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ABSTRACT

This article describes the evolution of computer interface research issues from text-based interface design guidelines to more complex issues, including media selection, interface design, and visual design. This research is then integrated into the Analysis-based Message Design (AMD) process. The AMD process divides the interface design process into four action steps: (1) identify conditions--analyzing the environmental, learner, or instructional needs which define or create boundaries for the instructional product; (2) select design features--using instructional and learning theories, media selections research, and personal experience to support design feature selection; (3) resolve conflicts--giving special consideration to features which are desirable with regard to one or more conditions and undesirable with regard to another condition; and (4) create the design layout--using the ABC's R US design principles (alignment, balance, contrast, chunking, repetition, utility, and simplicity). Explanations and graphic examples of these principles are provided. (DLS)

Analysis-Based Message Design: Rethinking Screen Design Guidelines

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Abstract

Since the 1960's computer interfaces have evolved from text-based to multimedia formats, resulting in an evolution in the research regarding interface design. This article describes the evolution of research issues from text-based interface design guidelines to more complex issues including media selection, interface design, and visual design. This research is then integrated into the Analysis-based Message Design (AMD) process. The AMD process divides the interface design process into four action steps, the fourth of which features the ABC's R' US design principles.

Introduction

Since the design of computer screens was first addressed in the 1960's, the types of features used in instructional products have not just expanded, they have exploded with new possibilities such as graphical user interfaces, hypermedia, digital video, and virtual reality. Similarly, the area of interface design research has also evolved in order to adjust for these changes.

The purpose of interface design research is to determine which factors help computer screen layouts support learning and which factors may detract from learning. The goal of this paper is to describe the genesis and development of existing interface design research and to describe a process called Analysis-based Message Design (AMD) which incorporates this research throughout its four-step process.

Print-based Design Research

Computer-assisted instruction (CAI) began in the 1960's with text-based programs such as the Stanford CAI project, the IBM 1500 CAI system, and the PLATO project (Saettler 1990, p. 456). The first interface design guidelines for the growing number of text-based CAI programs were based upon research on print-based instruction, especially M. A. Tinker's *Legibility of Print* (1963). While Tinker's work was a compilation of legibility studies on various print topics (see Table 1), his findings were the basis of a series of prescriptive guidelines for computer text (Reynolds, 1979; Rambally & Rambally, 1987; Shires & Olszak, 1992).

Table 1. Summary of Tinker's Legibility Findings and Corresponding Design Guidelines

Topic	Tinker's Findings	Design Guidelines
Text Style	• Italic type was found less legible than normal text. • Bold text used for emphasis did not decrease legibility. • Lower-case letters were more legible than all-caps.	• Avoid italic type. • Use bold text for emphasis. • Avoid using all-caps.
Text Font	• Sans serif and serif fonts were found equally legible; however, readers preferred serif fonts.	• Use serif fonts for large bodies of text.
Text Size	• Very small and very large type sizes decreased reading speed.	• Use 18pt text for headings and 12pt text for body text.
Line Spacing	• Leading had an important effect on legibility. An average leading of 2-4 points proved the most legible for most font and line length combinations.	• Double space text or skip a line between paragraphs.
Line Length	• Readers preferred moderate line lengths and ample margins.	• Leave white space in the layout.
Text Blocks	• Square blocks of text were found less desirable than regular blocks of text.	• Avoid justified text blocks.
Color Combinations	• The most legible color combinations were those with the greatest contrast between the text and the background, such as black text on a white background	• Use dark text on a light background or light text on a dark background.

Current Interface Design Research

The 1980's brought a new face to computers, the graphical user interface (GUI). While the first computers with GUI interfaces were manufactured by Xerox, they did not have national attention until Apple announced its line of GUI computers in 1984 (Cambell-Kelley & Aspry, 1996). This new interface with its multimedia capabilities presented designers with a variety of text, audio, and visual design options. As a result, print-based guidelines were supplemented by interface design research which related to text, as well as multimedia.

In the past, some designers have sought prescriptive design guidelines, lists of the "do"s and "don't"s of interface design. However, as Megarry relates, such simplistic lists of guidelines cannot adequately address the design variables in complex multimedia products (1991). Therefore, current interface design research involves a rethinking of the concept of interface design guidelines. From the 1980's until the present time, the focus has shifted to three main types of interface design research: media selection research, interface research, and visual design research.

Media Selection Research

Media selection research is based upon the assumption that certain media are more effective than others with regard to certain types of learners or content (Kozma, 1991). This research tests the effectiveness of different media under various learner, content, and delivery environment conditions. Instructional designers can use this research to guide their selection of the most effective media features to meet the conditions surrounding their instruction.

Interface Research

Interface research deals with the design and testing of human-computer interfaces (Apple, 1989; Cates, 1994; Laurel, 1990; Nielsen, 1990; & Shneiderman, 1992). It revolves around the consistency between the content, the media, the functionality, and the metaphoric theme of a multimedia product. Instructional designers can use this research to help them develop a product which supports clear and consistent interaction between the user and the computer program.

Visual Design Research

Visual design research addresses the visual principles used in interface design. These heuristics are extensions of the ancient Greek aesthetic principles of symmetry, order, emphasis, unity, and balance. These principles have been extended to also include proximity, and parsimony (Heinich, Molenda, Russell, & Smaldino, 1996; Williams, 1994; Reilly & Roach, 1986). Instructional designers can use these principles of aesthetic visual design decrease feelings of stress among learners and increase feelings of confidence and stability (Reilly & Roach, 1986, p. 39; Rambally & Rambally, 1987, p. 151).

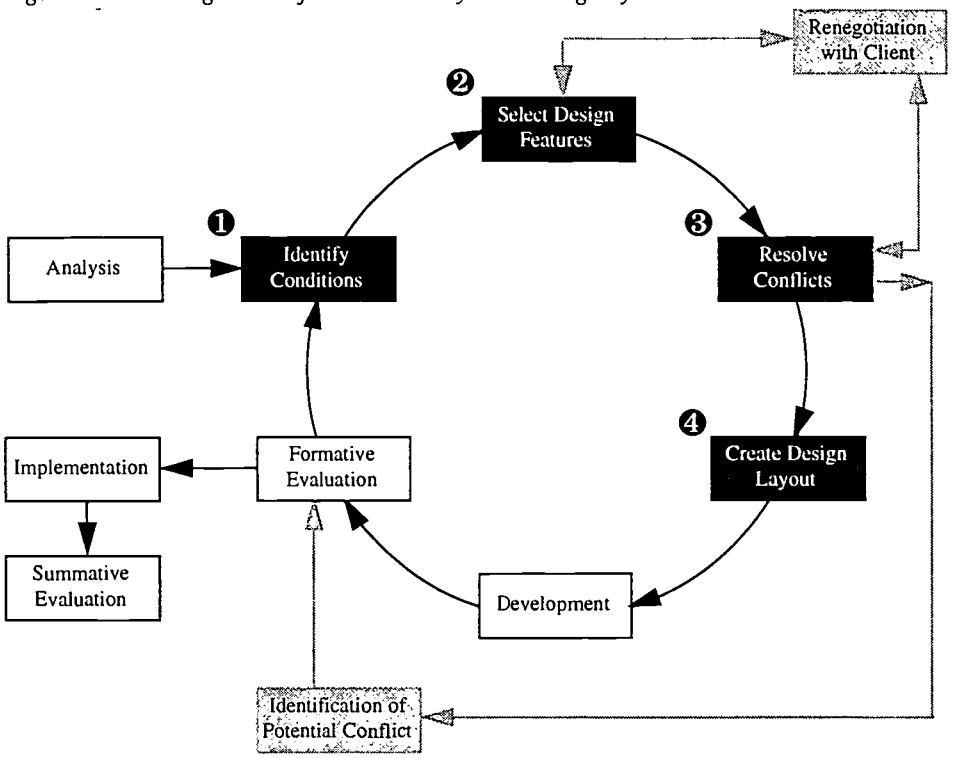
Analysis-Based Message Design Process

Computer screen message design addresses the three layers of a screen: the content layer containing the information to be learned in the form of various media features, the interface layer containing the means through which the learner interacts with the information presented (text, graphics, etc.) including the structure through which it is presented (navigation, metaphor, etc.), and the aesthetic layer which organizes the information and interface according to aesthetic principles. The AMD process reflects the way in which these three layers are designed. It addresses how the research is used in making design decisions. AMD is a process which separates the design phase of the Instructional Systems Design (ISD) model into a four-step process. During this process, the instructional design team will (1) identify conditions, (2) select appropriate design features, (3) resolve conflicts between design features, and (4) create a design layout for use in the development of the product (see Figure 1).

Step 1: Identify Conditions

The first step of AMD does not directly incorporate interface design research. Its purpose is to link the analysis and design phases together and to emphasize the importance of analysis as a foundation for design. . While it is outside the scope of this paper to discuss how to collect analysis and evaluation data, the author would like to stress the importance of this data. Therefore, in this step the instructional design team analyzes the conditions which surround the instructional context. These conditions are environmental, learner, or instructional needs which define or create boundaries for the instructional product. While collecting or compiling the conditions which result from

Figure 1. The integration of AMD into a cyclical design cycle



analysis or formative evaluation data, it is crucial that instructional designers identify answers for the following four analysis questions:

- **What is the content like?**
  (subject area, type of learning, scope of content, expected outcomes, instructional approach, etc.)
- **What are the learners like?**
  (age, ability level, experience level, motivation, culture, learning styles, student groupings, etc.)
- **What will be the final delivery environment?**
  (computer type, processor, speed, memory, disk space, operating system, network configuration, color, sound, and video capabilities, etc.)
- **What constraints are being put on the production process?**
  (time, cost, resources, etc.)

It should be noted that in a cyclical design process, evaluation results, not just analysis results, will also generate conditions which will create boundaries for the product. Sometimes these results will even de-emphasize the importance of some of the original pre-design analysis results. Therefore, it is important to include both pre-design analysis results and formative evaluation results since both of these types of data affect the conditions surrounding the instructional product.

Step 2: Select Design Features

The second step of AMD is to take the conditions which surround the instructional context and to select the design features which will best address those conditions. In the case of each condition, there are some features which should be avoided and others which should be included in the future design layout (Romiszowski, 1981, ch. 17; Gagné, Briggs, & Wagner, 1992, ch. 11). The research basis for these decisions should stem from media selection research studies and subsequent research summaries (Jonassen, 1996; Thompson, Simonson, & Hargrave, 1996).

The most important issue to remember during this step of the AMD process is that methods should not be chosen arbitrarily. On the contrary, instructional designers should use instructional and learning theories, media selection research, and personal experience to support design feature selection. All three of these areas are important sources of information. While some instructional designers may argue that professionals in the field disregard this step, the author would argue that is not the case. Professional designers have a high level of expertise

because they have internalized much of the research and procedures involved in the design process. However, when they reflect on their product design, it becomes evident that they have selected features which were tied to effective learning of the content while taking into consideration the learner, environmental, and process conditions which surround the instructional context.

Example:

Let us imagine that there is an instructional designer who is working on an instructional product to teach Spanish conversational skills. In the first step of the AMD process, he discovered a number of conditions. For the sake of brevity, let us concentrate on three of those conditions, the content/skill of Spanish conversation, the low motivation level of the learners and the delivery computer configuration (networked 486 PCs with 8MB of RAM but lacking sound cards and CD-ROMs). During the second step of the AMD process, the designer will determine which design features will be most effective for these conditions (see Table 2).

Table 2. Selection of design features based on three conditions of content, motivation, and delivery computer specifications

Condition:	Features to Include:	Features to Avoid:
Spanish conversation	• Text • Graphics (to support text) • Digital audio • Digital video	
Low motivation level of the learners	• High interaction • Multimedia features (graphics, audio, video, etc.) • Learner control • Real-world examples (graphics, video, etc.) • Simulations	• Drill Structures • Fixed linear navigation structure
Networked 486 PCs with 4MB of RAM but lacking sound cards and CD-ROMs		• Speed intensive programming • Digital audio • Digital video

Step 3: Resolve Conflicts

The third step of AMD resolves the conflicts which may exist between the features to be avoided and the features to be included for all the conditions surrounding the instruction. Conflicts occur when a feature is desirable (to be included) with regard to one or more conditions and undesirable (to be avoided) with regard to another condition. There are four ways to resolve these conflicts:

- **Avoid the feature.**
  A conflicting feature which is not expected to significantly impact the effectiveness of the instruction can simply be avoided.
- **Include or avoid the feature according to the condition with the highest priority.**
  When feature selection varies with respect to different conditions, however one condition has a high-impact upon the product or the production cycle (such as instructional objectives or cost issues), the feature can be avoided or included with regard to the highest priority condition. The focus here is on maximizing the effectiveness of the instructional product within the constraints which surround its development.
- **Include the feature, but address its effectiveness during formative evaluation.**
  If it is uncertain whether a feature will improve instruction due to the conditions which surround it, the feature can be included in the design and while being flagged for formative evaluation. In this case, the risk of including the feature can be minimized by testing its effectiveness during the formative evaluation phase.
- **Renegotiate with the client.**
  Although it is not common, there are times when a conflict should be resolved through renegotiation with the client. This is the case when including or avoiding a given feature would compromise the effectiveness of the instructional product.

Example:

Features which are in possible conflict need special consideration. They are too important to simply be avoided since they meet certain conditions of the instructional environment. Sometimes the solution of these conflicts involves more than one of the four resolution strategies listed below. For example, the instructional designers who are designing the Spanish conversation product might decide to forego the aspects of multimedia since the delivery computers do not have the hardware requirements for such features. The addition of digital video would probably not have a major impact on the learner's auditory practice so it could be avoided without compromising the instructional effectiveness of the product. By avoiding digital video, the program would take up less storage space. However, it is crucial to have digital audio in order to teach the oral and auditory skills needed to converse in Spanish. In this case, there needs to be a renegotiation with the client since delivery conditions are in direct conflict with instructional effectiveness and there is no other way to resolve this conflict. In the end, the client agrees to invest in sound cards for the machines but not CD-ROMs. With the sound cards and the available hard disk space on the machines it is now possible to have digital audio. In this case, conflicts were avoided by using a combination of avoidance and renegotiation.

Step 4: Create the Design Layout

The fourth step of AMD involves the creation of the actual design layout. This layout takes the design features which are deemed effective for the conditions that surround the instructional product and gives them a form for the screen. Layout creation relies upon interface research and visual design research. The results of both of these types of research can be summed up with seven ABC's R' US design principles: alignment, balance, contrast, chunking, repetition (theme), utility, and simplicity.

- **Alignment**

  Alignment refers not only to the alignment of text, but also to the alignment of all visual objects. Objects have six points of alignment: right, center, left, top, middle, and bottom. The eye can perceive the strongest alignment when objects are aligned on the outer points on the right, left, top, and bottom.

- **Balance**

  The center of a page or a screen is its fulcrum of balance. Balance is achieved when the weight of the objects on the left side are relatively equal to those on the right side and when the objects on the top half are relatively equal to those on the bottom half. On a light background, objects which are darker have more visual weight than those which are lighter. On a dark background the opposite is true.

- **Contrast**

  Contrast is the level of difference in appearance between objects. Contrast can be achieved by placing a dark object by a light object or by putting a thin-featured object by a thick-featured object. If an object has a high level of contrast from its surrounding objects, it draws attention to itself. The key to effective contrast is to use it sparingly. If one object stands out on a page or on a screen, it will draw the learner's attention. If a number of objects contrast on a page or on a screen, they can distract or even confuse the learner.

- **Chunking**

  Visual chunking refers to the placement of objects. Objects which carry out similar functions, such as navigation buttons, should be chunked or placed in the same visual zone of a page or a screen. Likewise, text headings should be chunked with the text which supports them.

- **Repetition**

  Repetition has many related layers. It refers to the consistent use of objects, effects, fonts, sizes, styles, and colors both on an individual page or screen and also throughout the product as a whole. Repetition also refers to the metaphor or theme used throughout the product. In this sense, all objects should repeat and support the same visual message.

- **Utility**

  Utility refers to the usability of the visual interface. It should be clear to the learner which objects are interactive and where the learner is located within the instructional product.

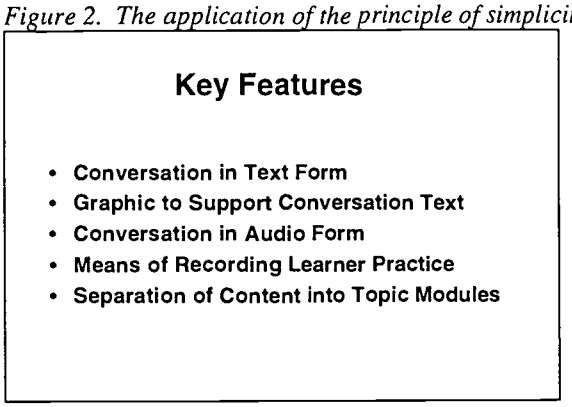
- **Simplicity**

  Simplicity addresses the appropriateness and the necessity of the visual objects on a page or on a screen. The purpose of visual objects is their instructional value not their impact value. Objects which do not support instruction can detract from learning. The key is to keep the visual design simple and only include those visual objects which are necessary to convey the instructional message.

Example:

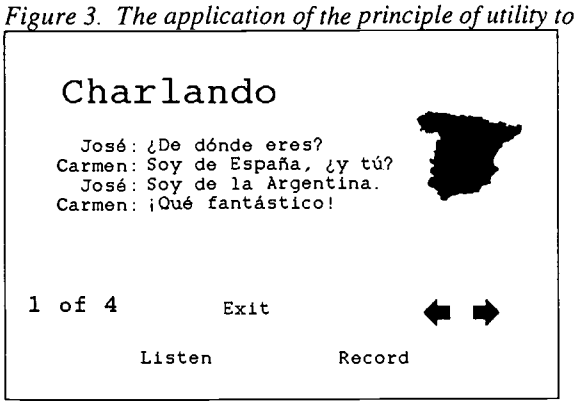
The ABC's R' US principles are the keys to building a usable and aesthetically sound design. Let us see how the instructional designers use these principles to build the layout design for the practice screens of the Spanish conversation product.

Figure 2. The application of the principle of simplicity to a Spanish conversation project



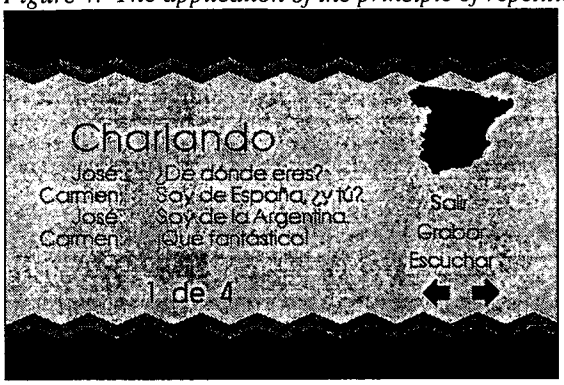
When building layouts for the various types of screens in a given interface, the principles are used in reverse. Therefore the designers use **simplicity** from the beginning of the design process, since the key to effective design is focusing on instruction and ease of interaction (see Figure 2). They select the key media features for the interface from steps two and three which are most integral to their goal of effective instruction. In the case of the Spanish conversation project, the key features are conversation text, a graphic to support the conversation text, a digital audio recording of the conversation text, a means of recording learner practice conversations, and separation of the content into separate topic modules (for future sample screens, the topic is "charlando (small-talk)").

Figure 3. The application of the principle of utility to a Spanish conversation project



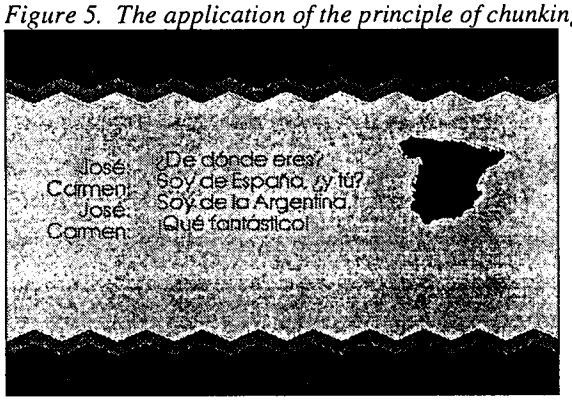
Next the designers focus on **utility**. They decide that each screen needs to have the following elements: a title, the text of the conversation, a simple graphic image to focus the learner on the topic of the conversation, a means of accessing the digital audio clip of the conversation, a means of recording the learner's practice conversation, a means of moving from one card to another, and a means of leaving the practice area of the program (see Figure 3). The designers decide to use a short tutorial on how to use the program at the beginning so that the learner knows how to interact with these elements and their is no need to repeat instructions for using the interface on each of the module screens.

Figure 4. The application of the principle of repetition (theme) to a Spanish conversation project



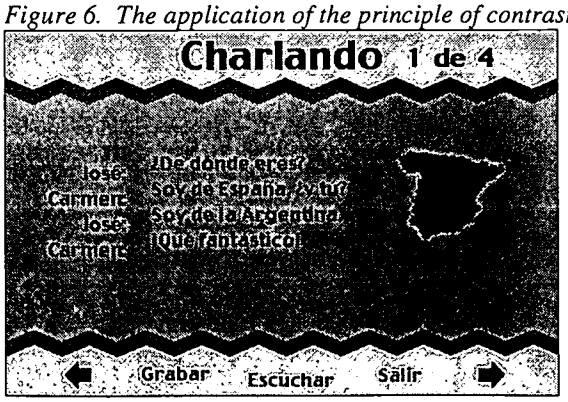
As they apply the principle of **repetition**, the designers decide to use a Spanish theme to echo the objective of teaching Spanish. The background image on the screen uses colors which are present in the flags and crafts of many Spanish-speaking countries. The pattern is based upon the pattern used in goods woven in several Central American countries. The screen reference and the words on the listen, tape, and exit buttons are in Spanish, as well, to repeat the Spanish theme. These thematic elements are repeated on all the module screens to create a Spanish look and feel to accompany the Spanish content (see Figure 4).

Figure 5. The application of the principle of chunking to a Spanish conversation project



Next the **chunking** of the interface elements separates like elements into the same visual zone. The zigzag red patterns also serve to break the screen into three different visual zones so that the various types of elements can be chunked separately. The top zone is used for the title and the page number. The middle zone holds the content of the screen (the text and accompanying graphic). The bottom zone is contains the navigation and interaction buttons (see Figure 5).

Figure 6. The application of the principle of contrast to a Spanish conversation project



After the elements are chunked into the different visual zones, the text and graphics in the top and bottom zones is no longer legible (see Figure 5). Therefore, the designers increases the **contrast** by using black text and light background colors to maximize the contrast and the legibility of the text in the heading, and the bottom buttons.

The light color also goes with the repeated Spanish theme which was earlier established. In addition, a heavier font is used for all text, including the conversation dialogue text, to increase legibility (see Figure 6).

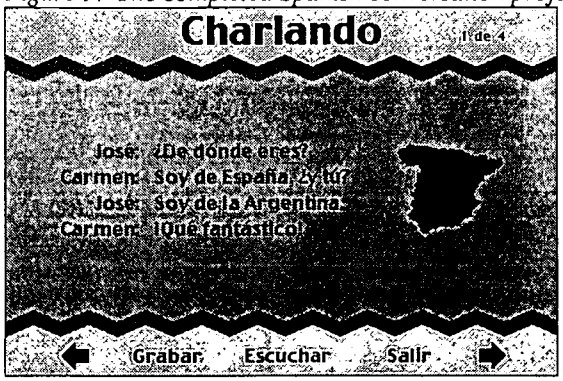
Figure 7. The application of the principle of balance to a Spanish conversation project

The interface appears **balanced** for the most part; however, the designers notice that the top zone needs some adjustment. They decrease the size of the module screen number so that it increases the left/right balance of the layout (see Figure 7).

Figure 8. The application of the principle of alignment to a Spanish conversation project

Finally, the designers **align** the outer edges of the text and the graphic with the outer edges of the arrow navigation buttons. All of the buttons are middle aligned, as are the text and graphic of the middle zone. The information top zone is bottom aligned to align it parallel to the red design (see Figure 8).

Figure 9. The completed Spanish conversation project



After working through the seven principles of the ABC's R' US, the finished design (see Figure 9) is now ready to enter the development stage where it will be the basis of the grid layout for the module screens.

Conclusions

The changes in computer technology has moved the realm of interface design research from print-based guidelines to generative interface design research on media selection, interface design, and visual design. These three research types are integrated into the AMD process. The true strength of the AMD process lies not so much in its four-step process, but in its integration of these four design steps with current types of interface design research. The process tools of conflict resolution and the ABC's R' US design principles provide designers with simple ways to tackle interface design decisions. Although one example of the AMD process is included in this paper, future research could verify if using the AMD process and the principles of ABC's R' US increases the effectiveness or efficiency of the visual design process.

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