Catalan Journal of Communication & Cultural Studies
Volume 3 Number 1
 doi: 10.1386/cjcs.3.1.21_1

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The use of IST applications in Catalan museums: A comparative evaluation carried out at the Museum-Monastery of Sant Cugat del Vallès

ABSTRACT

This article presents some preliminary conclusions on the use of information society technologies (IST) as communication tools in Catalan museums, drawn from a research project that was undertaken jointly by the University of Manchester and the Universitat Autònoma de Barcelona. The general aim of the project was to widen the understanding of the specific usefulness of technology for exhibitions. We evaluated an exhibition in the United Kingdom and a second exhibition in Catalonia, by interviewing staff, observing and interviewing visitors and holding a round table discussion with museum experts. The general conclusion was that the

KEYWORDS

museum exhibitions
IST applications
comparative evaluation
design guidelines
Churchill Museum
Museum-Monastery of Sant Cugat del Vallès

integration of technological applications might ultimately depend on the museological tradition of the country, which influences the use and perceptions of technologies. The article also describes empirical data for Catalonia and guidelines for future applications.

INTRODUCTION

In the last fifteen years, cultural heritage museums have widely adopted information society technologies (IST) as a new communication tool given their features seem to match at least theoretically with postmodern museological trends. Thanks to their virtuality, multiple interfaces and interactivity, they are capable of transcending space and time to provide personalized information in different formats; they are more or less immersive; and they can establish a real dialogue between museums and audiences. However, previous evaluations and visitor studies (for a critical review, see Economou and Pujol 2007) have revealed that IST applications in exhibitions have suitability problems for single and group interaction, most likely because of their physical interface and communication language, which are directly imported from the engineering field and therefore do not match the specific communication paradigm of the exhibition (vom Lehn et al. 2005). This would seem to be the trend in Catalonia, where ISTs have been introduced more recently, predominantly with a broad goal in mind and with computer-based interfaces. Yet little is known here about the extent to which ISTs accomplish their goals and are perceived by audiences, since specific evaluations related to technological exhibits have rarely been conducted or disseminated.

In the last five years, new high-tech displays have appeared in different European exhibitions that would seem to indicate the beginning of a shift in the design of IST applications for museums: (from purely technological to more hands-on or mixed interfaces) that would enable better integration in their spatial and social context. It has been demonstrated that hands-on exhibits – considered to be highly effective for group learning and exploration – have interaction limitations if they are not properly designed (Pujol and Economou 2009b; vom Lehn et al. 2005). This means that IST effectiveness with regard to single and group interaction in exhibitions might not be related to the inescapable fact of being high-tech (as assumed to date) but to the adequacy of the display in terms of a specific communication purpose.

Notwithstanding the reliability of previous findings and hypotheses, it is possible that the apparent dichotomy between high- and low-tech exhibitions with regard to the interaction features is also the result of the specific theoretical stance adopted in previous studies and the subsequent evaluation methodologies that were developed. With regard to the former, the studies aimed to compare the two kinds of exhibits and consequently were implicitly opposing them, one against the other. With regard to the latter, the studies analysed the exhibition's spatial and social context, the features of the displays and the characteristics of the visitors. Despite a willingness to be integrative, this method was summative and external and so failed to take into account the specific purpose and concept behind the exhibition design.

In spite of a similar transformation process during the second half of the twentieth century that led to the so called New Museology (Falk and

Dierking 2000; Hooper-Greenhill 1994, 1998; Pastor 2004; Valdés 1999), European museums can be classified according to two broad traditions (Gómez Martínez 2006). On the one hand there is the Mediterranean tradition, headed by France, where museums aim to catalogue heritage objects in order to preserve them. Consequently, exhibitions are based on a 'museology of the object' or 'of the idea' (Davallon 1992) and are contemplative, informational (García Blanco 1999), academic and static. In the Anglo-Saxon tradition, on the other hand, headed by the United Kingdom and the United States of America, museums build narratives to enlighten visitors. Exhibitions are therefore based on a 'museology of the point of view' (Davallon 1992) and are didactic (García Blanco 1999), disseminative, dynamic or interactive.

During the 1960s and 1970s, when education stopped being an epiphenomenon of museums' conservational and taxonomical function to become their main social role, divergent pedagogic models were followed by Europe and the United States due to the influence of cognitive psychology (Hooper-Greenhill 1994). The latter adopted a constructivist model, which led to 'didactic' exhibitions in the sense of an active exploration and construction of the message by visitors (García Blanco 1999). The former adopted a behaviourist model, emphasizing a rigidly compartmentalized environment with clearly delimited and sequenced goals; this is how exhibition design focused on the environment and not on what happens to people (Hooper-Greenhill 1994). It was not until the 1980s that the constructivist model penetrated European museums, proposing a more active role for visitors. But the curator's authority was kept, which led to 'informational' exhibitions – that is, like an illustrated text (García Blanco 1999). This is the reason why Anglo-Saxon museums are considered informal learning environments, where visitors acquire generic learning outcomes through an active social process. Catalan museums, on the other hand, are more closely associated with formal learning and are regulated by the didactics of the social sciences (Hernàndez Cardona 1998; Santacana and Serrat 2005).

Bearing the previous technological and museological contexts, would the use of IST be less homogeneous than it seems? Are the differences in different IST applications not only determined by contingent factors such as the subject and contents of an exhibition, its age and the available technology but also ultimately conditioned by the museological concept of each museum? These are the main questions that this article seeks to put forward for discussion.

AIMS AND GOALS OF THE STUDY

Given the background described above, the University of Manchester and the Universitat Autònoma de Barcelona (UAB) undertook a small research project aimed at determining and developing the specific usefulness of ISTs for exhibitions. The first goal was to obtain new empirical data about the use and effectiveness of IST applications in exhibitions by selecting and evaluating different exhibitions containing high-tech displays. The perspective that was adopted was different from previous studies in two ways.

First, the analysis was less external and display-oriented than visitor studies, since it would take into account how different applications were introduced by exhibition designers according to a specific purpose/concept

and would then evaluate to what extent the communication goals were fulfilled.

Second, a comparative approach was adopted because the project departed from the premise that a continuum in the use/integration of ISTs in exhibitions can be established in order to classify them. Many museums in the United Kingdom introduced high-tech exhibits into the main exhibition's discourse during the 1990s (Parry and Sawyer 2005), with very specific communicational purposes usually satisfied by a narrative or game-like design. Some of these museums are now experimenting with more 'museographic' interfaces. Many Catalan museums have introduced ISTs in the last ten years, mainly in the form of computer stations containing knowledge organized in a database system and with a broad goal generally linked to interaction.

An important outcome of this project is that it would make empirical information on the use of IST applications in Catalan museums available for the first time. Although many evaluations and visitor studies have been conducted (see, for example, Alcalde 1992; Asensio and Pol Méndez 2002; Santacana and Serrat 2005), they have never purposefully focused on the role and suitability of technology for exhibitions. Due to the limited funding for our project, it was not possible to systematically analyse several exhibitions belonging to different knowledge domains enabling general conclusions to be drawn. Instead, two similar exhibitions were chosen (one in each country) and the study was focused as an exploratory one, which would provide a set of explicit hypotheses to be tested in the future through broader research projects.

The above-mentioned changes in the methodological perspective laid the practical foundations for the second main goal of the project, which was to improve IST evaluation studies in order to obtain better tools for assessment and integrative design. This purpose constitutes the second justification for this article: to provide museums, especially in Catalonia (still at the beginning of the introduction of technology), with evaluative instruments and design guidelines specifically adapted to the new media, which, because of their peculiarities and costs, present new communication and management challenges to cultural institutions.

METHODOLOGY

The project started with the selection of the cases for study. The chosen museums were the Churchill Museum of London for the United Kingdom and the Museum-Monastery of Sant Cugat del Vallès for Catalonia. They were selected because of both similarities and differences. In terms of similarities, they shared the knowledge domain (history), the museum category (visitable monument), the museological concept (few objects and a message transmitted mainly by a set of audio-visual means) and the fact that they had introduced ISTs at different moments of their development. As for differences, the museums were considered representative of the two extremes in the aforementioned continuum of IST integration in exhibitions, for which reason it was considered potentially fruitful to compare them in relation to several issues: effectiveness according to the exhibit's goal, enjoyment, engagement, immersion, interaction, learning, usability, relationship with other exhibits and objects and group exploration.

In both cases, five consecutive methods were deployed, with each step verifying the hypotheses of the previous and posing the research questions for the next step:

1. Exhibition analysis
2. Interview with a staff member
3. In-situ observation
4. Bibliographical search (in the United Kingdom)/visitor survey (in Catalonia)
5. Round table of museum professionals (in the United Kingdom).

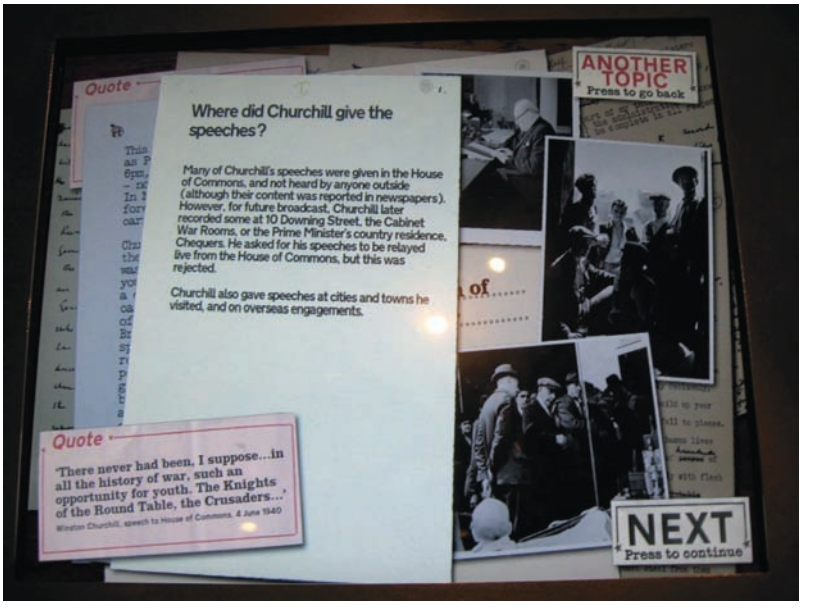
Since the methodology of the research project combines qualitative and quantitative methods it can be qualified as mixed. The analysis of the specific purpose of high-tech exhibits within the exhibition structure and the observation of their use by visitors were based on interpretative methods. The interview with a member of staff was the main source of information. And the round table could be likened to a focus group discussion. The evaluation carried out in Catalonia used the same qualitative methods, except for the final round table and the bibliographical search, which was replaced by a visitor study and so involved a more quantitative, statistical approach. This difference is justified by the different research contexts in the two countries. The United Kingdom has a different museum studies tradition, which was worth exploring by discussing the subject with different professionals in the field. Evaluations previously conducted or commissioned by the Imperial War Museum provided all the empirical information necessary to verify our conclusions regarding the United Kingdom. Since very few evaluations are available for Catalonia, it was more appropriate to include a quantitative analysis that would provide a preliminary overview.

RESULTS

Exhibition analysis

The Churchill Museum and Cabinet War Rooms, located beneath the Treasury building in the Whitehall area of Westminster in London, is one of the five branches of the Imperial War Museum. The Cabinet War Rooms are an underground complex that was used as an operations centre by the British government during the Second World War. The facilities were abandoned in 1945 and were opened to the general public in 1984. From 2003 to 2005, they underwent significant renovation work, in which some storage rooms were transformed into a chronological exhibition that uses original and facsimile objects and different kinds of technological displays to explain Winston Churchill's public and private life (Pickford 2008). Depending on the interface design, the exhibition contains four types of high-tech exhibits:

- Large screens. These accomplish a mass-media function and use dynamic, digitally created content to present controversial or interesting aspects of Churchill's life.
- Touch screens (Figure 1). These contain small multimedia applications based on real documents. Two of them access a database containing Churchill's paintings and the rest use discovery or game-like strategies to motivate users and create immediate conceptual links for new knowledge to be more easily incorporated.



Source: Reproduced with permission from the Churchill Museum.

Figure 1: Touch screen containing a multimedia discovery application.

- Mixed interfaces (Figure 2). These more complex exhibits combine real objects and screens, audio files and visual projections. Some are non-interactive and others use a hands-on discovery learning model.

Source: Reproduced with permission from the Churchill Museum.

Figure 2: Mixed interface.

Source: Reproduced with permission from the Churchill Museum.

Figure 3: The Lifeline multi-user interactive table.

- Multi-user interactive table (Figure 3). This large multi-user digital archive contains a biography of Churchill and information on associated historical events.

The permanent exhibition at the Museum-Monastery of Sant Cugat del Vallès aims to explain the architectural and cultural evolution of the monument. Because there are few original objects remaining in the monastery, the dissemination of knowledge relies mainly on audio-visual mediators endowed with an intentionally didactic character (Campins and Miquel 2008). The first and second phases of development, which were inaugurated in 2003 and 2008, respectively, are clearly different: while the first contains mainly low-tech non-interactive mediators, the second phase mostly consists of high-tech interactive independent units.

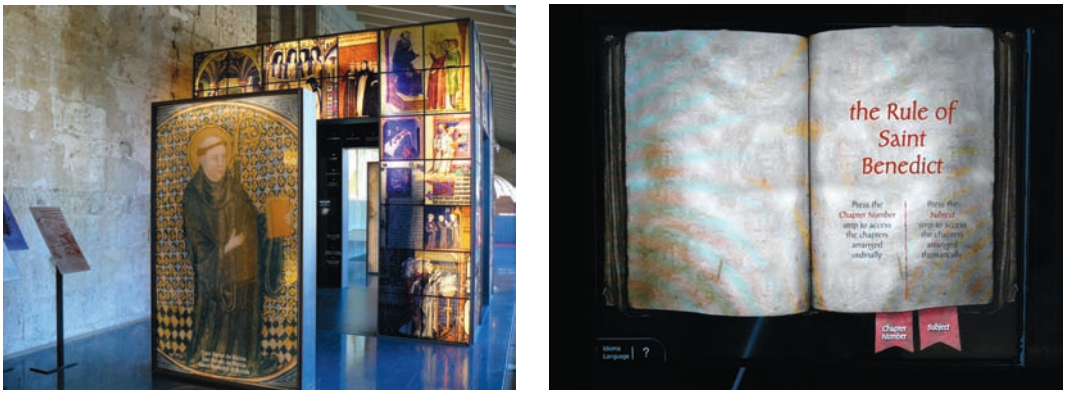
Three kinds of exhibits are used to introduce the visitors to the basic vocabulary of Romanesque architecture: texts with images; a large wooden reproduction of a Romanesque nave that the visitors can enter; and two digital videos with three-dimensional (3D) reconstructions (Figure 4) that sequentially explain the construction of different architectural elements. These three exhibit types present the same content using different cognitive resources: symbolic and iconic in the case of texts; 3D immersive in the case of the wooden reproduction; and dynamic, iconic and symbolic in the case of the 3D reconstructions. They therefore serve different kinds of learning skills but also potentially support and complement each other if visitors use them all. Cognitive studies (Osberg 1997) have proved that dynamic representations are better than texts with images for understanding certain kinds of content.

Source: Reproduced with permission from the Museum-Monastery of Sant Cugat del Vallès.

Figure 4: One of two digital videos.

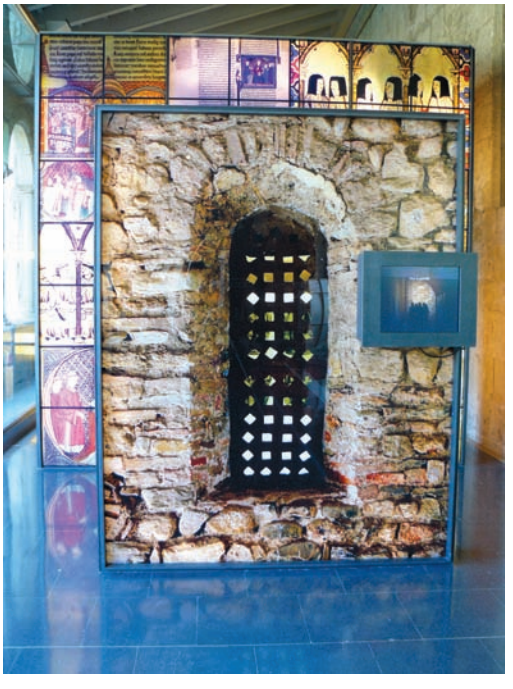
The second museum phase, located in the Renaissance extension of the cloister, consists of text, images and three high-tech interactive units aimed at explaining the origins and monastic life in Western Europe.

- Interactive module on Saint Benoit's rule (Figure 5). This immersive multi-user exhibit is in the shape of a black cube with four entrances and



Source: Reproduced with permission from the Museum-Monastery of Sant Cugat del Vallès.

Figure 5: Module on Saint Benoit's rule.



Source: Reproduced with permission from the Museum-Monastery of Sant Cugat del Vallès.

Figure 6: Module on Benedictine foundations in Catalonia.

four touch screens. The application consists of a database that is navigable through digital reproduction of an ancient codex and that which can be explored according to subjects or chapters by pressing on the corresponding buttons or by a realistic movement of pages. This reproduction of the tactile world is also present at the Churchill Museum's touch screens.

- Module on the Benedictine foundations in Catalonia (Figure 6). This small, flat touch screen accesses a multimedia database where the user can search for information on medieval Benedictine foundations in Catalonia according to four different criteria (name, geographical location, gender and chronology).
- Module on popular devotion of Saint Cucuphas (Figure 7). A wooden dome contains, among other objects, a screen with three buttons that the user can activate to listen to devotional music dedicated to Saint Cucuphas.

In this second phase, technology is obviously more present and seems to have been introduced because of its interactivity and capacity to display multimedia information.

Our conclusion from the exhibition analyses was that there were five factors influencing the different uses of technology: subject, presence of objects, moment of introduction, design team, available interfaces and budget.

Source: Reproduced with permission from the Museum-Monastery of Sant Cugat del Vallès.

Figure 7: Module on popular devotion to Saint Cucuphas.

Interviews with staff

The next step in the research project was semi-guided conversations. In the United Kingdom we talked to Phil Reed, Director of the Churchill Museum, and in Catalonia we interviewed Lluís Campins, Director of the Museum-Monastery of Sant Cugat del Vallès. We anticipated that their answers would verify our conclusions regarding the main factors influencing the use of technological applications drawn during the analysis of exhibition structure.

According to the directors, ISTs were introduced in the exhibition design with the aim of helping visitors learn complex content in an interactive and consequently more motivating way. The ISTs also constituted another kind of exhibit, intended to make the exhibition more appealing through the variety of resources. More specifically, the 3D reconstructions on the ground floor were aimed at learning, whereas those on the first floor added an interactive approach to this learning goal. In the directors' opinion, what marks the difference is not the subject but the complexity (quantity and nature) of the information to be transmitted. Since the building constitutes the central object of the museum at Sant Cugat, there is no dialogue, but rather a juxtapositioning between high-tech exhibits and the few objects present in the exhibition.

In the case at the Churchill Museum, the objects are used to illustrate the content provided by the other mediators.

At the Museum-Monastery of Sant Cugat the two phases were designed from scratch and technological applications were taken into account from the outset. Both phases were designed and implemented by the same team, comprising three historians with knowledge of museology and the didactics of the social sciences and one designer. This team prepared the content and commissioned the audio-visual shows and technological applications from external companies in the business of designing cultural products, including exhibitions. At the Churchill Museum, the whole exhibition was commissioned from an external company, which worked closely with the museum team (composed of several curators and education and exhibition experts) and a graphics designer. The museum contributed the content, the company proposed how to convey the information and the designer contributed the graphic style.

At Sant Cugat the additional technology in the second phase was related to a desire to increase interactivity in the museum. This association is also found in studies by early authors (Belcher 1991; Hall 1987), who distinguish between 'interactivity' – a dialogue established with a computer – and 'participation' – which involves hands-on exhibits. At the Churchill Museum, the clear predominance of technology is due to the desire, on the one hand, to build a state-of-the-art museum and, on the other, to facilitate access to a historical archive by building an engaging story from the information contained there and so allow visitors to adopt their own critical stance on the subject and record their own views. Budget was influential at two levels. From a general point of view, it decided the amount of technology to invest in and while it allowed full deployment of different interfaces in the UK museum, high-tech applications could not be massively introduced at the Catalan museum in the first phase because they were too expensive and also because of the time required to install them. At the Churchill Museum deadlines were not decisive for the choice between high- and low-tech solutions, although the budget did influence directly the specific final shape of the exhibit.

Yet, choices at Sant Cugat were not exclusively technology-driven; content was decided at the beginning and it was then decided where technology would be the best mediator, bearing in mind the need for a diversity of resources. With regard to the audiences, although high-tech exhibits are perceived to interest more and be more easily used by younger visitors, they were not purposefully aimed at them but at a general family audience, with different people interested in different content/resources and likely to locate the exhibit that matched them. Nevertheless, group exploration was also taken into account, and this is why two solutions were applied: an elevated screen in the case of non-interactive exhibits and several screens for interactive exhibits. At the Churchill Museum, the focus was not so much on formal diversity but rather space design, so that the visitors could choose the most attractive content inside each chapter. The most important difference is maybe in the visitor's approach, since it is acknowledged that families – the main target group – explore displays together. This is why, leaving aside the choice of big screens, the Lifeline multi-user display (a fifteen-metre-long interactive table with information on every year of Churchill's life) and different kinds of mixed interfaces were designed.

In conclusion, the goal of ISTs in exhibitions according to both directors is to transmit knowledge in a more enjoyable and motivating way.

Observation of visitors

The aim behind the observation of the visitors was to explore and verify several issues (motivation, immersion, usability and museographic transparency) that arose in the analysis of the exhibitions or that were suggested during interviews with the curators.

On the ground floor of the Museum-Monastery of Sant Cugat del Vallès, irrespective of the door through which visitors entered the room, the wooden reconstruction (because of its visibility) and the small-scale models (because of their sequentiality and detail) were the exhibits that received most attention and generated most comment, mainly about the function and the evolution of the monastery. Hardly anybody read the texts, other than people (as indicted in the surveys) with a specific interest in art or history or who preferred this kind of learning style. With regard to the 3D reconstructions, very few people paid attention to them, with the surveys revealing that they were appreciated only by visitors with a certain knowledge of, and interest in, the subject/technology.

On the first floor, we could also appreciate different uses of the resources, determined by their visibility and ease of use. A great deal of attention was paid to the large images located at the beginning. Visitors to the first module mainly used the screens on the left-hand-side because they are those most visible from the entrance. As observed in previous studies (Pujol and Economou 2009a, 2009b, 2009c), adults were more interested in exploring and acquiring content, so they read the instructions and, after an initial exploration of the interface, followed the predetermined path through chapters or subjects. Children were more interested in triggering responses and their exploration was more random; they pressed buttons wherever they understood an input would be detected. Although experience with technology played an important role in ease of use, we did not observe major usability problems, mainly due to the touch screens and the realistic interface, which younger visitors very much appreciated. In the Churchill Museum, touch screens also appeared to be a user-friendly interface, even for older visitors.

In the case of synchronous exploration by several visitors, we had two broad categories of behaviour, corresponding to children and adults. In the first case, younger children tended to try and use something together and therefore the accompanying adult needed to organize turn taking while acting as a mediator to explain the content. Older children preferred to split up and go to different screens. Young adults explored together, alternating roles, one as user, the other commenting or recommending where to go. In this case, people seemed to be attracted by the exhibit's shape and then become engaged in the realistic interface and the content. Nevertheless, the screens are too small for visitors who preferred to explore the resources together. This is also the case at the Churchill Museum, where the presence of a single station for each exhibit leaves co-visitors to one side or prevents other visitors from approaching the exhibit when someone is already using it.

The second module was clearly underused; because of its position behind a 'wall' and between two very visible exhibits, people went directly from the first module to the scale models and maps. In the few observed cases, we could appreciate that only people with experience in databases/multimedia applications made the most of this. Nevertheless, people did not spend a long time at this application; once they had found a known monastery, they abandoned the search. On the contrary, the touch screens and the Lifeline exhibit at the Churchill Museum engaged visitors in lengthy explorations. The

surveys did not provide an explanation, but we are inclined to say that without a clear pre-existing interest in the subject or a clear starting question (as in the Churchill exhibits), the content was not appealing enough. The screen was big enough for a maximum of two visitors exploring together.

At the third module, people mainly explored the central screen (more visible from the entrance), while the other two resources remained underused. Nevertheless, this screen had three problems (confirmed by the surveys): first, people expected it to be a touch screen and needed some time to locate the buttons; second, they were confused by the loading time; lastly, they were disappointed because they could not stop the music at will to pass to the next record.

Visitor survey

The purpose of the visitor survey was to verify several issues detected or suggested during the previous phases of the research project, namely, motivation, usability, immersion, interaction, and especially how these have influenced learning. Data were collected from 28 May to 19 June 2009. Exchanges lasting an average of fifteen minutes took place in the porch of the monastery once visitors had finished their visit. We conducted 28 interviews, which is obviously not enough to draw statistical conclusions, but do provide a first qualitative overview of visitor opinions of the exhibition. It is also worth noting that, unlike in UK museums, most visitors in Catalonia are not used to participating in evaluation studies; they feel they are being assessed and refuse to participate. In the Museum-Monastery of Sant Cugat del Vallès visitors said ten minutes was a long time for an interview or they hesitated when answering with the excuse that they did not know about the subject. Only visitors with certain expertise in the subject and/or experience with museums willingly agreed to participate.

The typical interviewed visitor was female (64.3 per cent), aged between 46 and 55 years (28.6 per cent), from the province of Barcelona (92.9 per cent) and more specifically from Sant Cugat del Vallès (42.9 per cent), of Spanish nationality (82.1 per cent), held a university degree (50 per cent), related to the museum's subject (46.1 per cent),[1] had intermediate experience with technology (42.9 per cent), worked as an employee (23.1 per cent) in the educational field (14.3 per cent), visited alone (32.1 per cent) or with friends (17.9 per cent), and had come to see the monument (50 per cent) and to learn (23.3 per cent). These results differ from previous studies (Pujol and Economou 2009a, 2009b, 2009c) and from the United Kingdom, where the main visitor types are couples or families with no special link to the museum or the exhibition's subject, but with a greater proficiency in technology (more used to videogames and specialist applications). Nevertheless, as in previous studies, the average visitor claimed to be very interested in heritage (64.3 per cent), visited museums very often (33.3 per cent) and believed that museums are places where people learn through objects (88.9 per cent), which, depending on the kind of museum or exhibit, should encourage manipulation of the material and foster discussion (39.3 per cent).

In their opinion, the usefulness of the ISTs in the cultural heritage field (Table 1) is related to learning (36.4 per cent), namely, they provide more information or facilitate understanding, increase enjoyment and attract younger audiences and provide interactivity. Nevertheless, ISTs are something alien to exhibitions and therefore should be used carefully. Although the first two

1 Humanities (19.2 per cent), Creative Arts and Design (15.4 per cent) and Architecture and Planning (11.5 per cent).

Usefulness of technology in cultural heritage museums	%
Provides more information	20.5
Makes the experience interactive (innovative, better than guides)	20.5
Is a complement/foreign element/aimed at those familiar with technology/must be used carefully	20.5
Facilitates learning and understanding of the subject	15.9
Increases attraction and enjoyment (young people)	15.9
Reconstructs non-accessible things	6.7
Total	100

Table 1: Usefulness of technology in cultural heritage museums.

answers were found in previous evaluations (Forte et al. 2006) and especially in the United Kingdom, the last two appear for the first time in a study. In any case, ISTs were perceived as a complement or a means of communication, which is why 75 per cent of visitors categorically rejected the notion that technology justified a higher-priced ticket. With regard to visiting a museum containing only technology, there seems to be an association between visitor age and the acceptance of technological exhibitions, since categorical refusals tended to appear amongst the older age groups (46–66 years old), while positive answers seemed to be encountered more amongst younger visitors (26–35 years old).

Once the conversation about the general aspects of the visit was launched, the surveyors asked the same questions in relation to both floors. In the case of the ground floor, visitors found it was easy to follow the exhibition because 'good explanations were provided'. Nevertheless, the spatial character of the room also played an important role, since the sequence of exhibits and the (lack of) signposting were also mentioned. Another influencing factor, though minor, was the number of exhibits which, instead of reinforcing learning (as hoped by the designers), because the fact that there were too many visible elements sometimes distracted the visitors. In the case of the first floor, and in spite of the fact that it contained fewer exhibits, visitor answers were less overwhelmingly positive. Visitors mentioned the satisfactory development of the content, the visual component of the exhibits and the simplicity of their spatial character. The negative elements were the excessive amount of information or the great diversity regarding the subject or its presentation (images, texts, multimedia devices, sound, etc.).

With regard to the most popular ground-floor exhibit, 38.5 per cent of the visitors chose the large-scale model – because it was large, immersive and original – and 34.6 per cent of visitors chose the small-scale models – because they showed the evolution of the monument. It is interesting to note that two visitors were unable to find anything special and that three others were puzzled by the question, stating that 'a museum is a serious place'. The 3D reconstructions were appreciated by two visitors because of their visual component, but could not compete with the screens showing the making of a capital (the crowning part of a pillar), which were seen by more visitors. In the case of the first-floor exhibits, 37.1 per cent of visitors chose the first module for three reasons: its realistic interactivity, its visual appeal and its novelty. Novelty and interactivity were also amongst the reasons for choosing

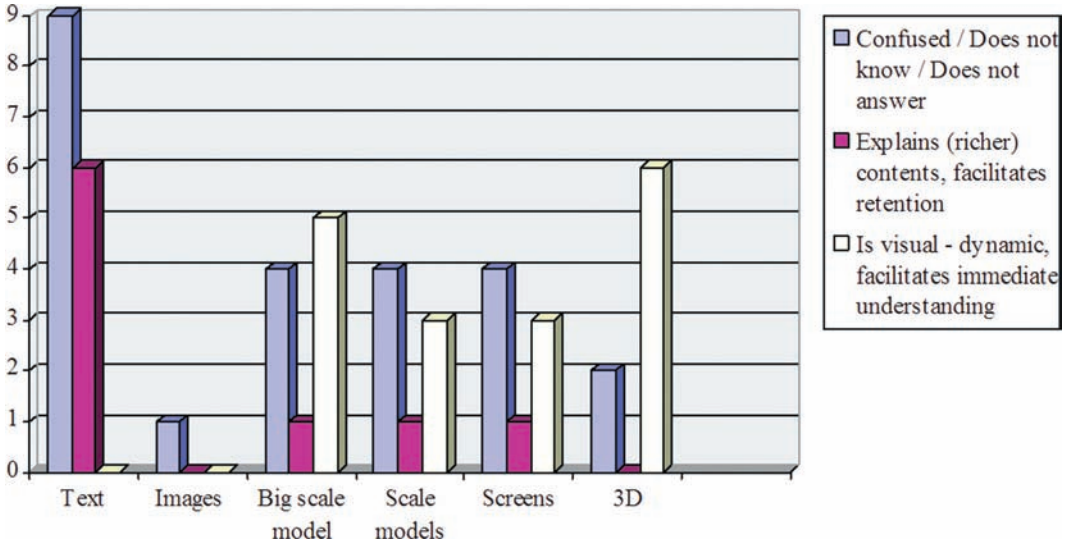
the other two modules, which, in addition, had sound as an important additional element.

With regard to the exhibits that most captivated their attention, on the ground floor, visitors chose the small-scale models (26.5 per cent) because they liked the visual 3D sequential explanation. The large-scale model was ranked second (20.6 per cent), because people were attracted by its visibility and dimensions, which invited them to explore the exhibit. The screens were voted for by 14.7 per cent of visitors, while the 3D screens occupied fourth position (11.8 per cent). Given the fact that both exhibits share the attractive 'television feature', it is interesting to compare the reasons provided by visitors for their choices in order to understand the specific contribution of the virtual reconstructions. The screens explaining the making of a capital were chosen because the subject was interesting and was presented in such a way that it was accessible to everyone (three cases). The 3D reconstructions were mainly chosen by visitors who had a professional interest, although others also appreciated their ability to present richer, multimedia content and to be understood regardless of the mother tongue. In the case of the first floor, visitors chose the third module (28.1 per cent), the images (21.9 per cent) and the first module (18.8 per cent). The reasons given for the interest in the technological exhibits were their innovation, interactivity and aesthetic value.

With regard to the most interactive exhibit present on the first floor, the three modules were mentioned, and in particular, the first one (46.9 per cent of cases), for a single reason: it can be manipulated and allows exploration at different levels, although this interaction is individual. With regard to the most user-friendly exhibit, visitors chose the second module (27 per cent), because the touch screen was easy to use, although at some points it was difficult to turn the pages, the second module (24.3 per cent), again because of the ease of use of the touch screen, and finally the third module, because users 'only have to press a button', although it was difficult to find where it was.

With regard to the most immersive exhibit, the term could be understood both as a sensation of physical envelopment and/or as a sensation of transportation in space/time. On the ground floor visitors experienced both sensations and mentioned two exhibits: the first was the large-scale model (31.4 per cent), because they 'could physically enter it', and the second was the 3D reconstructions (14.3 per cent), because they 'reconstructed the past'. The main choices for the first floor were the first (24.2 per cent) and the third (21.2 per cent) modules and the images (18.2 per cent). The first module was rated because its content and physical structure 'commands your attention, submerges you' (four cases). For the third module, apart from the physical surroundings (one case) and the 'unexpectedness of the experience' (one case), the main explanation was its sound (four cases), which has been detected in presence studies as a paramount factor in distracting a person's attention to the surrounding reality (Slater and Wilbur 1997). The images were rated third because their visual component allowed a better reconstruction of the past in comparison with texts, which only symbolically situate the visitors in the historical context.

With regard to the best exhibit for group exploration, the small- and large-scale models were the most popular on the ground floor, with 29.5 per cent and 27.3 per cent of votes, respectively. In both cases, the explanation was related to spatial issues: in the first case, visitors could stand around

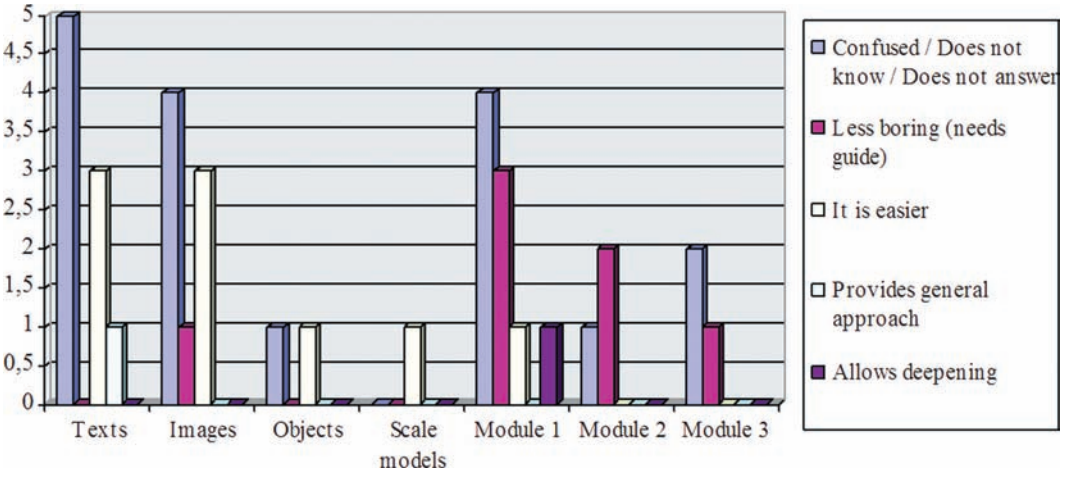


Source: authors.

Figure 8: Explanations regarding the best exhibits for learning on the ground floor.

it, and, in the second case, visitors could enter it. On the first floor, visitors chose the first module (28.3 per cent), the images (17.4 per cent) and the third module (15.2 per cent). In the first case, the main reason was the number of different screens, which allowed different groups of visitors to explore at the same time. Spatial justifications were also given for the images: 'they are bigger and therefore more visible' and 'they have more space around them'. It is interesting to note that, unlike in previous studies and in the United Kingdom, what most visitors had in mind were large groups led by a guide, or individual exploration, rather than collaborative exploration by two or more co-visitors.

With regard to the best exhibit for learning, on the ground floor (Figure 8), 30 per cent of the visitors voted for the text because it was considered necessary to explain content. The remaining exhibits were also mentioned with quite similar percentages: 20 per cent for the large-scale model; 16 per cent for the small-scale models, the screens and the 3D reconstructions. The visitors justified their choices by adducing that the visual component enabled immediate and complete understanding. It is interesting to note that this was the question with the highest number of answers, which indicates that the visitors considered learning as the main goal of the room. Yet, what did they remember of it? Mainly specific exhibits, specifically the screens showing the making of a capital (41.7 per cent) and the small-scale models (25.0 per cent). Other visitors (21.4 per cent) also had a vague recollection of the topic of the room ('architecture and/or monasteries'). If they learned anything new or specific, as hoped by both the museum and the visitors, interviewees were not able to tell us. Moreover, it does not seem that the 3D reconstructions contributed to learning since very few visitors paid attention to them (50 per cent of non-responses). Those who watched them remembered superficially that they 'showed architectural elements' (21.4 per cent) or named specific content (10.7 per cent).



Source: authors.

Figure 9: Explanations regarding the best exhibits for learning on the first floor.

In the case of the first floor (Figure 9), the texts, the images and the first module shared the first position as the best for learning, with 22 per cent of votes. The first two were chosen because 'they are easier to understand', and the high-tech exhibits, because 'they are less boring'. This means that, in spite of the less intuitive interface, the IST added a motivational component to the learning process, exactly as the designers had intended. Nevertheless, it is notable that non-responses in the recollection question were higher in comparison to those for the ground floor (52.2 per cent compared to 17.9 per cent), with visitors mainly recalling information transmitted by texts and images: 21.7 per cent, for 'life of the saint' and 'the monastery' and 8.7 per cent for 'the location of the monasteries'. Only in one case was information content ('monastic organization') for the first module mentioned.

DISCUSSION

The general goal of the high-tech displays at the Museum-Monastery of Sant Cugat del Vallès was the transmission of complex knowledge: on the ground floor the aim was to complement the other exhibits and reinforce learning and, on the upper floor, the aim was to transmit knowledge in a more interactive and therefore more motivating way. This constitutes the first difference between Catalan and UK museums, since in the latter, technological applications are not intended to complement or introduce interactivity, but are a specific integrated solution for the transmission and reception of multimedia content. The application may or may not be interactive, depending on the specific needs at each point of the exhibition discourse.

A deeper insight might be offered by a comparison between the factors influencing the introduction of IST applications during exhibition design. According to the curators, the Museum-Monastery of Sant Cugat was slightly different from the Churchill Museum. In the latter, the role of objects in the knowledge domain preceded the communication goal as a general framework for any exhibition design, and the age of the exhibition did not play an important role because exhibitions are understood to be in constant renovation.

	Museum-Monastery of Sant Cugat del Vallès		Churchill Museum	
Role of objects	3	In the exhibition	1	In the knowledge domain
Communication goals	1	Interactive learning	2	Exchange of multimedia information
Target audience	4	Family members	3	Family as a group
Available technology	5	Increases interactivity	4	Novelty and specific final choices
Budget	6	Presence of technology	5	Final form of exhibits
Age of the exhibition	2	Determinant, new phase	6	Insignificant, constant renovation

Table 2: Comparison of influencing factors at the Museum-Monastery of Sant Cugat del Vallès and the Churchill Museum.

Seemingly (Table 2), the motivations for the choices, even in the case of the factors that occupy similar places, were different. ISTs are introduced because of their capacity to transmit and record multimedia information and are designed for group exploration. The available state-of-the art interfaces, as well as the budget, merely influence the specific final choices of each exhibit, independently of the level of technology and interactivity.

Given the many similarities between the two museums, how can the observations about use be explained? The empirical and bibliographical data collected during this research project seem to indicate that this might be due to the fact that, in general terms, each country has a different concept of what a museum is, shared both by designers and audiences. This influences the degree of interactivity and the use of technology in exhibitions. In the case of the United Kingdom, museums are increasingly perceived as 'edutainment' places (Hooper-Greenhill 1998) and the visit is considered to be an enjoyable participatory group experience, aimed at acquiring new learning skills. Hence, interaction was already present – through hands-on exhibits – before IST applications were introduced. ISTs are integrated, in the constant rethinking or renovation of museums, as specific museographic solutions; they are chosen according to their particular features and abilities, which are usually linked to their virtual and multimedia nature as well as to their capacity to record visitor inputs.

In the case of Catalonia, museums are more closely related or associated with a formal learning environment and the visit is understood (as demonstrated by the demographic profile of visitors, their behaviour, the scope of the ISTs and the group exploration solutions) as a way to individually acquire academic knowledge. Consequently, there is little space for collaborative interaction and the museological discourse is built mainly upon verbal one-way mediators. In this context, ISTs are seen as something external, the advent of which defines a new phase in museum design, coinciding with or even inducing a definitive shift to more 'constructivist' museological perspectives: high-tech exhibits are used as 'improved' versions of the traditional text-plus-image exhibit, introducing not a general (as implied by the curators' and visitors' answers) but a specific kind of interactivity based on the personalized exploration of more information in different formats. According

to the visitors, this has two advantages: first, the iconic component facilitates an immediate global comprehension and, second, interactivity enhances engagement.

However, how truly effective are the IST applications at the Museum-Monastery of Sant Cugat del Vallès, especially in comparison to other low-tech displays? As previously mentioned, high-tech exhibits were aimed at enhancing learning in two ways: by reinforcing other means (on the ground floor, where they are passive exhibits) and by adding enjoyment and motivation (on the first floor, where they are interactive). First we investigated whether the diversity of exhibits contributed to the reinforcement of learning or made it more difficult to follow the exhibition discourse. In spite of what we expected, visitors found it more difficult to follow the thread on the upper floor, highlighting as negative elements the excessive amount of information and diversity regarding the subject or presentation. Therefore, it is not a matter of the number of museographic units but of different subjects being presented in different ways. Unfortunately, it was not possible to verify if pure multimediality (a single subject presented using several different means, as on the ground floor) is always beneficial. Some studies (Ainsworth et al. 1996) seem to indicate the opposite; visitors did not look at the 3D screens, which attracted only those who were already familiar with technology rather than facilitated communication with general audiences. Moreover, when compared with the screens showing the making of a capital, the visitors preferred the latter because of the interesting subject matter.

With regard to the role of interactivity on the upper floor, the visitors mentioned explicitly, and observations demonstrated, that being able to actively explore the exhibit increased enjoyment and attention, exactly as the designers had intended. This relationship was only compromised by usability problems, in which previous experience with technology played an important role. Nevertheless, at the Churchill Museum the same also occurred with a complex mixed exhibit. This seems to answer one of the original research questions for this project: the dichotomy between high- and low-tech displays is more a matter of integrated museographic design than of technology. This was masked until recently by the fact that all IST applications in exhibitions followed the original imported computer-based paradigm.

Interactivity clearly enhanced engagement on the upper floor. However, did this contribute to learning? In comparison with the ground floor, where learning was almost exclusively associated with text, visitors considered the technological applications, and especially the first module, to also be suitable for acquiring knowledge. Taking into account visitor answers to other questions, the reason might be their database hypermedia format, which although close to the verbal mediators expected by the visitors in museums, may be an improvement in the sense that different pieces and kinds of information are virtually linked to build a complete discourse. Nevertheless, the number of non-responses in the recollection question was higher in comparison with that for the ground floor and the visitors mainly remembered information transmitted by traditional means. This is consistent with results obtained in previous evaluations (Pujol and Economou 2008) and seems to support the hypothesis that, although adding motivation, high-tech exhibits fail to accomplish, at least, the traditional notion of learning, consisting in the verbal transmission of factual knowledge.

The reasons might be several. First, the novelty of the tool (stated by the visitors to be a very important aspect) and its different functions and

interfaces distract people from concentrating on content. This would explain why visitors only remembered superficial aspects or failed to acquire the most basic details. The second reason as concluded by previous studies (Reid et al. 2003), is the presentation format. That means that although visitors do indeed learn something, they are not able to express it in traditional evaluation tests because learning occurred through visual means. However, the importance of the verbal content in the high-tech exhibits of this museum would seem to reduce the influence of this factor to the benefit of the distracting power of the interface. Moreover, the database format might also play a negative role by preventing the user from learning because, according to the constructivist concept of learning, there is no starting question and, unless they are experts, they may not have previous knowledge that would anchor the new information. This is why most multimedia applications at the Churchill Museum did not present a raw database but used a discovery learning strategy, whereby a relevant question was presented and the visitor was led to the answer through a succession of screens. As evidenced by the comparative observations at the Churchill Museum, not only was this more motivating, it also made the application accessible to non-experts. A final reason is methodological. In this and previous studies (Pujol and Economou 2009a) the fact that the visitors mentioned museographic units with more ease than content might point to a general problem inherent to the evaluation of learning in museums. Hence, due to the features of informal learning contexts, the visitors remember the media more than the message.

CONCLUSIONS

The research project from which the present article derives started from the premise that, in order to understand and develop suitable IST applications for museum exhibitions, a new comparative, more qualitative and less summative evaluative approach was needed. The systematic comparison of the results obtained from an analysis of two museums similar in their features, but belonging to different museological traditions in terms of how technology is introduced in exhibition design and later used by visitors, allowed us to advance in the empirical and methodological quest for the full integration of IST applications in exhibitions. Finally, it also provided a preliminary set of conclusions about the use of ISTs as a means of communication in Catalan museums and, consequently, guidelines to improve their design.

The Museum-Monastery of Sant Cugat del Vallès is characterized by a more academic or informational (García Blanco 1999) concept of the exhibition, aimed at active learning of pre-established factual knowledge. The exhibition discourse is thus based on verbal mediators to which an interactive multimedia layer is added via the external complements provided by IST applications. Nevertheless, (inter)activity is limited to the exploration of raw database content. In comparison, the Churchill Museum, considered an 'edutainment' place for families, aims at the enjoyable acquisition of different historical and biographic (re)interpretations. Here, group interaction is conceived from the outset, either in the shape of a hands-on or high-tech exhibit, depending on communicational needs. In this sense, ISTs usually take the shape of a challenge and are also used because of their unique capacity to allow visitors to build their own interpretations and 'modify' the exhibition by recording them.

This seems to be the trend in many Catalan museums – such as in diverse branches of the Archaeological Museum of Catalonia, the History Museum of Catalonia, the Museum of Lleida, the DHUB Museum of Textile and

Clothing and the Museum of Science and Technology of Catalonia – which have screens at some points in their galleries, in contrast with many museums in the United Kingdom – such as the diverse branches of the Imperial War Museum, the Manchester Art Gallery and the Science Museum of London – where IST applications seem to be more integrated from a social, spatial and conceptual point of view.

We can conclude that the ways in which ISTs are used in exhibitions may indeed be directly influenced by the perception the institution has about itself and also shared by audiences, because, in general terms, this depends on the museological tradition of the country. In the visitor-centred museums within the Anglo-Saxon tradition (Gómez Martínez 2006), ISTs are understood as a new kind of hands-on exhibit and different solutions are experimented with. In the object-centred museums within the French tradition (Gómez Martínez 2006), high-tech exhibits take the form of computer-based stations and are more or less immersive (due to the addition of structures), thereby allowing more or less synchronous exploration (due to the addition of bigger or more screens); they nevertheless have problems fulfilling both the more academic and the new constructivist goals intended by the designers. The reason is that, in this context, current IST applications present several drawbacks:

1. The novelty of the medium is indeed motivating but it distracts the user from concentrating on the content.
2. The lack of familiarity with the medium, as well as usability flaws, interferes with acquiring the content.
3. IST applications are better at conveying audio-visual information in a dynamic way.
4. Computer-based interfaces are designed for one-to-one linear interaction, not for collaborative exploration.
5. The pure database format is inappropriate for broad audiences (who lack cognitive anchors and starting questions) and also requires a time investment that is more appropriately made at home.

In conclusion, if Catalan museums want to mark a real shift towards the 'constructivist museum', they first need to reconsider interactivity and dissociate it from IST, as occurs in many UK museums. Interaction existed before the advent of ISTs and this is why technological applications used a 'language of problems' – proposing questions to be solved (Bradburne 2002) – and are now trying to adapt by modifying content and interface to offer a 'language of games' – necessarily involving action and several participants (Bradburne 2002). The latter makes exhibits more engaging, more easily integrated and better for learning. Technological hands-on, that is, mixed interfaces offering a discovery game, reduce the expenses derived from a fully technological interface (since many components are low-tech) and also use computers for what they do best: to overcome the limitations of the exhibition's physical reality and create new multimedia content dialogues when visitors engage in exploration of the display.

ACKNOWLEDGEMENTS

This research project was funded by the Catalan Government (2008PBR0005) and the British Academy (VF2008/49113). We would like to thank the staff of

the Churchill Museum and the Museum-Monastery of Sant Cugat del Vallès for their help during data collection.

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SUGGESTED CITATION

Pujol-Tost, L., Busan-Vilar, A. and González-Marcén, P. (2011), 'The use of IST applications in Catalan museums: A comparative evaluation carried out at the Museum-Monastery of Sant Cugat del Vallès', *Catalan Journal of Communication & Cultural Studies* 3: 1, pp. 21–44, doi: 10.1386/cjcs.3.1.21_1

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