In this light, modifying the structured functions of the sound attribute for conventional and multimedia deisgn may take as much or more time, effort and resources as encoding its educational messages. Scriptwriting is the third activity before applying available sound resources to the technology.

Scriptwriting

Scriptwriting involves simply using the information from the structured function sheets as a guideline for placing the utterances music or sfx in the sequence. Then, different versions of the scripting format (e.g., using stated sound, implied sound categories or "text" and "subtext" categories) will encour-

age proper allocation of speech, music or sound effects resources. Figure 3 shows a typical multi-column script sheet. Notice that the six functions have been filled-in along the top of the form. The spaces under these columns can then be used to determine the approximate location and quantity of each structured sound function in a sequence, scene or keystroke.

This multi-column scripting sheet is an adapted animation-style layout with the addition of functions in each column instead of the conventional number of the tape tracks, voice overs and instruments. Together with the

Figure 3.
Multi-Column Scripting Sheet.

Scripting Structured Sound Functions
For Segment:

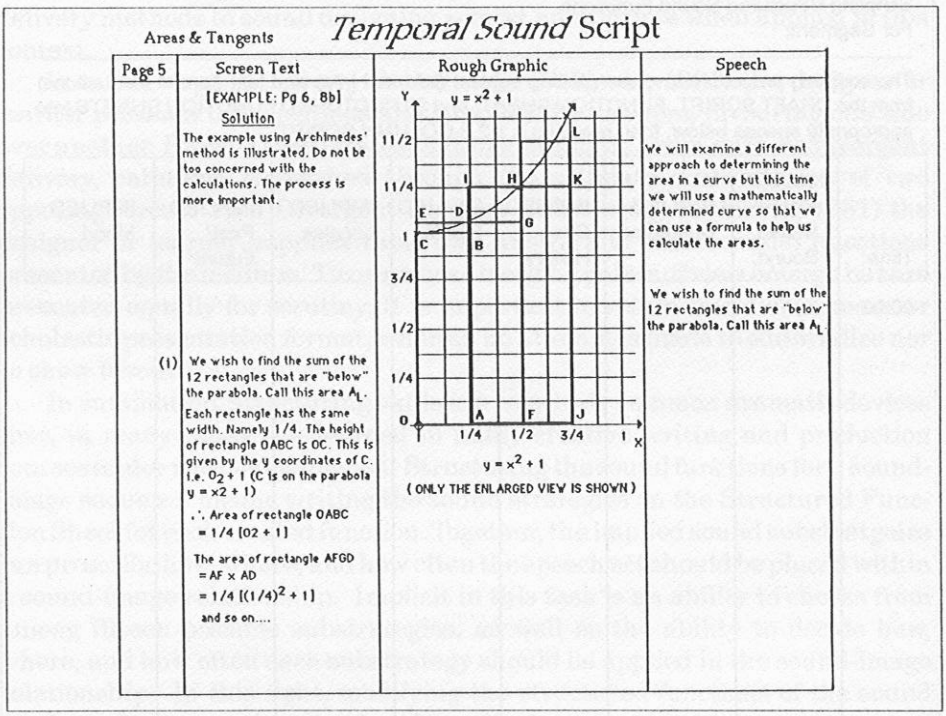
The scripting procedure involves plotting subtext (informal info) and text (formal instructions) from the DRAFT SCRIPT, FUNCTION SHEET, and STRUCTURED FUNCTION SHEETS into appropriate spaces below, then rewriting a 1,2,3-COLUMN SCRIPT.

Time:	stated Picture stated Sound:	IMPUED Character	IMPLIED Case History	IMPUED POWS	IMPUED Locales	IMPUED Past/ Future	IMPUED Mood
00:00							

Structure Sheet, the multi-column script should encourages quick stroming sessions using any of the sound functions in various combinations with analog or digitized video. Next, progressively more detailed versions of the script can be written by collapsing the columns down to three, two or one column depending on the technology used. Figure 4 shows a collapsed script version.

Figure 4 shows a collapsed script page for an introductory calculus unit using only the *Temporal (Past and Future) Sound Function* (Mann, 1990). This function has been structured with a *Moderately-Slow, Spaced, Discontinuous, Counterpointing* and *Convergent* instructional strategy (Mann, 1990). An important aspect in creating these collapsed versions of the script is that a psychological distinction is maintained: Between the picture and the sound; between the stated sound and the implied sound; and between the text and the subtext.

Figure 4.
A "Collapsed" Script Page for a Temporal Sound Function.



CONCLUSION

Although attribute research suggests *modus tollens* that sound may only produce equivalent learning, a review of the interdisciplinary literature is promising (Mann, 1990). The review has two interdisciplinary focii. First, there is an extensive literature base surrounding the long history of the impositions of literacy on unofficial oral forms (Havelock, 1988; Olson, 1988). Second, there is a substantial literature base in communications, education,

human factors and instructional psychology on the impact of dialogue and music to film (Cavlcanti, 1939; Eisenstein, Pudovkin & Alexandrov, 1949), to instructional film and video (Zuckerman, 1949) and to computer programs (Buxton et al, 1989; Fiedorowicz & Trites, 1985).

An Educational Communications Model

This paper presented the SSF Model to improve sound attribute research and scriptwriting guidelines in educational technology At first glance, this sound design model may be seen tobeonly workable for conventional dramatic entertainment, not for educational media. However, the model is partially based on principles adapted from educational films and television. The framework for four of the six sound functions and two of the six strategies that contribute to structuring a sound function were adapted from an analysis of instructional films (Zuckerman, 1949). The Review Rhythm and Pacing Strategies are based on the scripting guidelines of the Children's Television Workshop (Schramm, 1972). The balance of the variables and their systemic development is a mix of communications research and the author's research and experience.

For educational purposes, then, the SSF Model should be implemented as a subsystem of instructional designand is therefore dependent on other factors in the ID system- (e.g., a needs assessment, learner characteristics or mental models, etc). Structuring the functions of a sound attribute is a personal and situation-specific activity which requires an understanding of the external conditions of learning (Gagne & Briggs, 1979), the learners' characteristics or mental models (Johnson-L.&d, 1988), as well as the designers' preferences or biases (Bowers, 1988; Ragsdale, 1988; Winograd and Flores, 1986). Ongoing research and practical advice is required on the effects and interactions of these functions and structures on intentional and incidental learning.

The Media Mix Perspective

Educational communication-mediated by current technology requires decisions about bath the intended message and how the impact of the technology shapes that message. Although the SSF Model may be applied to any media mix with an audio capability, itsapplication should be selective and fully integrated with current theory and exemplary practice, Furthermore, current multimedia permit differentiated presentations, as well as adaptive and non-linear interaction that increase the variety of design possibilites. Use of these integrated technologies may require more complex levels of learner or designer control that challenge the user interface designer. The fullest utilization of these and other technological capacities (e.g., control ofinstruction, interactivity) requires a media mix perspective towards the attributes of communication technology in favour of a perspective that chooses one medium or attribute of one medium over another.

From a media mix perspective, conventional divisions between the media (e.g., computer, video and film) may be less useful than a clearer definition of

the structured function of the communication attribute (e.g., a brief convergent speech-counterpoint& subjective point of view). Moreover, conventional classifications of particular media (e.g., between tutorial, simulation or drill-and-practice programs) are lost in the speed and quality of transitions between these classifications. A media mix perspective, then, does not differentiate among sound designing activities for computer, video and film; nor does it restrict sound designing activities to particular classifications of use of one or more media. In designing sound with images, a media mix perspective advocates the application of the structured functions of the sound within media mix sequences.

Sound and Learner-Control

Throughout the planning and authoring of media mixing activities, sound must become an integrated part of the design of the program, not just a feature of it (Grimes, 1990; Lepper, 1985; Mann, 1990). Adding sound to currently silent programs may require a new definition or description about what will and will not constitute a sequence. Adding sound will also require new decisions about which functions (i.e., a Locale, Mood, etc.) the sound (i.e., music, speech and/or effects) will contribute to a sound-picture sequence. Morever, adding sound will then require decisions about how, where and how often the functions should occur throughout the sequence and throughout the entire program. Before and throughout media mixing activities, a psychological distinction should be maintained between the images and the sound, between the stated and implied sound, and between text and subtext; particularly when rapid changes are being made without being physically included in the script.

Timing and Duration

Optimal timing and duration of sound cannot in itself affect changes in human processing, attitude and performance. The design of communication and educational mixed media messages should supplant or activate cognitive strategies, aim to change attitudes or to improve skill-based or problem solving performance. In this way, sound design (i.e., speech music and effects) can make a viable contribution to the mixed media perspective.

Other sound design issues requiring elaboration include: How sound and image should occur simultaneously; whether or not sound should have an on/off switch and volume control; and whether or not it should be playable from a repeatable keystroke or clickable icon. Subsequent mixed media research should continue to aim at supplanting and activating cognitive strategies, changing attitudes and at improving problem solving levels using the SSF Model.

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