Advances in Human-Computer Interaction: Graphics and Animation Components for Interface Design

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Abstract. We present an analysis of communicability methodology in graphics and animation components for interface design, called CAN (Communicability, Acceptability and Novelty). This methodology has been under development between 2005 and 2010, obtaining excellent results in cultural heritage, education and microcomputing contexts. In studies where there is a bi-directional interrelation between ergonomics, usability, user-centered design, software quality and the human-computer interaction. We also present the heuristic results about iconography and layout design in blogs and websites of the following countries: Spain, Italy, Portugal and France.

Keywords: Interface, Icon, Computer Graphics, Computer Animation, Human-Computer Interaction

1 Introduction

In the 90s the momentum of the multimedia systems in the international commercial sector prompted the population of the economically developed societies to the acceptance of the virtual reality systems [1–4]. However, in that very same decade it was seen that it would not follow the expansion road of the off-line and on-line multimedia systems. In the mid nineties the university educational sector in Barcelona, for instance, received significant financial aid from the EU for R+D projects which would only become more audiovisual prototypes or in the paper support of industrial or computer engineering. Automatically, this failure of the democratization of virtual reality, as it happened with the multimedia systems, would generate the same distortion of concepts with commercial purposes, for instance, immersive multimedia is equal to virtual reality [4]. With the passing of time and making a diachronic analysis it can be seen that several factors have prevented the

advance of virtual reality, outside the scientific environment; the cost of the equipment (gloves, helmets, computers capable of processing a high volume of images in a short time, etc.), the lack of professionals in and outside the educational sector in the context of virtual reality and the feeling of balance that the user has in these tridimensional environments. At that time one could speak of immersive multimedia in attractions of Discoveryland in Eurodisney, for instance. In some of those attractions the audiovisual effects were joined to the movement of the armchairs, with which the degree of realism was greater. In these attractions the user does not suffer from the problem of the feeling of loss of balance because he/she is sitting on a chair, although immersed in a context that simulates outer space. Once again, the multimedia entertainment sector went ahead of virtual reality. Now many inside and outside the educational environment saw in immersive multimedia a solution by using it as synonymous to virtual reality, when in fact they couldn't tell the difference between the real and the virtual [4]. Here is one of the reasons why the multimedia notion flooded all the sector of R+D in the Mediterranean since the 90s until the beginning of the new millennium.

Obviously those who ran after a commercial and non-scientific purpose didn't know the differences among hypertext, immersive multimedia and virtual reality [5]. Those were interactive systems that required different interfaces, because of the limitations in the hardware and/or software, for instance in the timings of access to the information stored in the databases in a CD or DVD or in the Internet. To such an extent that in the first systems of virtual reality, the quality of the images is inferior to the computer-made 3D animations. The navigation through virtual environments required a great speed to generate those images [6]. Consequently, in that navigation there was a tendency to the emulation of reality rather than simulation. Besides, those were environments where the navigation icons were similar to those used in the multimedia systems for the videogames or encyclopaedia consultations.

In the current work is made a study of static and animated iconography in the navigation of the interactive systems. With this purpose are described each one of the main categories that make up the layout or presentation of the information on the screen of the interactive systems, making a special stress on bidimensional and three-dimensional animation, such as the combination of both. The impact of the iconography on the interface is also measured from the perspective of the metaphor and the different existing models in the current hypermedia systems. Simultaneously communicability, acceptability and novelty of the metaphors are analyzed, through a set of quality metrics that make up a heuristic model named CAN (Communicability, Acceptability and Novelty).

The method represents a confluence of practical and theoretical knowledge about ergonomics, usability, user-centered design, software quality and the human-computer interaction [7–11]. The CAN method is being applied in a set of on-line websites randomly chosen among blogs or websites of the following countries: Spain, France, Italy and Portugal, with the purpose of determining those websites where the human-computer interaction from the prospect of the quality of the layout is superior, average or inferior (including icons and metaphors) and the animations. Its qualitative metrics are the result of a long period of evaluations and realizations of hypermedia systems. Addtionally, the obtained results make it possible to establish a first

guideline of qualitative design for the next years, from the point of view of human-computer interaction and communicability.

2   New Interfaces Design and Human-Computer Interaction

One of the main problems to be solved in the design of interfaces for the new mobile multimedia interactive systems and virtual reality are the icons [12–17]. Many of these icons have been carried out by ready-made experts coming from the computer sector, copying the operative systems of the personal computers of the eighties and then the apogee of Windows and Macintosh [18] [19] (figures 1 and 2).

Fig. 1. Windows icons with Spanish text

Fig. 2. Macintosh icons

In the nineties with the appearance of the design guide for the Macintosh environment many multimedia systems in on-line support started to use that book as a vademecum or ready reckoner [20]. However, in the context of Windows and the operators who did not use commercial applications for their hypermedia productions aimed at art encyclopedias, museums, teaching, etc. [21–24]. In this context started to interact in Southern Europe two groups of professionals: artists and technicians. Among the first were the professionals and amateurs of the fine arts, and in the second group the programmers, systems analysts, computer engineers, etc. [25].

The human-computer interaction labs had not started to train professionals yet. In some exceptional cases and within the context of telecommunications and multimedia engineering the first theoretical and practical bases of these professionals could be seen through subjects such as: Introduction to the Human-Computer Interaction; Dynamic and Static Means in the Multimedia Systems; Multimedia Production; Hypermedia Programming; Computer Animation; Usability Engineering and Design Models in the Multimedia Systems. The purpose was to obtain professionals who represented the intersection of the formal, factual sciences and experience in real projects through a technology transfer between the academic sector and the entrepreneurial or industrial context. Obviously the qualitative design factor required some time in the context of the human-computer interaction due to the to the human factors, that is to say, the relationship among the different factors. The quality in the first interfaces of those interactive systems shows whether the human-computer

interaction is high or low [25]. For the analysis of the interfaces one resorts mainly to semiotics since this discipline allows to split each one of the components from both the systematic and the structural point of view [26]. In the present context of study and in some cases, the linguistics notions allow one to establish the structural components of the minimal units of the information mainly in the signs and the symbols [26] [27]. Obviously inside the framework of human-computer interaction we have the cultural factors among the potential users of the interactive systems. Once more the instruments stemming from semiotics, some methods of heuristic evaluation, software engineering and the communicability professionals may make easier the task of detecting the failings and determine the possible solutions to increase the quality of communication between the user and the on-line off-line interactive system.

The communicability analyst has a series of knowledge and previous experiences that allow him to quickly detect the main problems of the interface in relation to the potential users. This ability of analysis is very important in the whole evolution of the products and/or services of the interactive services and where the predominance of the dynamic means has been chosen. Dynamic means which may have different costs in regard to the contents and the speed in generating them. For instance, a video about cultural heritage of a tourist zone may have a lower cost than the tridimensional reconstruction in a virtual reality environment in which reality is simulated. Evidently if we don't consider the copyright variable or permits of the local authorities to film those places as it may happen in some places in the South of the Mediterranean [28]. The advantage of working with images instead of the audio or the text, is that an image is worth a thousand words, although we have to remember that the veracity of the images has lost its value with their self-editing. Not for nothing some scholars sustain the need of going back to the text to get back the veracity of the digital information [29]. Once again semiotics plays a very important role at the moment of inserting the contents in the interface and most especially in the design of the icons which activate or deactivate functions inside the interactive traditional system or the new ones where micro computing prevails and besides, the micro interfaces, such as wristwatch phones (figure 1) or multimedia phones. These interfaces will spread not exponentially, but rather geometrically in the next few years, due to the OLED (Organic Light Emitting Diode) sheets.

Fig. 3. Wristwatch phone interface –classical keyboard

The new dimension of the screen which is considerably smaller than those existing in the PC desktops, mobile PC, Tablet PC and PDA have led to structuring the

presentation of the information on those screens through single-function or multifunction icons. A single-function icon is that in the operating systems such as Windows, Linux, Mac OS X, etc., and which has assigned a single operation. In contrast the multifunction icons are those which can be assigned more than one function and which are used in the mobile phones, for instance. Inside the operative systems for mobile phones we have the Subian S60 v5, generally installed in Nokia [30]. In the new version, there is an attempt to leave the pencil behind as much as possible, to adapt to the interaction using the fingers. This is the reason why on the main screen we come across with big-sized icons even if it is for the main menus, but unfortunately the vertical scrollbars are still used like in Windows, which prompts the use of a pointer. In contrast, in the Blackberry phone the menus are clear and simple with a minimalist interface and a really practical conception of design. With the incorporation of animations and 3D emulations of the keyboards in the interface, the communicability of the new version is optimal. Besides, it incorporates the possibility of having the whole QWERTY keyboard available. Many young and adult potential users are grateful for having single-function icons and even the option of the traditional keyboard, whether it is to write or calculate, as we can see in the image of the wristwatch. However, the problem of ambiguity of the visual information in the mobile phone icons of the iPod 4 persists, especially for those users of Windows operative systems who interact with it for the first time. An heuristic experiment with a group of 25 adult Italian users, whose ages ranged between 40-50 years, randomly selected from an universe of 150 and experts in computer science, in front of an iPod 4 have had problems to identify the 83% of the functions of the icons which are in the following screen (title of the icons were omitted):

Fig. 4. iPods 4 –ambiguity of the icons when the texts or titles are omitted

Therefore, title and/or subtitle for an icon is not the ideal solution. Besides, it shows that the novelty of a product and the acceptability on the side of the computer-wise public is not a total guarantee of the success of the communicability between the user and the interactive system.

3   Communicability, Acceptability and Novelty

Currently designing for the Web 2.0 and the Web 3.0 isn't easy, because the profile of the potential users has quickly changed in the last few years. In the off-line and on-line multimedia systems of the late 90s and early 2000 it was feasible to have a defined profile of the potential users such as are the eventual ones (less than an hour of navigation, for instance, consulting a topic of tourist information, intentional users (between one and two hours, generally, are users interested in the content of a subject and want to go deeper into it) experts (unlimited time, such as can be a scientific researcher), inexpert and intentional (unlimited time, for instance, students who have no experience in the use of computers but who are keen on learning). Now and in many occasions not even they know how to differentiate between seeking information to broaden their knowledge or navigating with the purpose of spending their time. Here is one of the reasons why many Web designs have adopted the strategy of designing as if they were advertising products and/or services. From the point of view of the distribution of the elements inside the interface, the concepts deriving from Leonardo Da Vinci about the divine proportion, are currently usually left out because of the scarce room available on the screen, as in the case of a multimedia mobile on a wristwatch or in the standard formats. These concepts must be kept as much as possible, especially in the PC tablets or e-Books, for instance.

It is striking to see the size of the icons and the distance among them in the homepage of the iPad, since their use requires having sufficiently long fingers. This ergonomic factor in the case of the Asian market and its potential users requires that the screen resolution must be adjusted at the start to make them smaller and closer among them. In the opposite side we have the multimedia mobile phones or the PDA (Personal Digital Assistant) phone, anwhich need a pencil to activate the functions through the pressure to the matching icons. Those who prefer the solution of adapting the resolution of the interface are the adult and old users, usually called single-media. Whereas the teenagers, young and adults expert in the interaction of the multimedia systems, that is, multimedia users, prefer the small screens of microcomputing.

Some single-media adult and old people are used to using a maximum of 8 buttons on the screens of the ATMs. These keys are aligned in two rows of 4. This is the ideal organization for the iPad screens. In the case of a horizontal reading, you can shift the icons downwards to make two groups of four. The ideal disposition can be seen in figure 5. Number 1 indicates the area of the most important visual centre of interest and number 4 that of the least important one [31]. Besides, it is necessary to remember that the reading direction of some Asian countries (from left to right) is contrary to the Western one (from right to left). Therefore, the icons should change their position inside the screen bearing in mind Leonardo Da Vinci's divine proportion notion.

The momentum of the social networks has boosted the presence of ambiguous icons in the net. Consequently, these icons need to be accompanied by text so that the anchoring principle is maintained in the image-communication relationship. This is a clear example of the involution of the icons starting with the new millennium, if compared with the off-line systems of the 90s, systems that were designed by professionals hailing from the graphic arts in paper support and with decades-long

experience in analogical communication, especially in Southern Europe. The principles of analogical communication must be kept in the digital media, especially in microcomputing because of the small size of the screens. It is also easy to realize how communicability is impossible with the user who lacks an experimental background or of knowledge with mechanical objects which in many cases are already museum pieces. In the modern devices we can find a wind-up alarm clock with Roman numbers, a landline phone with a frontal disk and an English candlestick model, etc. The communicability is equal to zero because a diachronic cultural factor of the users, even though the images of these icons are tridimensional with an excellent rendering and accompanied by shadows of the contours, light details or other lighting effects.
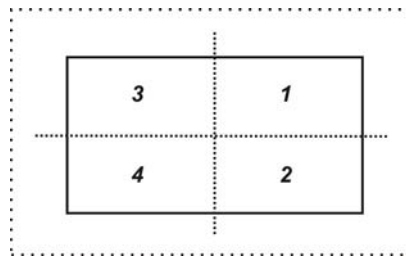

Fig. 5. Ideal disposition of the infornation on the screen

The context also has an influence in the choice of the different kinds of interfaces to access interactive content. Currently there is a tendency to the use of interfaces which are integrated with the space where the potential users are, such as for example a part of an interactive wall. Besides, in the case of organic interfaces they are being used in a progressive way to have access to the contents of cultural heritage in some science museums in the USA, Europe and Asia. The possibility of making interfaces in any way or shape is something that could change the traditional way of interacting in the immediate future. We should also not forget the possibility of having interfaces which can be doubled. In all these type modalities of interfaces, the problem of the distribution of the icons or active zones for the interaction lies in the height of the potential users. For instance, a standing person is not the same as a person sitting on a wheelchair. In these cases to guarantee a greater accessibility to the potential users it would be possible to work with the navigation icons or active zones between 1.10–1.30 metres. In regard to the shapes and the colours it is important to make previous assessments of the real and/or virtual environments where these interfaces will be inserted.

Now in the analyzed interactive systems in the social networks it can be seen how the standardization in the design templates has made easier the interaction among millions of users spread all along the world. The simplicity of the shapes, the universality of the distribution of the information on the screens of the main applications of the Web 2.0, the minimalist design in several free access applications evidently has also changed the diffusion of the new Internet era. However, from the point of view of communicability and design some problems belonging to the usability era persist. Our field of work has focused on three quality attributes which

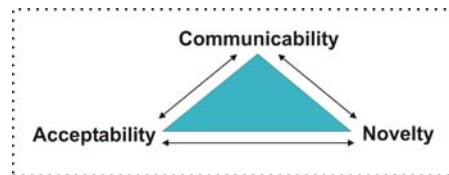keep among them a bidirectional relationship which can be depicted graphically in the following way:

Fig. 6. Bidirectional relationship between communicability, acceptability and novelty

In the upper part of the pyramid is communicability. Communicability is a qualitative communication between the user and the interactive system, such as hypermedia, mobile phones, virtual reality, multimedia immersion among others. Communicability is the extent to which an interactive system successfully conveys its functionality to the user.

The novelty is that set of elements which attracts the user's attention through the senses, especially audio and visual (80% of messages are perceived by the combination of the audiovisual in the off-line interactive systems, for instance [31]).

Finally, the accessibility to the interactive information is stored in the hyperbase. The ergonomics of the design as well as its size (due to the momentum of microcomputing in some cases) may leave out or bolster the factual function, that is, the direct communication in the interaction process between the user and the computer, without generating mistakes.

As a rule, direct communication is that which takes place through the different entrance peripherals of the interactive information (keyboard, microphones, arms movement, etc.) and which belong to the highest interdependence level in the dynamic process of user-computer communication.

4 Objectivity in the Choice of the Universe of Study and Results Obtained

One of the problems that is always latent in the heuristic evaluation works is objectivity and the margin of error of the results obtained. In our case, we have overcome both problems through the notions of descriptive statistics and the techniques used in the heuristic evaluation with some strategies deriving from the methods used in the social sciences [32] [33].

Methods and techniques which have been perfected along the years and which allow one to carry out evaluations of the interactive systems in an economic way and with 100% reliability. For the choice of the universe of study it has been generated in a random way a database with keywords.

Later on these keywords were inserted in the Google and Yahoo search engines, choosing the ten first entries of the first page. A new listing was generated with all of them, and a new random selection was made, until making up a universe of study of

100 Spanish, French, Italian and Portuguese blogs and/or portals –results heuristic evaluation in figure 7.
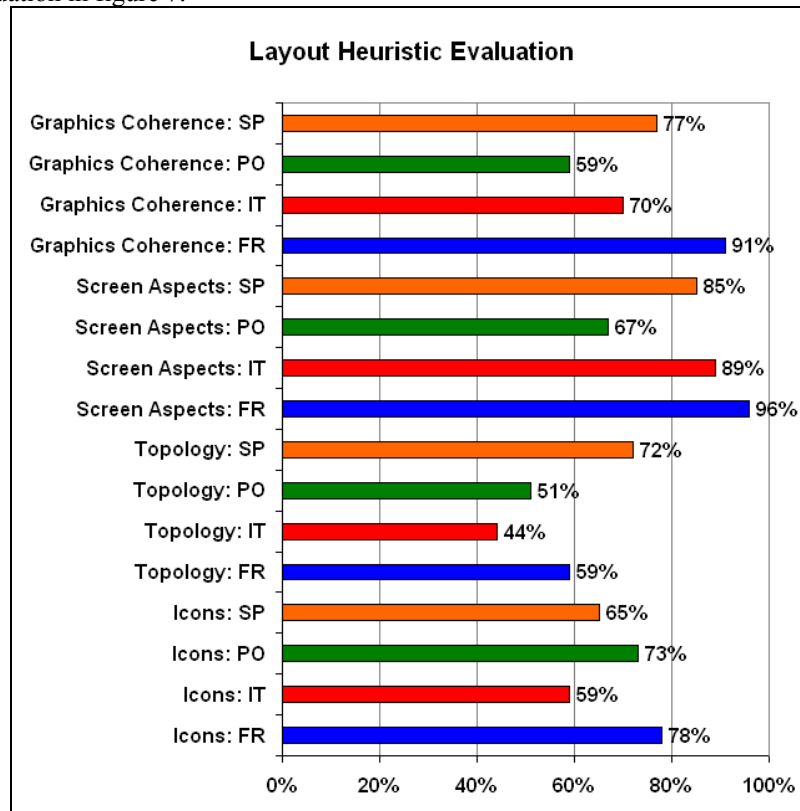

Fig. 7. Results layout heurist evaluation (metric binary of presence): FR = France, IT = Italy, PO = Portugal and SP = Spain

A table of heuristic evaluation aimed at the design category named "layout" has been applied to this universe of study. In it the main components have been analyzed of the static and dynamic images which are next listed:

1. Icons:
   a. Dynamics (animation). Static. Wire.
   a. Disposition of the icons upon changing the visualization/orientation of the screen. The icons remain in the same disposition reducing its size. The icons keep their size and shift downwards in the shape of a column.
   b. On-line connectivity icons. The icons for connectivity to internet depict the operative systems. The connectivity icon is associated to the phone company/ies.
   c. Explanation of the functions of the navigation icons: Title or name. When the cursor is placed over them. In the help. None.

    d. Gesture icons for multi-touch interactions: Classical hand. Emulation hand.

    e. Style: Universal for PC and microcomputing. Special for trademark, i.e. Apple. Mixed: PC, microcomputing, multimedia phone, etc.

2. Topology:
    a. The same position for the navigation keys.
    b. Shared text and image screen position.

3. Coherence of graphics aspects:
    a. Base colour: Primary. Secondary. Primary and secondary combination.
    b. Base texture: Text, colours and images. Only text and image. Only images.
    c. Transparencies: All screen. Frame. Windows. Icons.
    d. Illumination effects: Ambient. Omni-directional. Indirect illumination.
    e. Effects of 3D : Borders with shades. Reflection of light. Diffuse of the image.
    f. Video: Colour. Black & white.
    g. Camera effects: Zoom in. Zoom out. Horizontal movement. Vertical movement. Angular movement.
    h. Plane: General. Medium. First.
    i. Emission movement: Constant. Stop or break.
    j. Animation classes: Morphing. Rotation. Only 2D. Only 3D. 2D and 3D.
    k. Typographies: Classical. Special.
    l. Object or image presentation: With rendering (a perfect finish). Without rendering. Wire.
    m. Photographies: White & Black. Colours. Wire.
    n. Pictures format: Panoramic. Spherical. Plane.
    o. Drawings: White & Black. Colours. Wire.
    p. Key of navigation: 2D. 3D. Static. Animation. Arrows or cursors. Special icons. Draws.

4. Screen aspects:
    a. Transition types (2D): Cut. Dissolve. Random bars horizontal. Split vertical out. Split Vertical in. Wipe up. Vanish. Binds vertical. Blinds horizontal. Blinds central. Checkerboard. Diagonal. Spiral. Uncover. Strips. Cover. Box in. Box out. Fade througt black.
    b. Transition types (3D): Balloons. Bifolding backdrop. Box in box. Breaking up. Camera shutter. Closing box. Counter rotating disks. Counterrotating panels. Crushing slide. Cubic formation. Double cross. Dual screens. Fall out. Flip. Four square. Getting file from folder. Hyper slides. Infinite horizon. Mass production. Open up. Opening cylinder. Paddle wheel. Paint ball. Pods. Racing rectangles. Reassemble tiles. Revolving cube. Revolving frames. Rubic's cube. Shattering glass. Space cubes. Spring away. Starburst.

Swap. Tunnel travel. Turning billboard. Turning page of book. Twirling circles or panels or rectangles or squares. Undulating bars.
c. 3D simulation of the frames.
d. Screen content attention elements: Special symbols (circle or ellipse; squared or rectangle; arrows; and icons). Sounds. Words.
e. Space occupied by animations and videos on the screen: Full screen. A frame on the screen.

This table has allowed us to establish a metrics of binary presence of the element which had to be traced inside the analyzed portals, whose results are in the graphics divided up by countries (figure 7).

Later on, with the binary presence metrics being applied to the three quality attributes and to the design primitives, for instance; link, structural links, node, guided tours, index, frame, collection, etc. the metrics have been carried out to evaluate the systems again.

The procedure to generate these metrics can be checked in the following bibliography [9] [25] [32]. In this case a random sample of 50 portals for every country has been chosen and our final results of the three quality attributes are in the following graphic:
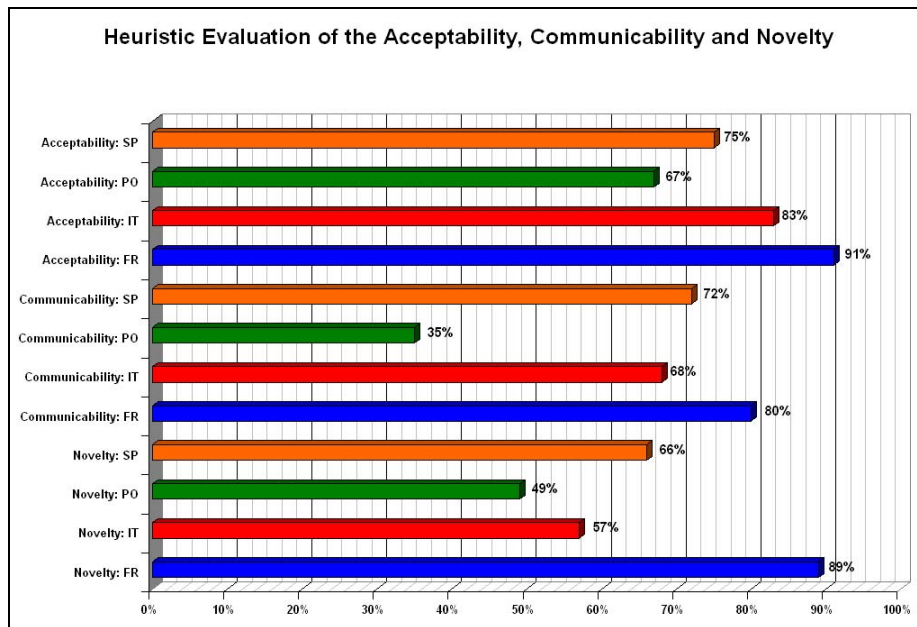

Fig. 8. Results layout heurist evaluation (metrics acceptability, communicability and novelty): FR = France, IT = Italy, PO = Portugal and SP = Spain

These results allow us to be optimistic to broaden our universe of study towards microcomputing interfaces such as mobile phones, for example, or the organic interfaces aimed at the promotion of cultural heritage and tourism.

5 Lessons Learned

In the study methodology it has been seen the constant evolution of the social networks from a quantitative point of view. However, in the last five years there is no great news from the design point of view in the Web 2.0. The minimalist style to occupy the first positions inside the search engines because the text prevails over the dynamic image, has boosted digital photography, where one tends to make not a spontaneous photograph but rather a marketing type, even with people. Where one tends to make not a spontaneous photograph but rather a marketing type, even with people. That is, there is a marketing of the human being in the Web 2.0 from the point of view of design. Consequently, the notions deriving from semiotics applied to marketing are very positive to carry out evaluations of the layout, applying the CAN methodology.

6 Conclusion

The obtained results make it apparent that the Web 2.0 has grown in quality in France because there is a greater tradition in the layout of the interactive systems and also in the use of the computer animations in the portals. Perhaps its websites do not occupy the main places in the Google or Yahoo engines, for instance, but its quality is superior to the rest of the analyzed countries. The reason also has to be found in a historic issue where more PCs for design were sold, such as the Macintosh in the 90s. The 90s were a key decade because they meant the digitalization of graphic design. The 2D and 3D digital images sector in France have lived this as a natural process. The other countries we have analyzed have plumped for other solutions aimed at managing computing, such as the storing and access of information, for instance, leaving in the background the layout. The minimalist design of the Web 2.0 has allowed that solution. Nevertheless, the layout has to be bolstered in those countries where there isn't a good communicability in the computer-made images in 2D and 3D. Currently we are going towards a new momentum of the new interfaces which emulate and simulate the 2D in great spaces or in small screens of micro computing that can even be doubled.

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