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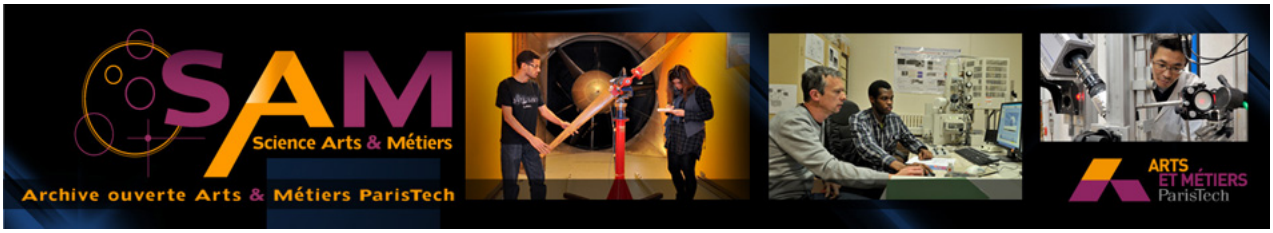

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Iterative process of design and evaluation of icons for menu structure interface of interactive TV services

Dokshin LIM, Carole Bouchard, Améziane Aoussat

RUNNING HEAD: ICON DESIGN PROCESS FOR ITV SERVICES

Keywords: icon usability, user interface design, interactive TV, design process

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ABSTRACT

This paper shows an iterative process of design and evaluation of icons for future interactive TV services. In doing RNRT (French National Network of Research in Telecommunications) iTV project, we tried to generate icons easy to identify, to associate and to memorize for 32 categories and services related to menu structure of our iTV system.

We processed several iterations between design and evaluation at the end of which we obtained a set of valid icons. First iterations were processed in the multidisciplinary project team. Once we got more or less valid icons, we went through user tests. On the basis of the Multiple Index Approach, we evaluated icons in terms of intuitiveness, associativeness, preference and suitability with the subjective certainty of users.

We extended this approach by adding a delayed session of recall test. As a conclusion, we propose a methodology of icon design and evaluation.

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1. INTRODUCTION

The RNRT (French National Research Network in Telecommunications) sponsors researches in telecommunication. Since 2001, they specially call for researches centred on usage. This is because it is now being realized that considering users in developing innovative technologies is of great importance. This governmental support allows researches highly centred on user while usually interactive products released on the market tend to be produced to be well sold, not to be well used by common users.

The RNRT Interactive TV project is a multidisciplinary collaboration project: usability engineer, specialist in multimodal interaction, psychologist, product designer, computer programmer, innovator and president of a small sized enterprise. The goal of the project was to anticipate future iTV services.

In the iTV domain, technologies are being developed so vigorously that the definition changes everyday. Gawlinski (2003) defined iTV as anything that lets the television viewer or viewers and the people making the television channel, programme or service engage in a dialogue. More specifically, it can be defined as a dialogue that takes the viewers beyond the passive experience of watching and lets them make choices and take actions – even if the action is as simple as filling in a postcard and popping it into the mail, or drawing a picture on the television screen.

According to statistics (IDATE, 4 March, 2003) ITV users now count 52.7 million (TV households) and will continue to increase at an annual rate of 16 %. However, there are few studies questioning on which services are really useful from users' perspective and how to design

them usable by majority users. As a result of the project, we proposed a model of future iTV including 90 services that we consider useful for common users. The services are also organized in a usable way. All services are accessible by navigating 2-depth menu designed on the basis of the results obtained by card sorting method with 18 users.

Why was it necessary to add icons to our system? Icons are used more and more frequently in the context of the controls and indications of a large variety of devices. In common usage, the term, icon, has come to denote any small raster image appearing in a GUI (Graphic User Interface) display [Mullet, 1995]. Well designed icons offer the speed and directness with which recognition and identification take place.

We tried to take account of existing guidelines proposed by THERASIS and Multimedia User Interfaces for Interactive Systems and TV [MUSIST] when designing icons for our system. This research aims, when defining appropriate icons for iTV services, to evaluate icons by user tests and in the end to propose design recommendations for iTV icon design and evaluation.

In many cases, icons require less learning time and effort than text-based alternatives. However, as Wiedenbeck (1999) pointed out, using only icons without label can lead the system much poorer performance than when using texts only or icon-text combination. In particular, when users don't intend to use this interface frequently, which may be the case for certain interactive services of our model, it seemed us necessary to display icons with their text label.

Designing icons is a creative process. Considering that today few guidelines that guarantee usable icons for iTV exist, they should, as Nielsen (1993) emphasized, be subjected to early usability testing to gain a useful assessment from users. Our iterative process of design and

evaluation continued till a set of wholly new icons replacing precedent ones is sufficiently small (see Figure 1).

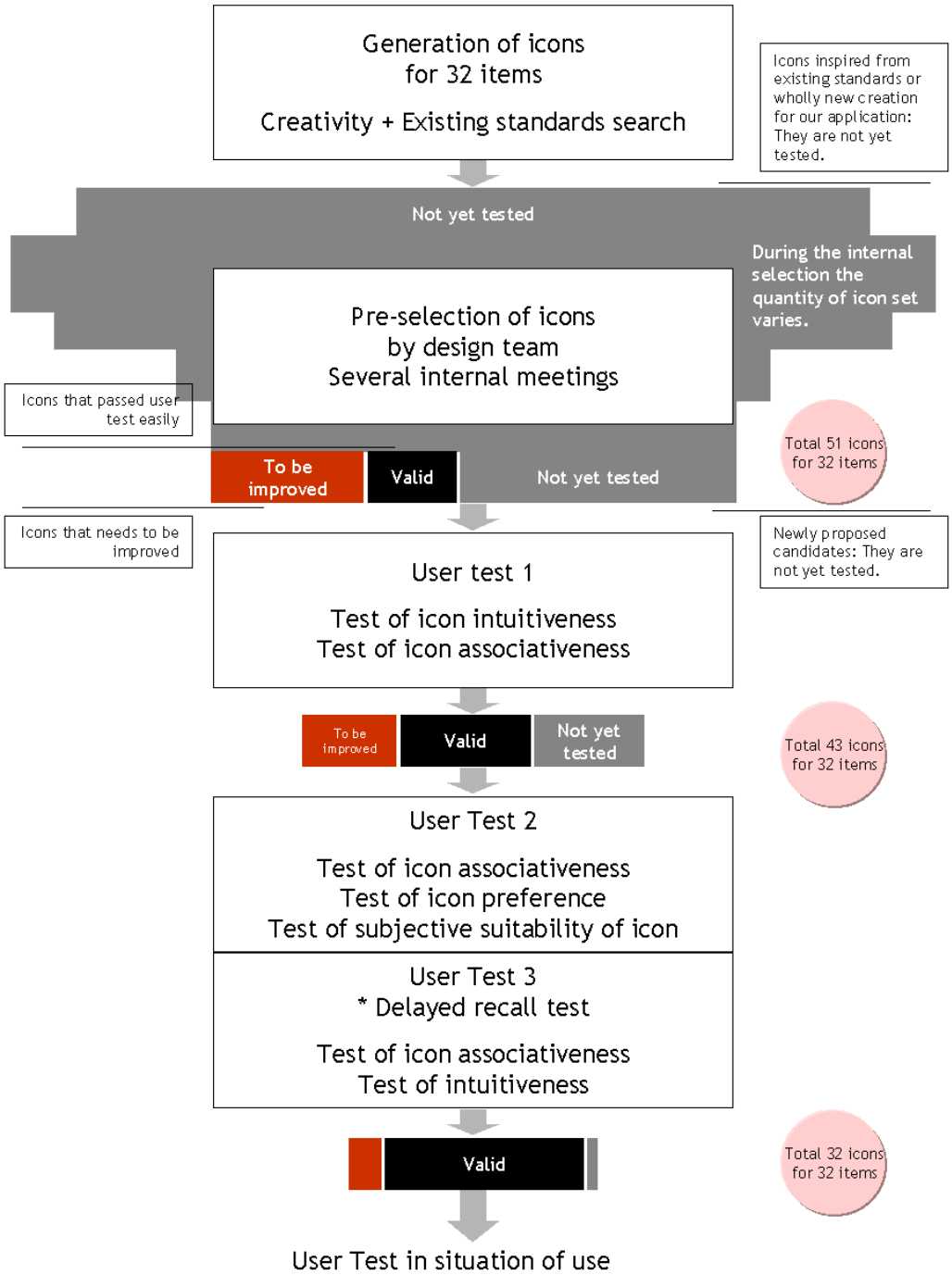


Figure 1. Iterative process of design and evaluation of icons for iTV services

2. GENERATION OF FIRST ICON SET

A designer in the multidisciplinary iTV project team was charged of the generation of icons for 32 items (main or sub categories, services and functions) figuring in the menu structure of our interactive TV services.

When there exist already largely adapted icons for common users or standards, we adopted the existing idea and adjusted it to fit our system. For example, we referred to existing standards (European Telecommunications Standards Institute [ETSI], 1993, 1994) (MUSIST) and universal public signs (Yang, Kumekawa, & Hotta, 2003) (see Figure 2). We tried not to limit ourselves to copy icons that are familiar to frequent PC users but not for non PC users. However, for some items, essentially known for their functionality in PC environment and so largely accepted that it seems us difficult to invent another, we used existing icons for PC environment (ex: “Print” and “Help” functions and “Mail”, see Figure 2).

For services such as “Going out”, “Cyber sightseeing” or “Multimedia encyclopedia” for which there isn’t yet well adapted icons, rapid brainstorming sessions were organized to generate ideas. Icons proposed in this way (search for existings, creativity) were at first gone through an internal preselection.

The task of designing icons, whether the designer creates new icons or he adapts existing ones, leaves him a great deal of artistic freedom. Some icons may be highly ambiguous and lessen the usability of the device. So, it is imperative that icons be empirically tested in order to establish whether the user does indeed associate the function to the represented (from this point known “referent”).

Existing icons, public signs, symbols	Intended Meaning	Icon iTV	Referent & Intended Meaning
	ETSI standard Videophone / Telephone: In videophony, for switching between videophone (sound and picture) and telephone (sound only modes).	Visiophone	Videophone
	Public sign Museum	Visite touristique	Cyber sightseeing
	Windows Print	Imprimer	Print
	Windows Help	? Aide	Help
	Windows e-mail	Messagerie	Mail
	Web www.amazon.com Shopping cart	Boutique achat	Home shopping

Figure 2. Example of icons using existing standards

3. PRESELECTION OF ICONS BY THE DESIGN TEAM

The designer, when designing icons, tried to propose several alternatives for each item. The first icon set was presented to our multidisciplinary design team and passed by a brief pre-selection. All project team members participated to several votes. The quantity of the icon set went through up and downs. Finally, 51 icons (among 32 referents, 19 had two alternatives) were internally selected to be tested by users.

4. USER TESTING METHOD

The Multiple Index Approach (MIA) had been developed, tested and employed in the context of an European Telecommunications Standards Institute [ETSI] study on pictograms for basic videophone functions (see also (Böcker, 1993)). Piamonte (1999, 2000) found that this method had been found to be suitable as a general testing method for pictograms from all areas. Our test method relied mainly on this MIA.

The main purpose of evaluation was to collect data with the help of which the best suited icons of a number of icon proposals (for some items, two candidates were proposed) could be selected. Three tests (User Test 1, 2 and 3) were designed. Each test aims to measure some of the following indices:

(1) Test of icon intuitiveness: Icon intuitiveness is a measure employed in the work of Nielsen (1994, 1995). Our icons will be normally presented with text labels. Anyway, it would be ideal that icons possess immediacy that allows them to be recognized at a glance as the intended

meaning even when they are not associated with text label. In icon intuitiveness test, respondents were shown icons one by one without their label and were asked to describe what each icon was supposed to represent.

(2) Test of icon associativeness: One referent (name and description of an item) is presented on a questionnaire. A group of icons is presented on the TV screen. The respondent's task is to choose the appropriate icon for the referent in question. His choice can be analysed in terms of the hit rate, false alarms and missing values. In addition, subjective certainty is required for each rating. The following is the description of each index.

- Hit rate: Score of correct associations between the referent and icon

- False alarms: For a given referent, to which other icons, it is associated when it should be associated to its relevant icon

- Missing values: How many instances a respondent doesn't answer a question presumably because he did not know the answer

- Subjective certainty: This index indicates how certain the respondents feel in their identification and association. For example, if the user is extremely uncertain about a choice on a test of icon associativeness, he may decide, in a real situation of use, not to use it at all.

(3) Test of icon preference: The respondents indicate which of the candidate icon for one referent represents best the referent in question. Calculating p-values of each pair will show if there exists a significant difference between two candidates.

(4) Test of subjective suitability: The subjective suitability indicates how certain the user is in the given association in question of an icon and a referent. The multiple scale dimension analysis

will allow to dissociate icons in groups depending on their mean of subjective suitability. The groups with low suitability should seriously be redesigned.

Each test needed to use different orders of presenting icons to counter-balance learning effects. Icons were displayed on the TV screen (Sony 70 cm in diagonal standard cathode screen). The distance between the television screen and the users' faces was set to 3 m as Gawlinsk recommended (2003)[1].

Each step of iteration needed different composition of performance measures described above (see Figure 1). We also collected some descriptive data from respondents on their technical experience (PC, Internet, mobile phone, …).

5. RESULTS

5.1. User Test 1 (icon intuitiveness / icon associativeness)

We showed icons, on by one, to four users[2] without its label. Users were asked to state their best guess as to what the icon was supposed to represent. This test assessed the degree to which the graphic chosen for the icon represented the intended concept. Subjective uncertainty let us have conviction on making decisions.

Some icons passed the test easily, with most users guessing the intended meaning or at least guessing something that was very close and would not be misleading in the context of the full

[1] The distance between television viewers' faces and the television screen is typically 2-3.5 m (Gawlinski, 2003).
[2] This type of test can be done by a small number of users, typically five (Nielsen, 1995). Four students (22 – 26 years old) participated to our test.

system. For example, only one user explicitly used the word “See and Listen (in French Voir et écouter)” to describe our “Watch/Listen (Regarder/écouter)” icon, but descriptions like “Audiovisual (Audiovisuel)” and “Image and sound (Image et son)” actually showed that people got the general idea. In cases like this, we were satisfied that users would understand the icon when it was combined with its label in the full system. So we did not feel a need to change it, especially given that we had planned several additional user tests that would reveal any hidden problems. For these icons, only minor adjustments were made, (see Figure 3).

In other cases, users did not get exactly the correct meaning of an icon but we decided to keep it anyway. “Learn (Apprendre)” was one such example, because we thought that it could be easily accepted when it is presented with the text label. The underlying problem was that sub categories were not coherent to the main category icon. So, we reused the “teacher” image to all sub categories of the main menu “Learn” (see Figure 3).

With respect to the “Going out (Sorties)”, people didn’t get the intended meaning. They identified the icon as “Assisting a person at home” and “Home automation appliance” (two subjects over four had no idea). At this stage, the project team generated wholly different concept. An icon using a “chick” going out of the egg. Major change was made also to the icon of main menu “Practical life (Vie pratique)”. A thumb recognized as “Nice”, “OK” and “More information” didn’t seem appropriate. It was redesigned as a Swiss knife (see Figure 3).

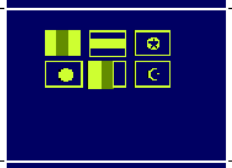
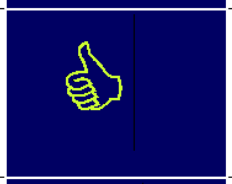
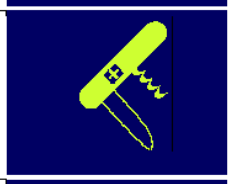
Intended Meaning	Before user test 1	Motif of change	After user test 1
Watch / Listen *Regarder / écouter*		Simplify contour lines	
Learn to cook *Cours interactif de cuisine*		Use consistent concept in the same category	
Learn language *Cours interactif de langue*		Use consistent concept in the same category	
Learn yoga *Cours interactif de yoga*		Use consistent concept in the same category	
Going out *Sortie*		Change concept itself	
Practical life *Vie pratique*		Propose an alternative in using wholly different concept	
Communicate *Communiquer*		Use consistent concept in the same category	
Visiophone *Visiophone*		Use consistent concept to differenciate	
Dialogue *Dialogue en direct*		Use consistent concept to differenciate	
Discussion Forum *Forum de discussion*		Use consistent concept to differenciate	

Figure 3. Example of changes made from the results of User Test 1

The intuitiveness is the principal factor that defines the usability of icon in an absolute condition. However, in real context of use, the correlation between co-existing icons should also be considered. According to the hit rate and false alarms, we were able to make decisions on some icon sets. For example, we discovered poor associativeness of three icons in the main menu "Communicate": "Visiophone", "Dialogue on line" and "Discussion forum" (all 3 errors over 4). They were redesigned using ordinary smile head and empty smile head at the same time (see Figure 3) because one of the distinguishing factors among the three services is if the correspondent is anonymous or not.

At the end of the User Test 1, we achieved a set of 43 icons. 18 icons could already be considered to be able to pass easily. 15 wholly new icons were added either as new alternatives or as replacing ones. 10 icons seemed necessary to improve (see Figure 4) but we kept them hoping that it would be better when they were to be labelled because we didn't have better idea.

Intended Meaning	Before user test 1
My Garden (*Mon jardin*): This main category is kind of one's "secret garden" to stock one's personnal data (video, photo, text, ...) that not anyone can access to	
On demand (*A la demande*): This subcategory leads to display menus of on-demand services such as "Films on demand", "Music on demand", etc.	
TV program guide (*Guide TV*): This service allows users to consult interactive TV programs	TV TV
Live (*En direct*): Display a variety of information related to the program on	
Video supervision (*Vidéo surveillance*): This service allows TV viewers to supervise the house (Who knock the door, my son in the swimming pool, ...)	

Figure 4. Example of icons proved not easy to identify and to associate on User Test 1

5.2. User Test 2 (icon associativeness / icon preference / icon suitability)

At this stage, the laborious icon intuitiveness test was replaced by the icon suitability test at the end. Instead of asking users to state what the icons inspired them, referents were given with associated icons for users to evaluate the suitability among four choices (very bad, bad, good, very good).

Icon preference test was added in order to choose better icons when there were more than two alternatives for one referent (we had 10 referent having more than two alternatives).

Thirteen subjects (student or staff of the New Product Design Laboratory) whose age varied from 22 to 59 participated to the test. Tests were performed in a group of 3 or 4 subjects at a time.

By integrating the associativeness and the subjective certainty (see Figure 5) and by using p-values of the significant difference in the mean of subjective preference, we were able to eliminate 7 alternatives among 10 couples of icons.

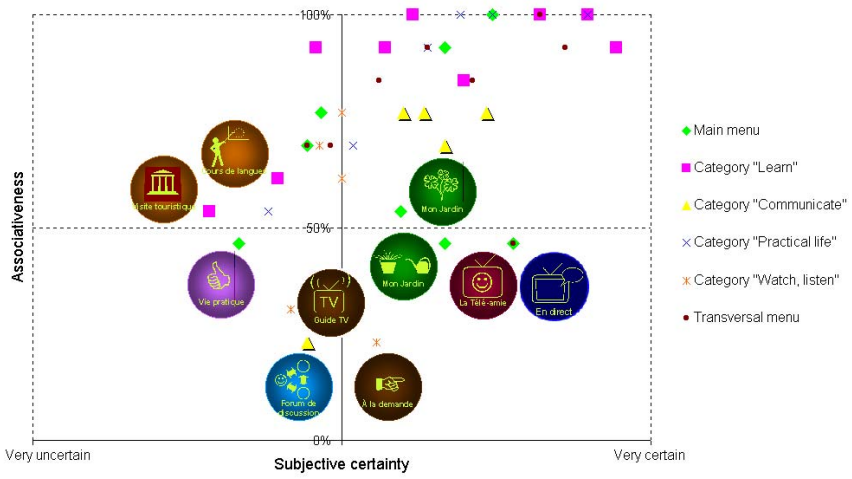


Figure 5. Associativeness and subjective certainty on User Test 2

We also found that with respect to the main category “My garden (Mon jardin)” missing values were high (6 and 7 over 13 for two alternatives), because of the imaginative label, subjects strongly tended to think of gardening related TV programs or shops. We renamed this category as “Perso” and redesigned it as a drawer that would let people think that one can keep personal data in it.

Nine subjects (over 13) chose the icon of “Dialogue” when asked to find the icon for “Discussion forum”. The category “Communicate” leaves users to learn the difference among “Visiophone”, “Dialogue” and “Discussion forum”.

5.3. User Test 3 *Delayed session (icon associativeness / icon intuitiveness)

Nine subjects who had participated to the User Test 2 were gathered again two weeks later. We asked them to associate two referents on each category to the icons. They were also asked to describe what would happen if they choose that item. The aim was to see if users were able to recall well the attribution of icons and services contents.

For icons such as “Friendly TV (TV amie)”, “Discussion Forum (Forum de discussion)”, “On demand (A la demande)” and “Live (En direct)” which had showed poorer intuitiveness and associativeness during previous tests, we found that most of users associated them well as we intended (at least 8 correct answer over 9 for all categories).

On the contrary, only by seeing icons and labels, they had difficulty in describing exactly what function the items were designed to do.

At the end of the User Test 2 and 3, we finally achieved 32 icons to use for a working prototype of iTV services. Two icons were new proposition, not yet tested. One icon in the

category “Communicate” seemed not easily associable to its referent “Discussion forum”, but we maintained it in hoping that in learning through several uses, users can memorize it. We could say that other twenty nine icons were comprehensible and suit for represent the related items. The final icon set ready to be integrated into the working prototype is shown in Figure 6.

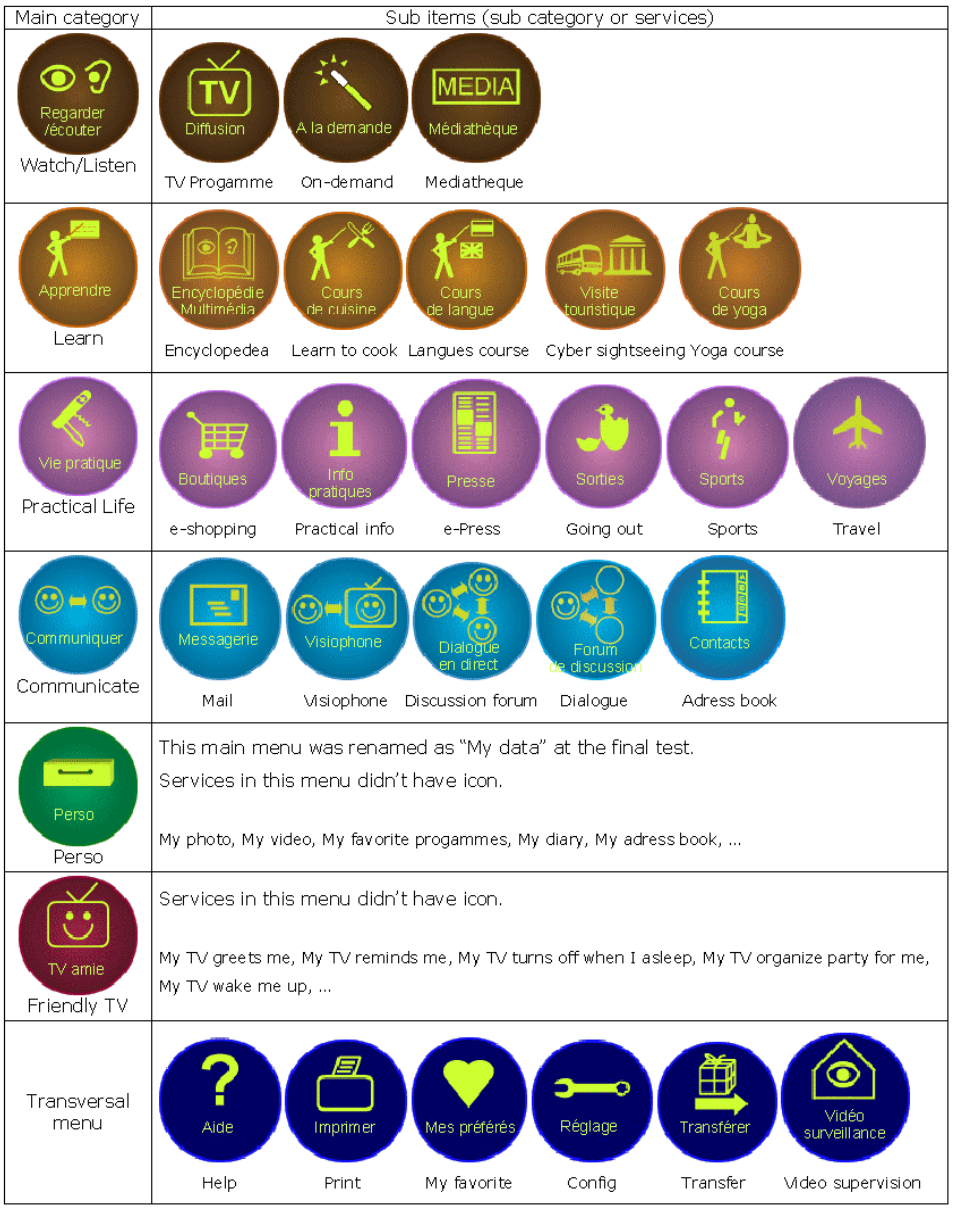


Figure 6. 32 icons of interactive TV services

5.4. User test in the context of real use using a working prototype

The limit of the above experiments is that we were not able to test icons in real context of use because at that moment, our mock-up was not working. We couldn't see if users given real use tasks like "Save or visualize your personal multimedia data" choose the intended icon "My garden" (modified as "Perso" on User Test 2).

A final usability test in which the icons were shown as a part of the full user interface of the global system was followed. Twenty-four adults and adolescents (6 over 55 years old, 12 between 22 and 40 years old and 6 under 17 years old) participated to the test. Users were given scenarios of use and asked to "think aloud" when they used the system to perform given tasks. The aim of the test was multiple: the usability of categories and hierarchy of services, using PDA remote control, contents of services as well as the usability of icons. The tested a working prototype looked like Figure 7.

We observed that at first users paid more attention to the text labels than on the icons to use the system. For example, the main menu "Perso" reminded "Personalization" or "Personal configuration" rather than "Personal data". The icon of a drawer didn't orient users to the intended meaning. This main menu was finally renamed as "My data (Mes données)".

When at the end of the test we asked users to recall icons, they were not able to draw exact concepts. Except some adolescents, subjects showed tendency to draw geometric forms (ex: diagonal line, rectangle) but not precise concepts (ex: Swiss knife, drawer) of icon.

Figure 7. Screen of television and PDA remote control of the working prototype

Did icons contribute to the ease of use of our iTV service system? We didn't find it through the test because users depended more on text labels than on icons. Some exceptions were observed when users were navigating on the two categories: "Watch/Listen" and "Communicate". In the former category, three unfamiliar items - "Diffused programmes", "On-demand" and "Mediatheque" – needed users to figure out what they are for. The latter ("Communicate") has three services that caused confusion: "Visiophone", "Discussion Forum" and "Dialogue". With respect to these items, text labels were not sufficient enough to understand the contents of the items that users paid attention to icons. We observed that users tried to figure out the contents by analysing the differences in icon design.

Our experience let us think that the major role of icon when users are not familiar with the system may be to bring user-friend environment of use. When users are familiar with the system after successive uses, we expect that users depend more and more on icons than on text labels due to the speed and directness of icons with which recognition and identification take place. In that case, we can consider icon-only interfaces for expert users.

6. CONCLUSION

We used the Multiple Index Approach (MIA) for iterative process of design and evaluation of icons structured in menu. We showed that the choice of indexes should be varied throughout iterations depending on the evolution of icon sets.

Initial user test (User Test 1) needed most of all icon intuitiveness test and then associativeness test. Spontaneous icon identification may seem laborious but it would be better to do it at least once in the early phase of iteration, even with a small number of users, in order to get productive assessment from users. For further iterations, the spontaneous identification may be replaced by simple closed questionnaire of subjective suitability. The associativeness test is well adapted for navigation system structured in hierarchical menu.

User Test 2 was composed of icon associativeness test, preference test and suitability test. At this stage, by the preference test, it was possible to eliminate some less powerful alternatives.

User Test 3 aimed to verify for suspicious icons if they can be well associated and well memorized after some delay. With respect to today's information appliances, we emphasize on the importance of the learning effect through time. Common users encounter more and more new

products in everyday life. New features having no predators need to be learnt and memorized. In this context, even if a new feature (icon, contents, …) shows poor performance at first because it isn't familiar to users, if it can be easily learnt and accepted, it can be considered as well designed one. The importance lies on the rate of improvement, not on the performance at first glance.

The main contribution of the present work is that we improved the multiple index approach of icon test by adding a recall test session. We empirically did the recall test after two weeks from the first usage test. Further research should define optimal length of delay to perform such king of recall test.

We briefly explained the final test with a working prototype during which we tested once again the icons. We found that the major role of icons was rather to let the system more user friendly than to make easier to use the system because users didn't pay particular attention to icons. It seemed that users relied more on text labels than on icons to figure out items. We also found that user began to pay attention to icons in order to figure out the service contents by analysing icons when the text labels were not sufficient.

In this paper, we showed a way of iterative design and evaluation of icons. User test of icons may begin very early in the process, even when any working prototype is not yet ready (generally when the designer begins to design icons, the working prototype doesn't exist yet). When major corrections were made in early phases, further development becomes simpler (ex: less charge for programmer). However, a final test of icons in real context of use with a working prototype is also necessary.

NOTES

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FOOTNOTES

1. The distance between television viewers' faces and the television screen is typically 2-3.5m (GAWLINSKI 2003).

2. This type of test can be done by a small number of users, typically five (Nielsen, 1995). Four students (22 – 26 years old) participated to our test.

FIGURE CAPTIONS

Figure 1. Iterative process of design and evaluation of icons for iTV services

Figure 2. Example of icons using existing standards

Figure 3. Example of changes made from the results of User Test 1

Figure 4. Example of icons proved not easy to identify and to associate on User Test 1

Figure 5. Associativeness and subjective certainty on User Test 2

Figure 6. 32 icons of interactive TV services

Figure 7. Screen of television and PDA remote control of the working prototype

FIGURES

Figure 1. Iterative process of design and evaluation of icons for iTV services

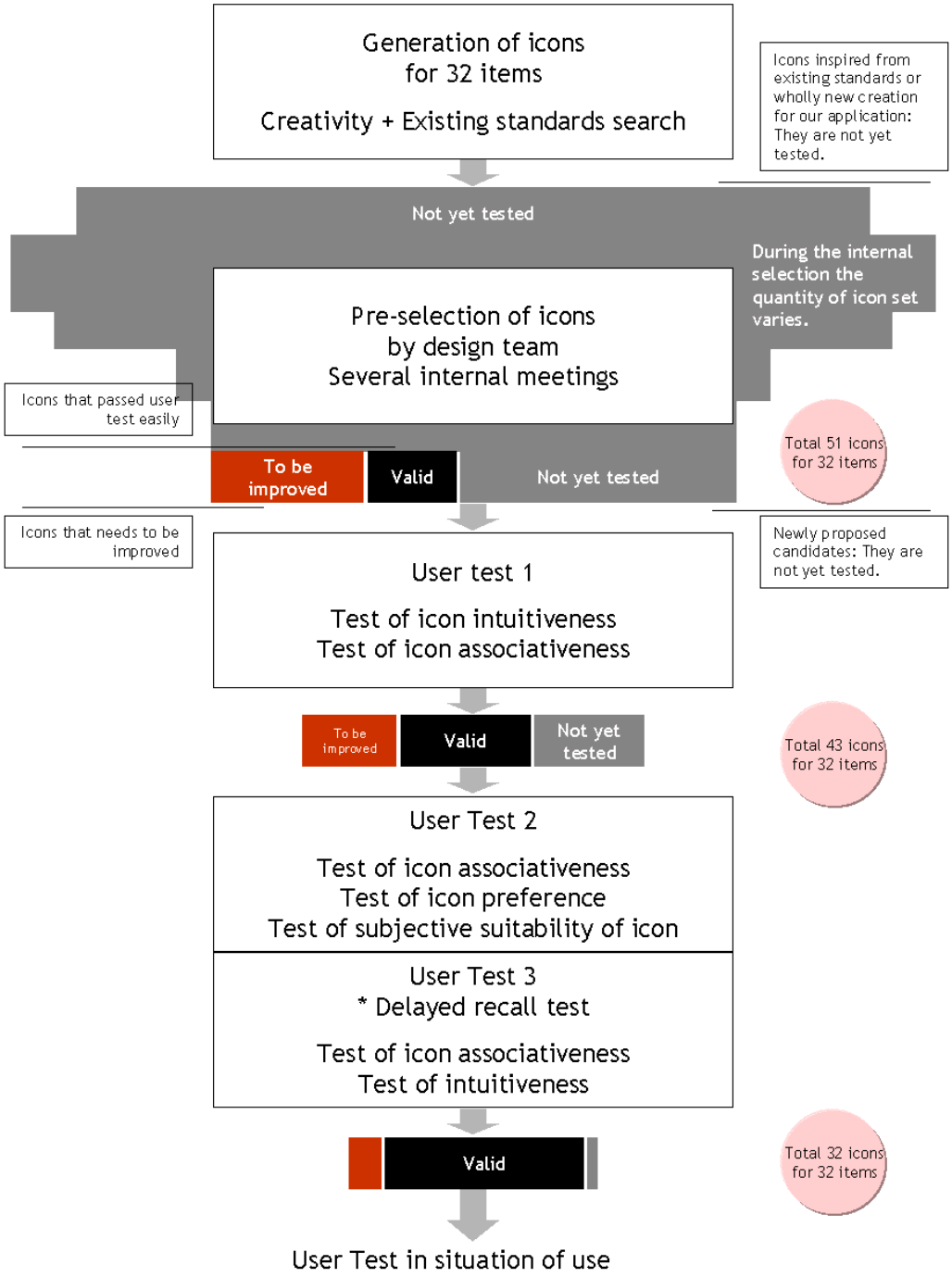


Figure 2. Example of icons using existing standards

Existing icons, public signs, symbols	Intended Meaning	Icon iTV	Referent & Intended Meaning
	ETSI standard Videophone / Telephone: In videophony, for switching between videophone (sound and picture) and telephone (sound only modes).		Videophone
	Public sign Museum		Cyber sightseeing
	Windows Print		Print
	Windows Help		Help
	Windows e-mail		Mail
	Web www.amazon.com Shopping cart		Home shopping

Figure 3. Example of changes made from the results of User Test 1

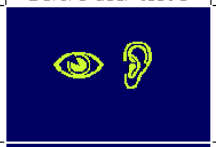
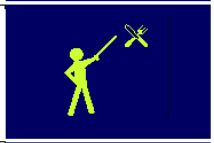
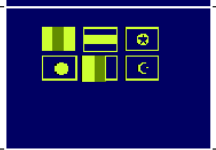
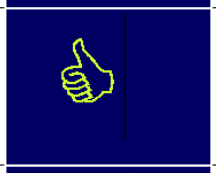
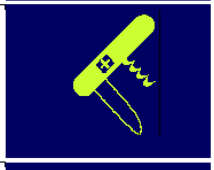
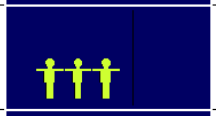
Intended Meaning	Before user test 1	Motif of change	After user test 1
Watch / Listen *Regarder / écouter*		Simplify contour lines	
Learn to cook *Cours interactif de cuisine*		Use consistent concept in the same category	
Learn language *Cours interactif de langue*		Use consistent concept in the same category	
Learn yoga *Cours interactif de yoga*		Use consistent concept in the same category	
Going out *Sortie*		Change concept itself	
Practical life *Vie pratique*		Propose an alternative in using wholly different concept	
Communicate *Communiquer*		Use consistent concept in the same category	
Visiophone *Visiophone*		Use consistent concept to differenciate	
Dialogue *Dialogue en direct*		Use consistent concept to differenciate	
Discussion Forum *Forum de discussion*		Use consistent concept to differenciate	

Figure 4. Example of icons proved not easy to identify and to associate on User Test 1

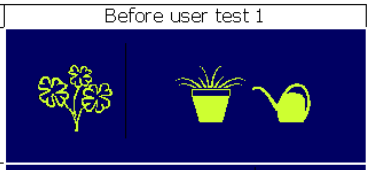
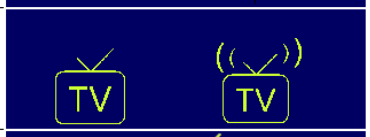
Intended Meaning	Before user test 1
My Garden (*Mon jardin*): This main category is kind of one's "secret garden" to stock one's personnal data (video, photo, text, ...) that not anyone can access to	
On demand (*A la demande*): This subcategory leads to display menus of on-demand services such as "Films on demand", "Music on demand", etc.	
TV program guide (*Guide TV*): This service allows users to consult interactive TV programs	
Live (*En direct*): Display a variety of information related to the program on	
Video supervision (*Vidéo surveillance*): This service allows TV viewers to supervise the house (Who knock the door, my son in the swimming pool, ...)	

Figure 5. Associativeness and subjective certainty on User Test 2

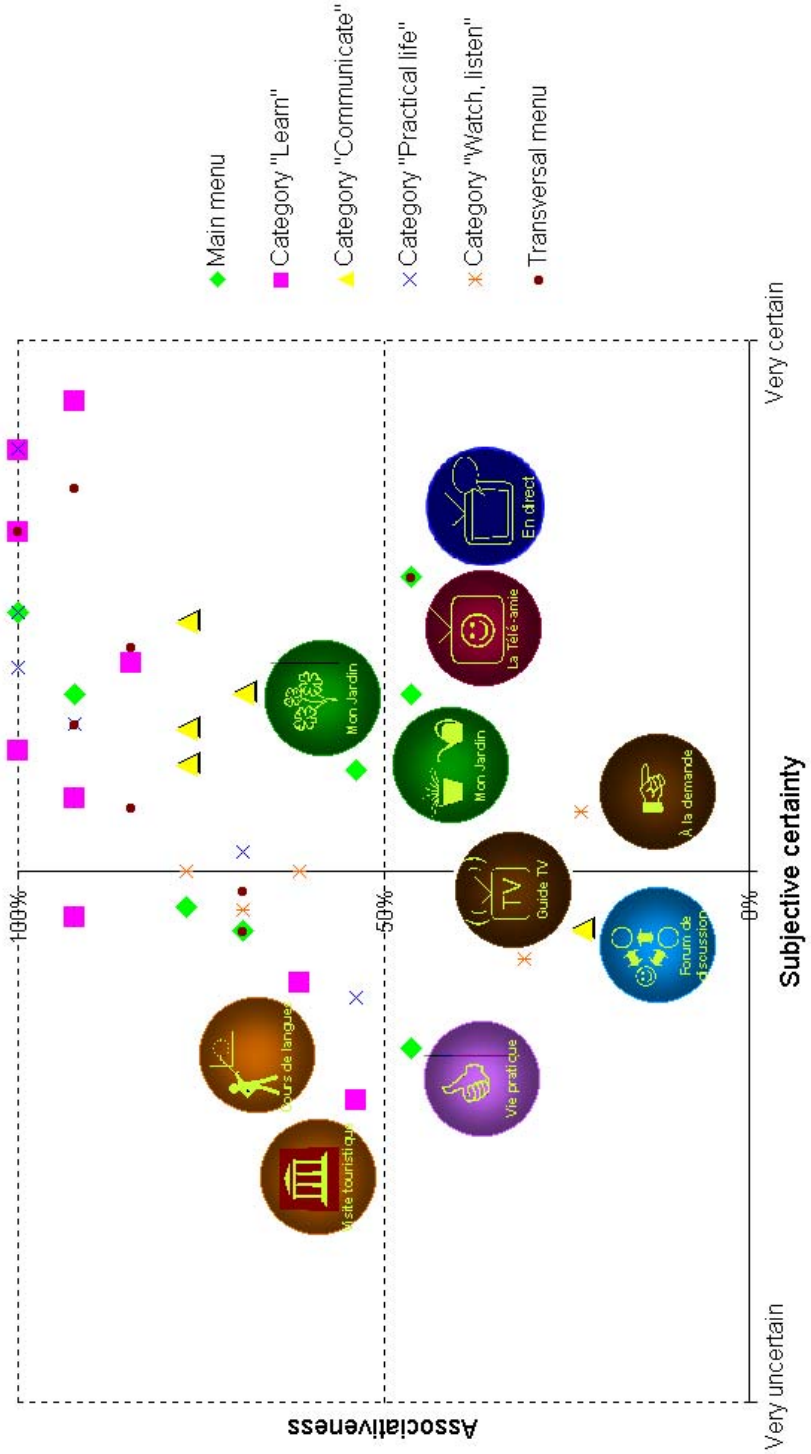


Figure 6. 32 icons of interactive TV services

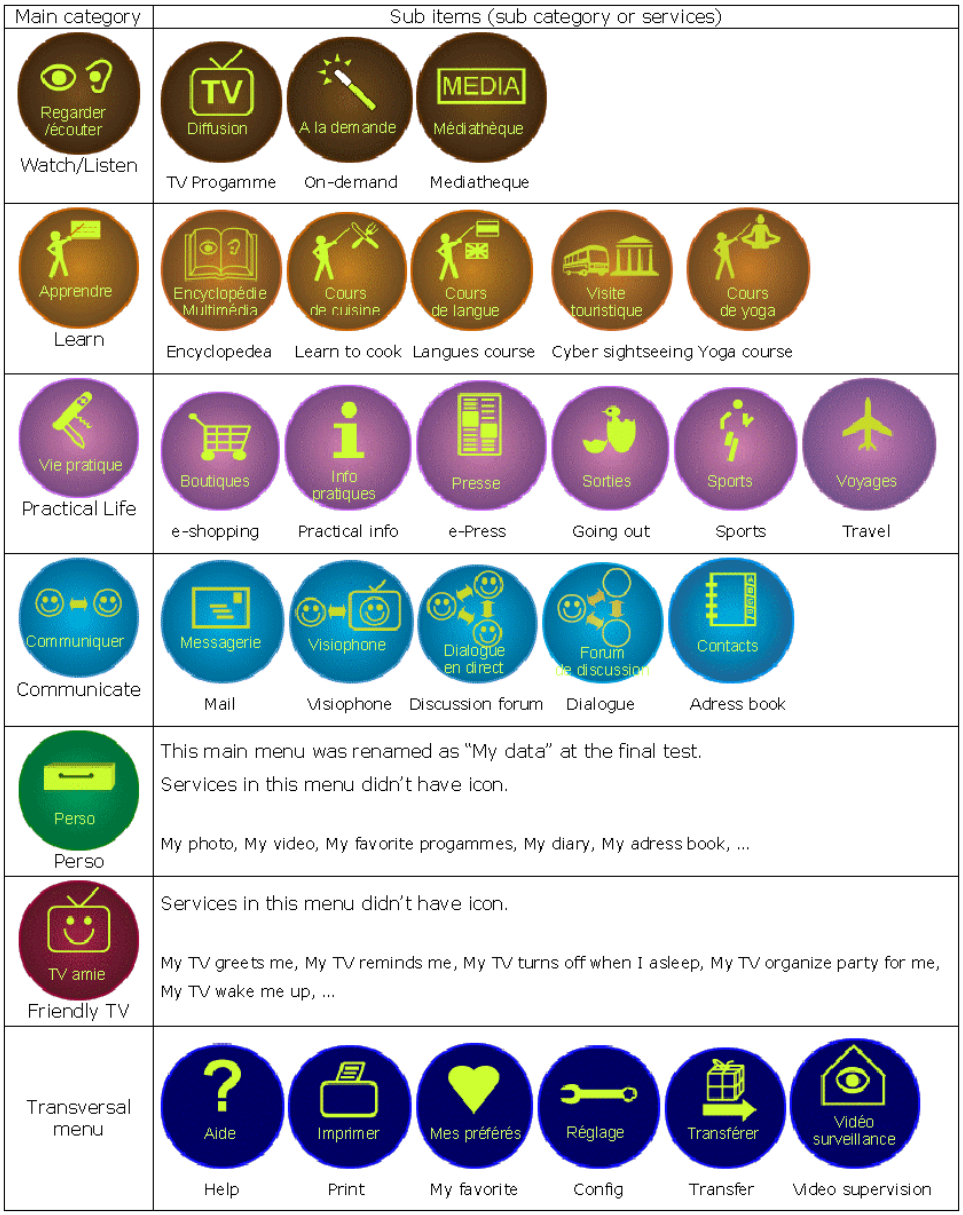
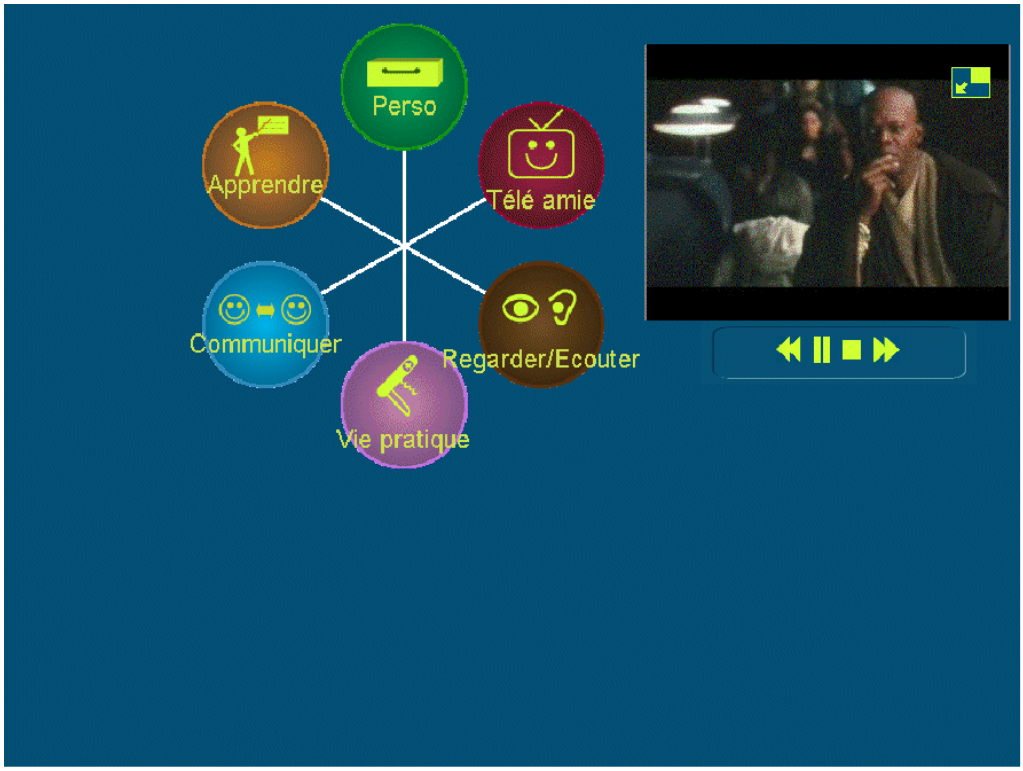



Figure 7. Screen of television and PDA remote control of the working prototype