

PAPER PROTOTYPES AND BEYOND

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Although approaches to user centered software development have existed for almost twenty years a rift still exists between theory and practice. In practice, many software projects are designed at the code level to the detriment of the endusers. Good Usability Engineering combines complex back-end functionalities with attractive, effective and efficient user interfaces. Successful interfaces minimize cognitive load and help users to achieve their goals. Goals can be defined in terms of intended outcomes which act as benchmarks for developing and testing functionality through prototypes. Paper-based prototyping bypasses the time and effort required to create a working, coded user interface. Instead, it relies on very simple tools like paper, scissors and stickers. However, to be a reliable guide, paper mock-ups need to model accurately the site's functionality and convey the right information.

This paper describes the challenges presented by a complex online information design project, an online research resource of over 45,000 records based on the catalogs of Exhibitions of the Royal Photographic Society 1870-1915. It describes how paper prototyping (used successfully previously) was used to address these challenges and reflects

on the problems that came close to derailing the project this time and their impact on the design and the design process. It concludes by considering a digital alternative to paper prototyping that offers similar ease of use and low cost, combined with the ability to quickly generate interactive mock-ups that overcome some of the limitations of paper prototypes.

INTRODUCTION

This paper is about usability engineering and rapid prototyping in Communication Design. Although approaches to user-centered software development have existed for about twenty years a rift still exists between theory and practice (Holzinger, 2005). Many software projects are designed at code level, to the detriment of end users. “Generally the last thing you want to do when beginning to design an interactive system is write code” (Buxton, 2007, 240). Good usability engineering combines complex back-office functionality with attractive, effective and efficient user interfaces. Successful interfaces clearly signal the affordances they offer (Norman, 2002, 87-104; Krippendorff, 2006, 111-114). Affordances are the perceived and actual properties of something that determine how it could possibly be used (Gibson, 1979, 127-135). Interfaces with clear explicit affordances minimize cognitive load and help users to achieve their goals (Krug, 2000, 11ff; Holzinger et al, 2008). Goals can be defined in terms of intended outcomes, and can be used as benchmarks or baselines (Brown, 2003) against which functionality of the design can be tested. If the intended outcomes of the design are clearly articulated, then the performance of the design can be tested to ascertain how well it supports those outcomes. In effect, all designs are tested after the sales launch. Sometimes they fail in use. An old but dramatic example was the Comet passenger jet aircraft. Launched in 1952 as the world’s first jet airliner, the aircraft was withdrawn from service in 1953 because of serious structural cracks caused by metal fatigue (Dempster, 1960). Four years later when the redesigned aircraft was re-launched, the Boeing 707 had reached the market and went on to dominate domestic passenger jet aircraft sales. Less well-known but more recent examples are the circular mouse for the original iMac and the Power Mac G4 Cube (Buxton, 2007, 44). These examples show that performance failures don’t have to be as dramatic as air crashes to matter. Norman (2002) describes a catalog of products including doorways, telephones, projectors, washing machines, refrigerators, radios, cookers, taps and hi-fi systems that frustrate their users. Also, designs don’t have to fail in use to be unsuccessful. Well-known examples from the history of design and advertising are the Ford Edsel (Bonsall, 1992) and Strand cigarettes (Hackley, 2003). Both failed dramatically in the marketplace because of lack of understanding of the consumer psyche. The affordances they offered were not what the buying public wanted. The famous “You’re never alone with a Strand” advertising slogan of Strand cigarettes was rejected by people who did not want others to think of them as lonely, inadequate and needing to seek company in a cigarette, even

though many smokers may have used a cigarette as a prop to boost their confidence in unfamiliar social situations.

Waiting to see how a design performs in the market is a high-risk strategy. By the time of the sales launch there has usually been considerable investment in design, production and promotion (Buxton, 2007, 75). A less risky approach is to test the design before significant investment has been made. Rapid prototyping is a well-established software engineering technique that attempts to address this issue by developing modules of code that can be tested early on in the design-development cycle (Leach, 1999). The advantage of rapid prototyping is that it enables real functionality to be tested objectively. It can help us to answer questions like “does the code work?” “Does it do what was expected or intended?” It can also be used to test user reactions to the design, i.e., “Does it do what users expect and want?” “Do they understand how to get data into and out of the model?” However code development, even rapid prototyping, can only be done when design ideas are relatively advanced, i.e., when what the design is intended to do is already agreed and the question is how best to achieve it. Thus while rapid prototyping is good at addressing “Comet”-like failures where the goal is agreed (a reliable, safe passenger jet aircraft), it is less helpful for “Strand”-like situations when what is required is not fully understood.

User-centered design helps us to deal with the latter kind of situation because it focuses on the needs, expectations and capabilities of the user and uses these to guide the design specification and solution (Katz-Haas, 1998; Vergo et al, 2001). The importance of user-centered design is amply demonstrated in the context of Web site design where people cannot find the information they seek about sixty percent of the time (User Interface Engineering, 2001) and badly designed sites lose repeat visits from forty percent of the users (Manning et al., 1998). This can result in wasted time, reduced productivity, increased frustration on the part of users and loss of repeat visits and revenue, increased training and increased support costs for site owners. Sites which have a clear purpose, are easy to navigate and search and which provide tools that help users to achieve their goals efficiently are more likely to encourage and facilitate access and use than poorly designed sites.

Paper prototypes are a valuable tool that can be used much earlier than rapid prototyping in the design-build-test cycle to explore ideas with users with very little financial outlay (Rettig, 1994; Henry and Martinson, 2003). Figure 1 illustrates how paper prototypes, when used in an iterative process of design and evaluation, can be used at the very start of the project, leading on to more advanced coded versions later. At its most basic all that are required for paper prototypes is some paper, pens, scissors, glue and some sample users willing to try the design and give their feedback. Design concepts can be quickly mocked up, tested, modified on the fly and retested. Since production costs and development times are so small, many alternative designs can be tested simultaneously and because the means of production (paper, pens, etc.) are so simple to use, users themselves can join in to suggest modifications and new ideas.

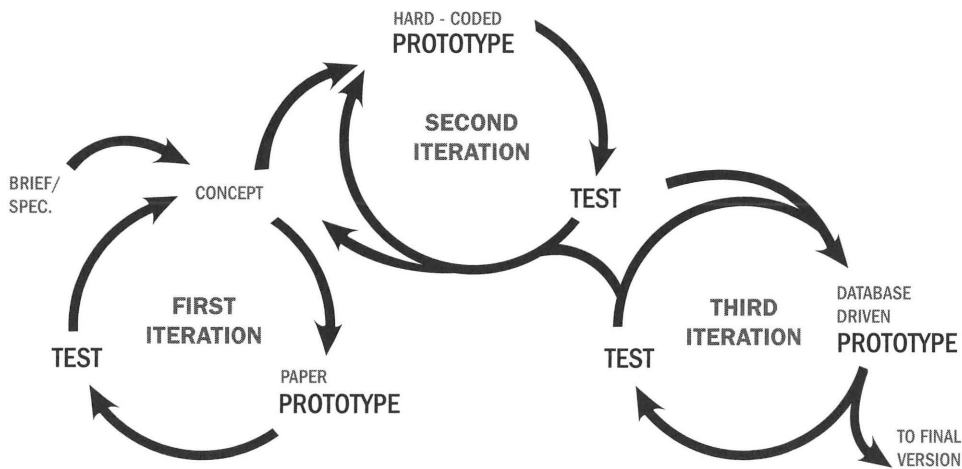


Figure 1
The role of paper prototypes in iterative design and test cycles

The emphasis in each test is on “usability.” The International Organisation of Standardisation (ISO) (ISO 9241-11, 1994) identifies three key factors associated with the usability of an interface: effectiveness, or the extent to which the intended goals of use of the overall system are achieved; efficiency, or the effort required to achieve the intended goals; and satisfaction, or the extent to which the user finds the overall system acceptable (John and Marks, 1997). Nielsen (1993) offers a more nuanced list as follows:

- Learnability: ease of learning to use the system so that the user can get started rapidly.
- Efficiency: once the system has been learned, a high level of productivity should be possible.
- Memorability: casual users should be able to return to the system after some period of not having used it without having to relearn everything.
- Errors: it should be easy to recover from errors. Also catastrophic errors should never occur.
- Satisfaction: the system should be satisfying to use.

Buxton (2007, 139ff) draws a distinction between prototype testing in the sense of evaluating ideas and what he calls “sketching the user experience” which is about involving users in the process of originating and developing ideas. This is a useful conceptual difference, even though in practice the two may be closely intertwined such that evaluating the designers’ concepts, modifying those in response to user feedback and eliciting user ideas alternate rapidly within even a single user trial session. Buxton also observes that sketching the user experience may involve more than just simple paper-based prototypes. He describes experiments where the proposed design has been mocked up using cameras, televisions, tablet PCs, string, cardboard and people to simulate certain functions. Such “sketches” share the low-cost and flexibility advantages of paper prototypes.

So, to summarize, testing concepts early and often to elicit user feedback and ideas is a sound design strategy that minimizes risk of failure in the finished design. Rapid prototyping, the development of working code, is a step towards this approach, but it tends to focus on the function of the code rather than the requirements of the user. Paper prototypes are a vehicle for deploying early, rapid and frequent user trials and can be used to elicit user ideas as well as test designers’ concepts. But what are the limitations of using paper prototypes? Do they model design concepts adequately? In what circumstances might it be necessary to supplement paper-based prototypes with more

advanced, computer-based code and are there any alternatives to the relatively high cost solution of bespoke rapid prototyping? The rest of this paper examines these questions in the context of a recent communication design project that employed paper-based prototyping to test ideas and elicit user suggestions. The design group had previously used paper-based prototyping successfully, but on this occasion found that it produced misleading results. Design decisions based on paper prototype testing feedback were found to be sub-optimal when more advanced coded prototypes were tested. This paper discusses possible reasons for this failure and proposes an alternative to both paper prototypes and conventional rapid prototyping.

EXHIBITIONS OF THE ROYAL PHOTOGRAPHIC SOCIETY

Exhibitions of the Royal Photographic Society 1870-1915 (ERPS) is an online database of photographic exhibition catalogs (<http://erps.dmu.ac.uk>). ERPS is the latest in a series of photographic history primary resources made available online by Knowledge Media Design at De Montfort University, UK (see http://kmd.dmu.ac.uk/kmd_photohistory_page/ for a full listing). Since we had used paper prototypes to help produce successful designs in the past it seemed reasonable to use the same approach in the design of ERPS; making extensive use of paper prototypes to develop and test ideas.

Exhibition catalogs are a valuable source of information in a field that is hampered by the limited availability of primary resources. Early photographic artifacts were often unique (e.g., Daguerrotypes) and made from ephemeral materials, so survival was precarious. While many major figures are well documented thanks to their prominence at the time (e.g., Hill and Adamson) and the survival of archives (e.g., The correspondence of William Henry Fox Talbot), much less is known about large numbers of other participants. Although various photographic societies flourished in Britain and held their own annual exhibitions, catalogs from most societies have not survived in any significant number. In contrast, the surviving catalogs, from what is now the Royal Photographic Society's annual exhibitions from 1870 onwards, contain detailed entries on photographers, photographs and commercial companies. Collectively, these exhibition records offer a unique insight into the evolution of aesthetic trends, the application of photographic processes and the response of a burgeoning group of photographic manufacturers, as well as the fortunes of the Society itself. The Society's exhibitions attracted a wide constituency of photographers, from Britain, Europe and America. Many individuals

launched their photographic career by exhibiting at the Royal Photographic Society and a significant number went on to become leading practitioners of their day. The exhibition catalogs were published in full in the journal of the Society *The Photographic Journal*, copies of which are available in many research and public libraries. However, even major UK libraries such as the National Science Museum and the British Library do not hold complete runs and loan policies are restrictive, making it difficult for most researchers to access and compare data such as exhibition sections, processes and exhibitors across different years. Our intention therefore was to provide online access to and facilitate the use of these catalogs by researchers, primarily those working in the field of photographic history, but also with a view to wider research audiences concerned with technological and scientific developments, art, culture and social trends. Our objectives were to build an information resource that combined browse-able rich visual information (page scans and photographic exhibits) with highly structured searchable data (exhibition catalog entries). The focus of our work was from 1870 when the first catalog was published to 1915, after which the annual exhibitions became smaller in scale and national in character as the First World War began to affect the progress of photographic culture throughout Britain and Europe.

The catalogs themselves contain three broad types of information: details of the exhibitions (e.g., dates, venue, title, sections, judges); the exhibits (e.g., exhibit number, title, exhibitor name, photographic process, award status, price and sources; and exhibitors (e.g., name, title, address, RPS membership, qualifications and affiliations). However, the exhibitions were discrete annual events. While there was some continuity from year to year, inevitably over the forty-six year period in question there were changes in exhibition content, structure and presentation, which are reflected in the catalogs. As time went by, the exhibitions became more complicated, trade entered the picture, the photographic press and industry became more complex, there were more products to choose from, more participants and ideas and technologies changed. The catalogs themselves also evolved. Thus in 1876 the first advertisement appeared in the catalog, in 1880 for the first time the judges were listed and by 1895 pictures began to appear to illustrate some of the exhibits. In 1870 the catalog ran to 8 pages only, but this rose to over 100 pages in the early 1900s. Figure 2 illustrates some of the different types of data and information presentation styles used.

CATALOGUE.

PHOTOGRAPHS.

N.B.—Where a price is mentioned, the exhibit is for sale, unless already marked sold. The price in all cases is for the exhibit itself, not for a duplicate, and includes the frame.

1.	Greek Study. (<i>Carbon</i>) ...	...	3	3	0	PERCY S. LANKESTER.
2.	Simplicity. (<i>Photogravure</i>) ...	...	0	10	6	WALTER L. COLLS.
3.	Morning on Tyse Fjord, Norway. (<i>Photogravure</i>) ...	...	0	15	0	HERBERT DENISON.
4.	"Emotions," Produced for Sir J. Crichton Brown, F.R.S., from an untrained model. (<i>Carbon</i>) ...	...	—	—	—	ANDREW PRINGLE.
5.	Beaulieu. (<i>Platinum</i>) ...	...	—	—	—	GEO. SCAMELL.
6.	The Haven under the Hill. (<i>Platinum</i>) ...	...	—	—	—	W. D. BOOKER.
7.	A marée basse. (<i>Photogravure</i>) ...	...	—	—	—	A. CHARREL.
8.	King Harry's Ferry, Cornwall. (<i>Photogravure</i>) ...	...	0	15	0	HERBERT DENISON.
9.	In the Winter of Life. (<i>Carbon</i>) ...	...	1	10	0	HALL EDWARDS.
10.	Janet ...	...	—	—	—	RALPH W. ROBINSON.
11.	As the Shades of Evening Descend. (<i>Carbon</i>) ...	...	1	1	0	W. DAWES.
12.	Along the Road. (<i>Platinum</i>) ...	...	—	—	—	OTTO NIEPORT.
13.	"Eileen Asthore," Light of my heart. (<i>Silver</i>) ...	...	3	15	0	OSCAR BLYFIELD.
14.	Une Bayadere. (<i>Platinum</i>) ...	...	—	—	—	J. S. BERGHEIM.
15.	Photogravure ...	...	—	—	—	HAROLD BAKER.
16.	A Foreshore Study. (<i>Cold Bath Platinum, Untoned</i>) ...	...	1	5	0	JOHN A. HODGES.
17.	A Country Lane: Denmark. (<i>Photogravure</i>) ...	...	—	—	—	HORACE WILMER.
18.	Portrait study in sepia, from negative by B. Collenette. (<i>Carbon</i>) ...	...	—	—	—	THE AUTOTYPE COMPANY.
19.	Cordelia. (<i>Platinum, not retouched</i>) ...	...	—	—	—	J. S. BERGHEIM.
20.	Coquette. (<i>Ditto ditto</i>) ...	...	—	—	—	DITTO.
21.	Whitby Harbour. (<i>Ditto</i>) ...	...	2	2	0	REV. F. C. LAMBERT.
22.	Horse Dyke, Norfolk. (<i>Photogravure</i>) ...	...	0	12	6	HERBERT DENISON.
23.	Evening on the North Sea. (<i>Ditto</i>) ...	...	—	—	—	HORACE WILMER.
24.	The Old Smithy. (<i>Gelatino-chloride</i>) ...	...	—	—	—	TOM BRIGHT.
25.	Clifford's Chantry, Bolton Abbey. (<i>Photogravure</i>) ...	...	0	12	6	HERBERT DENISON.
26.	A Sussex Team. (<i>Gelatino-chloride</i>) ...	...	—	—	—	TOM BRIGHT.
27.	Example of Carbon Process without Transfer ...	...	—	—	—	VALENTINE BLANCHARD.
28.	Sorrow. (<i>Platinum, not retouched</i>) ...	...	—	—	—	J. S. BERGHEIM.
29.	After Rain. (<i>Platinum</i>) ...	...	1	5	0	JOHN A. HODGES.
30.	Clifford's Chantry, Bolton Abbey. (<i>Photogravure</i>) ...	...	—	—	—	HORACE WILMER.
31.	The End of the Day. (<i>Platinum</i>) ...	...	—	—	—	FREDERICK A. CREW.
32.	Across the Moor. (<i>Gelatino-chloride</i>) ...	...	—	—	—	DITTO.
33.	Helluo Librorum. (<i>Carbon</i>) ...	...	1	10	0	HALL EDWARDS.
34.	Joyce ...	...	—	—	—	RALPH W. ROBINSON.
35.	Moorings off the Tower. (<i>Platinum</i>) ...	...	0	12	6	E. EVELYN BARRON.



No. 23.

EVENING ON THE NORTH SEA.—HORACE WILMER.

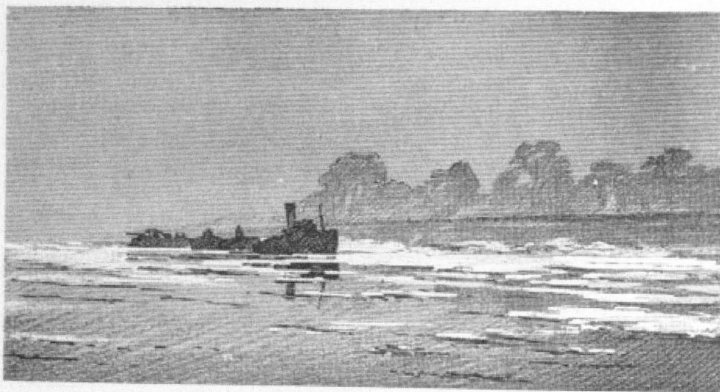
11 × 6.



No. 69.

PARTING DAY.—RODERICK J. FRY.

14 × 6.



No. 79.

THE BREAK OF THE FROST.—W. MARTIN, JUN.

11 × 6

Different, named sections within the exhibition were only introduced for the first time in 1877 and their names changed frequently thereafter. In the three years 1905 to 1907 the number of sections in the exhibition stabilized at eight, yet as the following extracts show, the names and subject matter of the sections evolved quite noticeably even in this short space of time.

View exhibit records by section: 1905

- | | |
|---|--|
| <ul style="list-style-type: none">• Lantern Lectures• Pictorial• Scientific and Technical Photography and its Application to Processes of Reproduction• Lantern Slides in the Scientific and Technical Section | <ul style="list-style-type: none">• Loan Collection of British Technical and Scientific Photographs from the St. Louis International Exhibition of 1904• General Professional |
|---|--|

View exhibit records by section: 1906

- | | |
|--|--|
| <ul style="list-style-type: none">• Lantern Lectures• Pictorial• Scientific and Technical Photography and its Application to Processes of Reproduction• Scientific and Technical Photography and its Application to Processes of Reproduction. By Invitation from the Council | <ul style="list-style-type: none">• Lantern Slides in the Scientific and Technical Section• Transparencies in the Scientific and Technical Section. By Invitation from the Council• General Professional Photographs• Photographic Apparatus and Material |
|--|--|

View exhibit records by section: 1907

- | | |
|--|--|
| <ul style="list-style-type: none">• Lantern Lectures• Pictorial• Scientific and Technical Photography and its Application to Processes of Reproduction• Scientific and Technical Photography and its Application to Process of Reproduction• Scientific and Technical Photographs, &c. | <ul style="list-style-type: none">• The Autochrome. Collected and Arranged by R. Child Bayley and Thos. K. Grant, By Invitation from the Council.• General Professional Photographs• Photographic Apparatus and Material |
|--|--|

The way in which an exhibit might be classified thus varies considerably over time. A “transparency” might at different times have been exhibited under any of the following section headings:

1. Autochromes,
2. Autochromes and Other Colour Transparencies,
3. II. Colour Photography. Autochromes and Other Colour Transparencies.,
4. II. Colour Transparencies,
5. III. Colour Photography, Including Autochromes and Other Direct Screen-Colour Transparencies,
6. II. General Photography, including Lantern Slides and Stereographs, Lantern Lectures,
7. II. Scientific, Natural History, Colour, and General Photographs - Lantern Slides
8. II. Scientific, Natural History, Colour, and General Photographs - Stereoscopic Slides
9. II. Scientific, Natural History, Colour, and General Photographs -Transparencies,
10. Lantern Slides in the Scientific and Technical Section,
11. Stereographs and Transparencies in Sections II., III. and V.,
12. Stereoscopic Photographs,
13. Lantern Slides,
14. Lantern Slides and Transparencies,
15. Stereoscopic and Lantern Transparencies,
16. Stereoscopic and Lantern Transparencies and Prints,
17. Stereoscopic Slides, Stereoscopic Transparencies,
18. Transparencies,
19. Transparencies in Sections II. and III.
Colour and Monochrome,
20. Transparencies in Sections II. and III.
Stereographic Transparencies,
21. Transparencies in the Scientific and Technical Section.
By Invitation from the Council,
22. III. Scientific and Technical Exhibits, Natural History,
Colour Prints, Lantern and Stereoscopic Slides.

It seems likely that researchers interested in one type of transparency such as 'Autochromes,' may be interested in some other types, such as 'Color Transparencies' and even possibly 'Lantern Slides.' So some grouping of categories might be useful for researchers because it would reduce the length and complexity of the searches required to identify all the items relevant to a query concerning transparencies. On the other hand, in the interests of preserving the accuracy of the original data, all these different sections should be listed individually, even in items like drop down search menus, even though this could make the menus impossibly long and confusing for most users.

Across the period in question the kind of information associated with exhibits changed. As previously noted, prior to 1877 the exhibition was not divided into different sections so not all exhibit records contain a section entry. Not all exhibits had multiple exhibitors, or sub components, or were part of a larger group, not all included information about prices and so on. So, although an exhibit record could potentially include up to fourteen different items of information, not all fields are required for every exhibit.

Furthermore different kinds of catalog entries were listed in different ways. For example "Lantern Lectures" and "Stall holders" were not given exhibit numbers for obvious reasons and fields such as "process" and "prices" did not apply to the latter. To show all possible fields for every exhibit would result in long tables of largely empty cells, making them difficult to read and tedious to page through. Omission of empty cells on the other hand hides from the user the hint that some records contain more or different information than others.

Our intention was to convert the catalogs to a digital database to facilitate searches and collations that would be tedious and time consuming if they had to be done manually, working from the original paper catalogs. For instance, it is a very simple matter to list all the records for a particular exhibitor in a single table so that their complete pattern of activity across the years can be seen. The difficulty lies in knowing for sure that exhibitors with similar names in different years are indeed the same person. Table 1 shows a listing of all the exhibitor records for the surname "Abney."

Records for Abney

Year	Name	Title	Address
1905	Abney, W. de W.	Sir	Rathmore Lodge, Bolton Gardens South, S.W.
1906	Abney, W. de W.	Sir	[Not Listed]
1870	Abney, W. de W.	Lieut.	Chatham
1871	Abney, W. de W.	Lieut.	Chatham
1872	Abney, W. de W.	Lieut.	Chatham
1873	Abney, W. de W.	Captain	St. Margaret's, Rochester
1875	Abney	Capt.	St. Margaret's, Rochester
1876	Abney, W. de W.	Capt.	Rochester
1878	Abney, W. de W.		3, St. Alban's Road, Kensington
1879	Abney		3, St. Alban's Road, Kensington
1879	Abney, C. E.		[Not Listed]
1880	Abney, C. E.		Derby
1881	Abney	Captain	3, St. Alban's Road, Kensington
1881	Abney, Charles E.		Derby
1882	Abney, W. de W.	Captain	3, St. Alban's Road, Kensington
1883	Abney, W. de W.	Captain	Willeslie House, Wetherby Road, South Kensington, S.W.
1883	Abney, C. E.		St James Street, Derby
1884	Abney, C. E.		6, St James Street, Derby
1884	Abney	Captain	Willeslie House, Wetherby Road, South Kensington, S.W.
1887	Abney, W. de W.	Captain	
1888	Abney, W. de W.	Captain	Willeslie House, Wetherby Place, South Kensington, S.W.
1889	Abney	Captain	Willeslie House, Wetherby Road, S.W.
1892	Abney	Capt.	[Not Listed]
1893	Abney, W. de W.	Capt.	Willeslie House, Wetherby Place, South Kensington, S.W.

Table 1
Entries for exhibitor “Abney”

From this list it is clear to a human observer that “Abney, C.E.” is not the same person as “Abney W. de W.” but that the various W. de W. Abneys and Captain Abney (1875 and 1889) are the same person. So should a search for “Capt. Abney” return results for “Captain Abney,” “Lieut. Abney” and “Sir W. de W. Abney” as well? Or all entries for “Abney” just to be on the safe side? While it is easy enough to associate variations on a name in the database so that a search for that name returns all the associated hits, the difficulty lies in deciding which names to associate with each other. While it is highly probable that Captain Abney (1892) is the same person as the other W.de W. Abneys, it is not certain from the information available here. In other cases, for example where a woman changed her name and address on marriage, the degree of interpretation required is even greater. The problem here is how to deal with ambiguity and uncertainty and it is compounded by errors as well as variations in the data. For example, exhibitor “Marjory T. Hardecastle” appears with alternative spellings of “Marjory” and “Margery.” While a search for “Hardecastle” would return both variations, an exact word search for one of them would not include the other. It would make searching for specific items easier if obvious errors like this were corrected. However errors are not always so easy to spot and there may be differences of opinion as to which is the correct version. So error correction raises the possibility of introducing more substantive errors of fact and poses a dilemma as to how far should one interpret the data in order to improve usability?

The communication design challenge we faced was to find a way of presenting such heterogeneous and ambiguous information in a consistent and usable way, that communicated the richness of the data available without overwhelming the user with a mass of information, while simultaneously representing that information faithfully and allowing users to see connections and patterns among small details.

APPROACH

While the database tables were determined to a large extent by the catalog data itself, the data views and the interface design issues were tackled using a user-centered design approach to ensure they were as fit for purpose as possible for the primary and secondary target audiences. This entailed gathering feedback responses from sample users to mock-ups of the site that exhibited increasing complexity and verisimilitude as the project advanced. According to Nielsen (1993), prototypes should vary according to the stage of the process and the purpose of the trial. Usually the choice is between three types:

“vertical” which offer in-depth functionality of a few selected features, “horizontal” which offer full interface features but no underlying functionality and “scenario” which offer functionality for specific pathways or task scenarios. In this project we began with paper-based “horizontal” prototypes and proceeded via paper and then screen-based “scenario” types to a fully functioning screen based system connected to a prototype database. Paper-based mock-ups were used in the earlier stages because they are quick and cheap to produce, can be modified easily and make users feel more relaxed about offering criticisms (Rettig, 1994).

The user trials were planned as four rounds with relatively small numbers (three to six subjects per trial), selecting a fresh sample each time to ensure that results were not cross-contaminated by previous exposure to the design. Sample sizes of three to five users are sufficient to obtain valid results in this kind of test (Krug, 2000; Nielsen, 1994), even though larger samples are usually required for scientific studies (Bevan et al., 2003). The first iteration entailed showing users simple hand drawn pages asking them what they thought the site was about, what it did and how they might use it to find certain types of information on the site (figure 3).

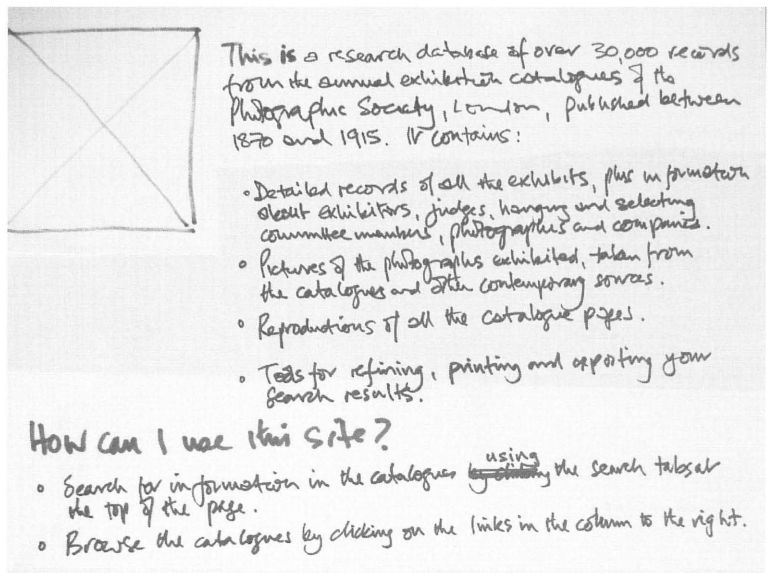


Figure 3
Early concept mock-up used to test intelligibility of the site

Subsequent trials were more focused and objective, requiring users to actually perform certain tasks in response to a series of questions, still using paper prototypes. Table 2 shows some specimen questions used in the trials and Figure 4 shows a specimen page used to simulate an information search task.

Table 2 Some of the search scenarios used in the user trials

- 1
- You are researching Alvin Langdon Coburn and want to use the ERPS site to find any references to his work and his involvement with the RPS.
- 2a
- You now want to start a new search looking for all individuals who were associated with both the Royal Society and the RPS between 1870 and 1900.
- 2b
- From these results you now want to find anyone who took photographs in South Hertfordshire at the turn of the century, so you need to find exhibitors based in Watford between 1890 and 1900.

Photographic Exhibitions in Britain 1870-1915

Records from the Photographic Society, London

HOMEGLOSSARYCONTACTCREDITS

SearchExpanded Search

for: word or phrase in all fields

AND OR NOT

in

AND OR NOT

in

Gold

List exhibitions

List exhibitors

List processes

List prices

Figure 4
A simulated search page

To answer these queries requires searching for particular items across different years and in different categories. Coburn was both an exhibitor and a judge. In some cases his work was shown by other exhibitors. For example a photograph shown in the 1914 exhibition by David Octavius Hill was printed from a paper negative by Coburn. So Coburn is listed under several categories.

Since the trials were task based, screen mock-ups had to include features such as drop down menus and search result pages (*figures 5 and 6 show examples*). It should be noted that in the case of search results the experimenters did not laboriously represent the possible results to every search query tested. Instead they wrote out just a few specimen hits for each query, to show the users what kinds of results they would get from such queries.

After two rounds of paper based trials the design moved on to simple hard coded “wireframes” that mocked-up the functionality with greater precision than the paper sketches and then in a fourth round to trials involving real (albeit incomplete) data drawn from a prototype database (*see figure 7*). In these rounds the emphasis was still on functional layout and navigation rather than visual appearance. The wireframes represented the design using simple blocks of text and was monochrome. The final visual treatment was added only after the designers were satisfied that the layout worked satisfactorily.

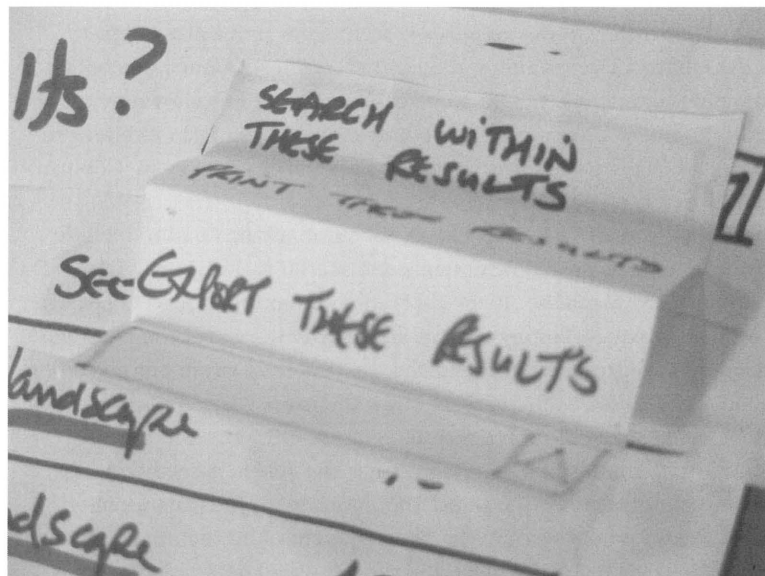


Figure 5
Drop down menu

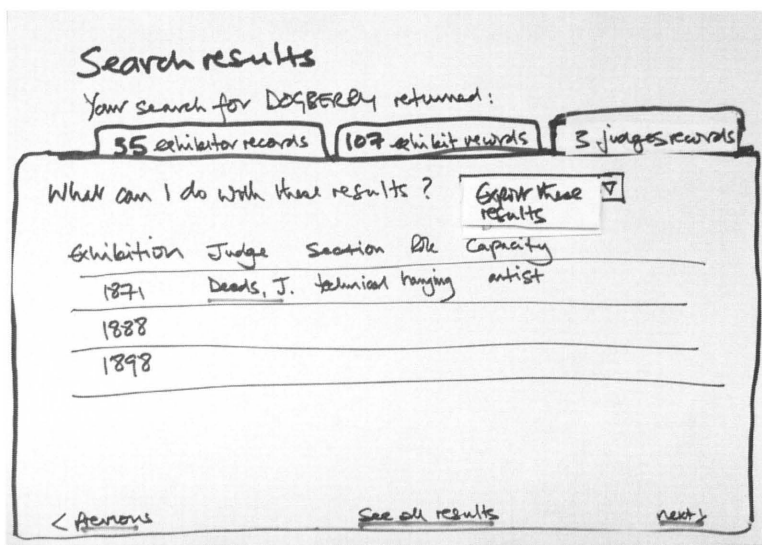


Figure 6
Example search results

RESULTS

The results of the first round of trials indicated that subjects easily understood what the site was about and what it could be used for, but there was some confusion about how the site worked, in particular they were confused by the Boolean search options offered. Most said they would either just search by browsing or, enter one or two words in the simple search box and then click on “go.” This is consistent with findings elsewhere (Brown et al., 2006) that Arts and Humanities researchers generally employ relatively unsophisticated digital resource search strategies (single or two word phrase searches in popular search engines are common) and generally they are largely unaware of the possibilities for data analysis and multimedia data presentation that digitization offers.

A major change resulting from this was the introduction of an additional, form-based, “guided” search that was intended to indicate to users the full range of fields that could be searched including lists with drop down menus of all exhibitor titles, RPS membership status, qualifications and affiliations; judges roles, capacities and exhibition sections; exhibit types, processes, prices, medal status, sources and exhibition sections, as well as drop downs for exhibition dates and free text entry boxes for exhibitor names, addresses, etc.

In the second and third round of trials most subjects preferred to use this guided search rather than the Boolean version as it provided more information on what kinds of data were available, but they were so overwhelmed by the complexity of the interface that they did not notice many of the information categories on offer and found it difficult to select the most appropriate ones. Many resorted to selecting the “search all fields” option to be on the safe side and explained that if they were using the real database they would expect to be able to visually scan the results to pick out the relevant hits for themselves. They also said that they preferred to see their search results presented as a single scrollable list rather than as “Google style” pages with a “next” button.

In response to these findings it was decided to simplify the interface by summarizing the information types. For example, the drop down menu of exhibition sections was reduced to the summary list shown in figure 7.

Exhibits

Exhibit type:

Title:

Section:

Process:
General Photography
General Professional Photography
Original
Colour Photography
Pictorial Photography
Scientific and Technical Photography
Some ex
Lantern Lectures
Stereographs
There are
Transparencies
Invitation Collections
In most c
Loan Collections
Occasion
RPS Permanent Collection
Search
Photographic Apparatus and Materials
Books

Many of the catalogue entries include descriptions of individual exhibits.

To do a free text search of these descriptions type your search terms in this box.

Word or phrase:

From: To:

Figure 7
Simplified drop down menu for exhibition sections linked to a prototype database

The fourth round of trials was significant in that it was the first time that the prototype was linked to a working database. A consequence of this was that searches returned complete listings of actual results rather than just representative examples mocked up by hand. Disappointingly, the trial results revealed that although subjects were able to use the search interface satisfactorily, they were confused by the results pages, because searches were returning more information than they expected. In some cases the results included information they had not realized they had requested (due to poor framing of the search query) and there were so many hits in some cases that it was not easy to scroll through them and visually select the relevant ones. It seems that the transition from scenario-based paper mock-ups to prototypes connected to a trial database turned out to be more significant than anticipated. The simpler paper-based and on-screen wireframe mock-ups did not give subjects an adequate impression of the volume and complexity of information available and this compromised some of their responses to the design, leading them to believe that they would be able to search effectively by asking for hits in all fields which they could then simply scroll through to select the relevant results. As a consequence, design decisions taken after the second and third trials concerning which search interface was most effective and whether to employ scrolling as opposed to paged results were contradicted by responses in the fourth trial.

Prototypes and sketch designs are types of models. That is to say they represent certain, relevant, features of the object in question and ignore or deliberately distort other features for the purposes of simplification and clarification. “As a general rule, models should be kept as simple as possible” (Jenkins, 1972, 94). A familiar example is Harry Beck’s iconic London Underground map that aligns the sprawling tunnels with a geometric grid and manipulates the positions of stations on the grid to convey a clearer picture of the network (Garland, 1994). The paper prototypes developed for ERPS were deliberate simplifications. For example, they were not given a visual treatment expressly because it was believed that this would distract users from their underlying functionality and result in unhelpful comments about color schemes, button shapes, etc. at the expense of valuable insights into the way the navigation was perceived. While this approach served well in previous projects, in retrospect it seems to have failed in ERPS because crucial features were oversimplified, distorting users’ perception of how they could use the site. If users had understood properly the complexity and richness of the data and the sheer volume of information in the database, it seems likely that they would have not reported a preference for simple search strategies such as “search all fields” and they would not have relied on scrolling through a set of results to pick out the relevant hits themselves. The paper prototypes used in rounds 1 and 2 and the wireframes used in round 3 relied on the researchers to adequately represent these characteristics, but because of the laborious nature of the task: identifying and writing out in some cases hundreds of search results, we unwittingly chose to oversimplify the task by writing out just a few sample results for each query. As a result, earlier design decisions had to be revised and a further round of trials conducted to ensure that the design was back on track to meet the needs of its intended users.

Some of the user feedback received since the launch of the final version (<http://erps.dmu.ac.uk>) indicates the extent to which these difficulties were finally resolved:

- “I found [*Exhibitions of the Royal Photographic Society 1870-1915*] easy to navigate, fast and efficient, what I found less easy was the multiple forms under which some names appeared but I got used to it.”
- “The alphabetical drop-down listing of exhibitors’ names is good, simple and goes some way towards getting around the fact that in many cases there [are] several permutations of names for the same person.”

- “Ability to refine the search within results was very useful and worked well.”
- “A fantastic, comprehensive rendering of all the information on RPS exhibitions which is contained in the RPS journals, with the huge advantage of being searchable and making links across journals. The search functions were good—I liked the combination of the ability to browse on several different fields with the more general search. It’s possible to approach the database in a [sic] many different ways, depending on whether you are researching a specific photographer, exhibition etc.”

While these results are reassuring they do not detract from the fact that the project encountered significant difficulties due to the way paper prototypes were implemented. So what can we learn from this experience? It would be easy to dismiss the application of paper prototypes in this case as incompetent, but that would not help us to avoid making similar mistakes in future. Paper prototypes were used in this instance because we wished to involve users in the design decisions. A prototype interface linked to a test database could have been set up earlier but we wanted to keep the informality and fluidity of paper prototypes until the design stabilized, “sketching the user experiences” in Buxton’s terms, while working prototypes were reserved for testing, i.e., validating the designs that emerged from the paper “sketches.” So the question is, is there a compromise between flexible, low cost, quick to produce and easy to modify paper prototypes and the relatively more expensive and inaccessible (by the user) rapid prototype?

One possible solution may be wikis. Wikis are “A series of web pages which users can add to or edit via any internet browser.” (JISC, 2009, 53). They do not require programming or even html scripting knowledge, but can be used by anyone with basic word processing skills. Their visual treatment or “skin” is very basic (although modifiable via style sheets). They thus have many of the characteristics of paper prototypes:

- Low cost: wiki server applications such as MediaWiki are freely downloadable and free wiki hosting solutions such as PBwiki are widely available.
- Easy to use: only word processing skills required. A small repertoire of formatting buttons facilitates insertion of hyperlinks, headings, pictures, tables, etc.
- Flexible: can produce html pages quickly that can be easily modified on the fly.
- Basic appearance: visual appearance is clearly not a polished Web page.

However wikis have a number of advantages over paper prototypes:

- Tracking: who made what changes and when is automatically recorded and easily checked.
- Roll back: earlier versions are automatically saved and can be easily restored.
- Neutrality: the visual appearance of basic wiki skins is even more bland than hand drawn pages. This is useful when one is trying to get users to see past the visual treatment and concentrate on functionality.
- Interaction: wikis allow embedding of a variety of interactive features such as hyperlinks to other wiki pages or to external Web sites, navigation bars, picture thumbnails, alt-tags, etc. that can be used to model Website functions much more convincingly than paper prototypes can.

This last feature is particularly useful if, as in the case of ERPS, one wishes to link the prototype to a database via a search engine. The search function can be presented on the wiki page as a hyperlink that takes the user to a data query screen belonging to the database, outside the wiki. While this is not elegant it has the merit of modelling the behavior of the proposed design much more accurately than a paper prototype allows but more easily and flexibly than conventional rapid prototyping allows. To test this idea we have recently been using a wiki to simulate a proposed Website for encouraging appreciation of electro-acoustic music, as part of an extension to a previous project (Landy, 2007). Figure 8 shows a test screen developed in PBwiki Media Wiki. While trials have yet to be conducted using these screens, learning how to use PBwiki *Media Wiki* was very easy for the designer (a PhD student without a computing background).

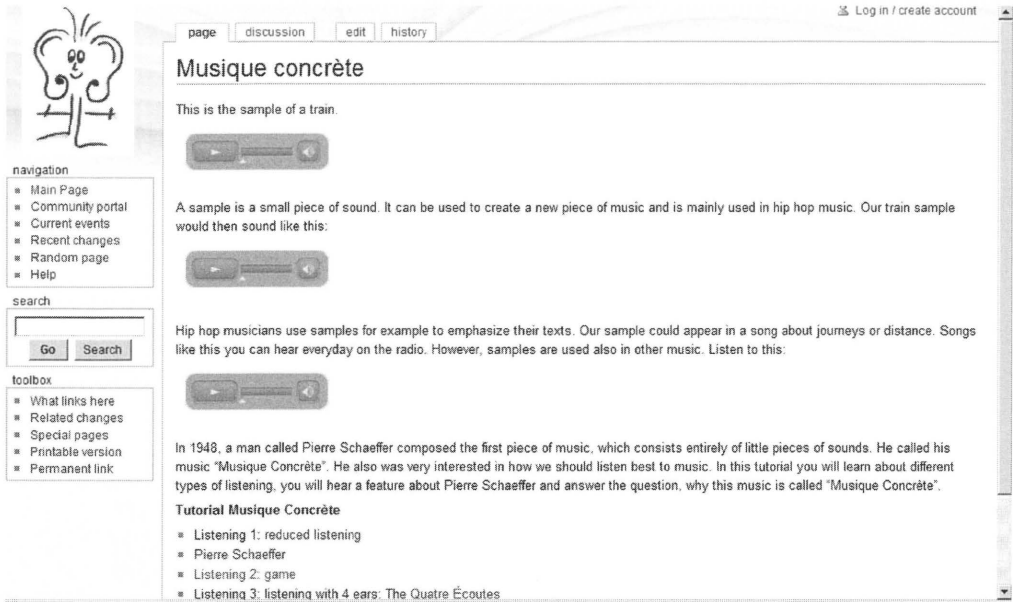


Figure 8
Wiki test screens showing embedded sound files

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

This paper has argued that users frequently cannot find the information they seek on websites generally and even researchers are reluctant to invest time in order to better understand and use resources more effectively. The result of badly designed sites is lost repeat visits, wasted time, reduced productivity, increased frustration and loss of repeat visits and revenue, increased training and increased support costs. One way of overcoming such problems is to develop designs that maximize the usability of the resources by promoting their affordances and by making it easier for users to achieve their goals. Historical, event-based, data such as exhibition catalogs present particular problems because the relationships between entities across different events are relatively weak and the number and type of data categories are likely to change considerably. This creates complexity, ambiguity and uncertainty that can be dispelled to some extent by data interpretation and simplification. However, doing so can result in oversimplification of the information and confusion on the part of the user. Managing the relationship between usability, functionality and data integrity is not a formulaic process, because different resources are targeted at different user groups that have different needs,

expectations and abilities. Resources should, therefore, be tailored to the requirements of their target users. This study has reported how paper prototypes were used as part of a user-centered design approach to identify user needs and preferences in relation to these issues and to elicit design ideas from sample users. However the transition from scenario-based paper mock-ups to prototypes connected to a trial database turned out to be more of a step change than anticipated. Critical characteristics of the proposed design were not adequately modelled in the paper prototype. While this shortcoming could have been overcome by using rapid prototypes earlier in the design process, rapid prototypes have a number of characteristics that make them less suitable for modelling designs where user needs are still unclear and there is a wish to encourage users to contribute ideas. They are more suitable for testing code than exploring user needs and expectations.

What is needed therefore is a low cost flexible rapid prototyping tool. It has been suggested that wikis may offer a solution because, while they possess many characteristics similar to paper prototypes, being computer-based enables them to be used to create a more realistic simulation without the disadvantages of conventional rapid prototyping. Trials currently underway at De Montfort University using a simple, free, hosted wiki to model ideas for a learning resource website will test this suggestion. It will be particularly important to ascertain how easily users can modify the proposed designs and contribute their own ideas using the wiki interface; how easy it is to link the wiki pages to other non-wiki computing elements such as sound synthesizers, flash movies, etc.; and the effect on users of seeing the design on a computer screen as opposed to rough drawings on paper.

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ACKNOWLEDGEMENTS

The Photographs Exhibited at the Royal Photographic Society 1870-1915 project was funded by the Arts and Humanities Research Council.

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