

# Designing Digital Library Resources for Users in Sparse, Unbounded Social Networks

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**Abstract.** Most digital library projects reported in the literature build resources for dense, bounded user groups, such as students or research groups in tertiary education. Having such highly interrelated and well defined user groups allows for digital library developers to use existing design methods to gather and implement requirements from those groups. This paper, however, looks at situations where digital library resources are aimed at much more sparse, ill defined networks of users. We report on a project which explicitly set out to ‘broaden access’ to tertiary education library resources to users not in higher education. In particular we discuss the problem of gathering *á priori* user requirements when by definition, we did not know who the users would be, we look at how disintermediation plays an even stronger negative role for sparse groups, and how we designed a system to replicate an intermediation role.

## 1 Introduction

If one were to consider a ‘typical’ digital library (DL) project reported in the literature one is likely to think of a digital library resource based on university library holdings and aimed at students or academic researchers (eg. [1, 2, 3]). The user groups in this case:

- are well defined** — it is possible to tell who is and who is not a potential user of the DL system,
- have well defined needs and tasks** — it is possible to tell what they want to use the system for,
- are co-located or easily accessible** — it is not expensive to question them to gather their requirements,
- are homogeneous** — their requirements are broadly similar; if you have a user population of one hundred undergraduate students doing the same course, interviewing, say, ten of them is likely to give an adequate picture of the group as a whole, and
- are highly interrelated** — the individuals in the groups tend to be closely related in their work, research or studies.

(Note that although we assert that it is *possible* to discover the boundaries and needs of such groups, we do not suggest it is particularly *easy*.)

In network analysis [4] such collections of users are called ‘dense, bounded groups’. This work, however, contends that many users of both traditional and digital libraries are not sufficiently accurately modeled by dense bounded groups, particularly when looking at user networks outside tertiary education. If dense, bounded groups are at one end of a continuum, then at the other end are ‘sparse, unbounded networks’. It is these networks of users we look at in this work, and report how we set to out design better digital library resources for them.

### 1.1 Dense, Bounded Groups and Sparse, Unbounded Networks

Network analysis (eg. [5, 6]) is a branch of social science that looks at the structure of social networks, in particular analysing the relationships between the actors in networks. The domain of social networks looked at by network analysis is very broad: from analyses of markets to the structure of riots, but it is the work of Wellman [4] that applied network analysis to the field of IT, by characterising the different social networks that can be mediated online, and it is Wellman’s description of the difference between dense, bounded groups and sparse, unbounded networks that we base our work on.

Dense, bounded groups<sup>1</sup> are characterised by networks that have well defined boundaries and a high degree of interrelationship between the actors in the network. Typically the starting point for an analysis of a dense bounded group is the definition of the boundaries of the group: this implies who is or is not inside the group, and analysis can proceed on the group members.

In contrast sparse, unbounded networks are characterised by relationships that cross formal boundaries. For example, a formal boundary may be organisational: there is a clear line around who does and does not work for a particular organisation. Networks that cross these boundaries may be friendship networks, or networks of common interests. Because by definition we cannot start an analysis by defining the boundaries of an unbounded group, analyses of sparse, unbounded groups start by looking at the relationships of one or two individuals and then traces their relationships outwards. If boundaries are discovered, then they *emerge as a consequence* of the analysis, not as in bounded groups where they are the starting point for the analyses.

Wellman describes one of the characteristics that differentiate sparse networks and bounded groups is that the relationships in sparse networks ‘tend to ramify out in many directions like an expanding spider’s web’ whereas the relationships in dense groups ‘curl back on themselves into a densely knit tangle’ [4, page 180]. Note that the difference between the two types of networks is defined both internally by the characteristics of the relationships in the network, and externally by the way that they are analysed.

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<sup>1</sup> Note that the term ‘group’ has a specialised meaning in network analysis: a dense, bounded network is referred to as a ‘group’. In this paper we shall adhere to this specialised terminology.

## 1.2 Is the Difference Important?

This paper gives examples of digital library users that are much better characterised as sparse, unbounded networks. We argue that standard development methodologies are not ideal for designing systems with unbounded user networks, and that intermediation is critical for sparse networks. But before moving on we need to address the question: how much does it matter? Even though standard development methodologies and disintermediated DL models are based on the assumption that user groups are dense and bounded, can we still use those methodologies and models to develop good DL resources?

Evidently the answer is yes: good DL resources have been developed using standard methodologies. However we would argue that the risk of failure is higher because of this mismatch between the assumed and actual characteristics of the user populations. Furthermore as we argued above much reported DL work has been developing resources for tertiary education users, where user groups are generally dense and bounded. However, once we move outside the tertiary education domain the evidence for successful DL projects becomes weaker (see [7]). There are many difference reasons for this lack of success, but we suggest that user networks outside tertiary education being much sparser and unbounded, is a contributing factor.

## 2 The Accessing Our Archival and Manuscript Heritage Project

The Accessing our Archival and Manuscript Heritage (AAMH) project was a fourteen month project undertaken at Senate House Library, University of London which aimed to develop online resources to encourage and assist life-long learners to use the materials held in University of London libraries and archives<sup>2</sup>. The project was particularly aimed at opening up access to the libraries' special collections and archives. It was felt that these collections held much material that would be of benefit to users outside tertiary education.

The explicit aim of the project was the broaden access to library resources. Precisely how this broadening of access was to be facilitated was not explicitly addressed in the early project proposal. It was up to the project staff to decide (for example) whether directly surrogating library resources by digitising materials or by the more indirect route of surrogating library services would best fulfil the remit of the project.

Taken to its furthest implications 'broadening access' means that we *could not* know beforehand who the users of the proposed system would be. We would have to build it and see who came; we could not perform *à priori* user requirements gathering. But given that non-existent, incomplete, changeable or otherwise ill defined requirements are often quoted [8] as the main culprit in project failure

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<sup>2</sup> The University of London is a federated university, consisting of several colleges, and academic institutions. Many of the constituent colleges and institutions have their own libraries and archives.

this seemed to be a recipe for potential disaster. A search of requirements and software engineering texts for methodologies that helped us gather user requirements when we did not know who the users were was, unsurprisingly, fruitless. However some requirements gathering methodologies showed more applicability to our situation than others, and in the next section we outline the methodology we used and review how it worked in practice.

In order to get started we had to devise some assumptions about who our potential user base would be. After liaison with several of the university archivists it became clear that the resources in their archives was most of use to outside of the usual students and academics were ‘amateur’ family and local history researchers, who we refer to collectively as ‘personal history researchers’. Even though deciding to initially limit ourselves to personal history researchers set some sort of bounds on our user population, this user population was still fairly unbounded and sparse.

Compare the characteristics of these users to that of the ‘typically’ reported user population set out at the beginning of this paper. They:

**are only very loosely bounded** — an interest in personal history hardly constitutes a limiting boundary: who is *not* interested in their family history?

**do not have well defined needs and tasks** — there are a multitude of ways of tracing your family tree, particularly once researchers have moved beyond the basic census and birth, marriage and death registers.

**are not easily accessible and co-located** — personal history researchers are quite happy to work on their own: how does one find and contact these researchers to analyse their needs?

**are extremely heterogeneous** — in talking to several members of local and family history groups we encountered researchers with an enormous range of skills, from researchers who had no training in research skills to a retired history professor.

**are only weakly interrelated** — many researchers we contacted were members of local or family history groups, but these met occasionally (typically monthly) and in most cases this was the only contact they had with other similar researchers.

All this adds up to a sparse, unbounded user population.

Note that the AAMH project was action research. The main outcome of the project was a working, useful DL resource: we did not explicitly set out to develop for sparse, unbounded networks of users. That the users we were looking at shared characteristics with models described in social science literature emerged as a consequence of the design work we were doing. The work described below is therefore a largely *post hoc* rationalisation, looking at the work we did through the lens of network analysis.

### 3 Iterative Requirements Gathering and Implementation

The software and requirements engineering literature (eg [9, 10]) was surveyed, but we could not find a methodology that suited our needs. It is clear that

most software development and requirements gathering processes are based on the assumption that the projected user groups for the system to be developed are bounded groups. Most requirements engineering methods, advise that the developers should first define who the users are, and then carefully and explicitly gather and analyse their requirements. Clearly the process of ‘defining who the users are’ is about setting boundaries on the group, and gathering requirements takes place within that defined group: this is an exact parallel to the approach to analysing bounded groups set out in the introduction.

Furthermore DL systems are highly interactive user driven systems, and therefore to ensure usability and usefulness there are strong arguments [11, 12] that an iterative design process is needed. Simply put, an iterative design process gathers requirements from a user group, rapidly prototypes an implementation that hopefully meets those requirements, then evaluates the implementation with the users. Evaluation will suggest changes to the prototype or to the requirements, and the process iterates taking these changes into account. The idea is that from an approximately acceptable starting prototype an increasingly acceptable implementation is developed.

The spiral model [13] is about iteratively developing prototypes whereas the star model [11] shows that the requirements should also be included in the process. The star model also argues that developers do not work in a linear way from requirements to implementation at all: they may start with a prototype, and then work ‘backwards’ so that the requirements for the prototype emerge. The key point is that whenever any artefact (requirements statement, prototype, etc) is proposed it should be evaluated before moving on to develop further design artefacts.

However the unbounded nature of our users posed problems for these iterative process. Recall that the boundaries of an unbounded network emerge (if at all) as a consequence of analysing the network, in other words, we would have to do a lot of analysis in order to delimit who the users actually are, *before* we could embark on the sort of iterative design process described above. In a time limited project like AAMH this was not practical: once we had an analysis of our user population that was good enough to use in the design, we were likely to have run out of time to develop anything. Therefore a different approach was needed such that the analysis of the unbounded user network took place at the same time as the DL resources were being developed.

### 3.1 ‘Early Phase’ Requirements Engineering

However, ‘early phase’ requirements engineering [14] offered promise. The key principle in standard requirements engineering is that requirements state *what* a system should do, as opposed to *how* the system should do it. This should promote a clearer understanding of the system among the designers, who are liable to lose track of what a system should be doing among the messy details of how it does it. ‘Early phase’ requirements engineering goes one step further, not only describing what a system should do, but *why* it should do it. These ‘why’

statements should promote a clearer understanding not only of the projected system, but the context (organisational, environmental, user, etc) in which it sits.

Early phase requirements engineering looked valuable because it is the why statements — the understanding of the users — which would hopefully emerge as the project progressed. We therefore proposed to use informal early phase requirements engineering in an iterative manner to develop our DL resources.

### 3.2 Our Proposed Design Process

Using early phase terminology there are three groups of design artefacts: why statements which describe context and assumptions, what statements which describe requirements, and how statements which describe implementations. As described above the spiral model is about iteratively refining how statements, and the star model iteratively refines what and how statements. The innovation of our design process is that it includes why, what and how statements in the process. In effect our design process was an augmentation of the star model, where contextual assumptions are also treated as design artefacts.

A likely consequence of such a process would be that we would not get a ‘neat’ incremental improving of the prototype: changes in the why statements were likely to result in very dramatic changes to the prototype. Such largely changes are probably unavoidable, but the important point is that the project expects them, and leaves enough slack in the project schedule to deal with them.

In our case the design process would start with a set of educated guesses about who the potential users might be and a broad description of their characteristics (the why statements), what their needs would be (the what statements) and a rapid prototype of a DL system that met those needs (the how statements). We would then evaluate these three sets of statements with potential users, change them according to the evaluation, and then iterate.

### 3.3 The Design Process in Action

Space precludes a detailed description of how this design process worked in action on the AAMH project (see [15, section 5] for a more detailed account), but we include a sketch here to demonstrate the value that this design process added to the project.

**First iteration.** Our initial ‘why’ statement proposed that our potential users would be people interested in using library archive materials in their research. We further proposed a model of the four processes they would engage in to use archive material. We suggested that they would:

- propose research questions,
- identify archival collections that would help answer those questions,
- search for materials in those collections, and
- interpret the materials they found.

We also proposed this as a roughly cyclical model: we were aware of researchers who look in collections, and then form research questions based on what they

know they can find, and so on. It is not necessarily a linear process from question formation, through archive identification and searching to interpretation.

Furthermore we proposed that question formation and identifying archives were the two key processes for users not in higher education. Undergraduate students are given research questions (usually in the form of essay titles or project proposals) and are pointed by their tutors in the direction of the useful library collections. Similarly postgraduate students and academics have (or are developing) skills in identifying sensible, tractable research questions, and know how to use the library staff and their colleagues to identify likely looking archives. In other words academics and students are a dense group: there are strong and supportive relationships between students, tutors, colleagues and library staff which help them construct research questions and identify useful research materials. Sparsely related non-HE users (we assumed) would have neither the skills or the supportive network. However we assumed that the users would have good skills in searching and interpretation, or at least would have access to tutorials in these skills that our project would not need to replicate.

From this 'why' statement stemmed a set of 'what' statements: that the website should offer a collection of online tutorials on question formation, and a discussion group-like facility to allow interaction between users and library staff to help users identify collections.

A prototype of this system was mocked up and made available to users. We then set out to evaluate the prototype and the assumptions underlying it. This was done by inviting local and family history research groups into the library and visiting meetings of such groups. Individual researchers were also invited into the library to discuss their work with the project team, and public libraries with strong local history sections were contacted and they supplied us with contacts with researchers who used their facilities. We also tried indirect routes to get at possible users: primarily by interviewing archivists about what their collections were used for by non-HE users. Our contact with potential users began to 'span out' from the first users we contacted in exactly the way Wellman predicts the analysis a sparse group would.

**Results of evaluating the first iteration.** We found that three of the four main assumptions were correct: users did need support identifying archives, and were already competent searching and interpreting archival materials. However we found that, contrary to our expectations, they did have well developed, tractable research questions, or if they did not, then they would not be interested in the collections held in university libraries. In retrospect this makes sense: researchers with badly thought out research questions are likely to be beginners, and would only be interested in the records held in public libraries or in census data. Once the possibilities of the census data and so on have been exhausted, then the researcher may find value in the collections held in university libraries, but by this time they will have become experienced researchers and will have defined and refined their research questions. Note how through this analysis a boundary for our user population has emerged, again, as predicted by Wellman.

Our contact with the archivists also provided a key insight: that what was published about an archival collection described objectively *what was in it*, whereas the archivists told us subjectively what research one *could do* with the collection. This shows the intermediation role that the archivists play (and is discussed in more detail in the next section) but also suggested to us that a better way of supporting users in finding archives useful for their research questions would be to encode the archivists' knowledge of what a collection could be used for as a searchable, online database.

**Second iteration.** Based on the evaluation we then had a much clearer idea of who the users were, what they needed, and how we could fulfill those needs. We now developed a prototype that did not have tutorials on question formation, and had a database of 'use centred descriptions' of University of London archival collections that suggested to personal history researchers what they could do with those collections. This prototype and its underlying assumptions were evaluated, and this time the feedback was much more positive: we now felt we were firmly on track to deliver a useful DL resource.

**Third and subsequent iterations.** The way that we were to structure these use centred descriptions was determined by further evaluation and iteration, and various user interface issues were dealt with, until a finished artefact was launched at the end of the project.

### 3.4 Summary

We have shown a design process which is intended not only to design a working artefact, but also to iteratively develop the designers' understanding of the user population. It is not a radical departure from existing methods, but simply makes it explicit that when defining for unbounded groups, the very basic underlying assumptions need to be evaluated and refined as much as the working artefact does.

When looking at the process in action we see that there was a sizeable change in our ideas about the characteristics of the users after the first iteration, and correspondingly the first prototype was completely dropped before entering the second iteration. The key point is that this big change occurred relatively late in the project, but the project managed to cope with it and still deliver a working product on time, largely because we were *expecting* a large change once we had explored enough of the users in our sparse network. This meant that the early decisions and prototypes were held very lightly, and therefore could be abandoned without major cost.

Obviously this description of what actually happened has been retrospectively neatened up. In particular the process of exploring the user networks was not a linear one: to visit local history groups we had to wait until they had meetings, or for personal history researchers to visit the library we had to fit our timetables around their's. This meant that the analysis came in fits and bursts and did not fit neatly into our design iterations.



Another observation that emerged was how important liaison with archivists and other front line library staff was in designing the system. This is because such staff have long been in the job of analysing the needs of their users, and the results of that analysis was very useful to us in designing our DL resources. Even though it may be difficult for system developers working on short term projects to gather requirements directly from users in unbounded networks, it is possible to get a good indirect picture of their needs through librarians and archivists who liaise with them in the long term.

## 4 Disintermediation in Sparse Networks

Butterworth and Davis Perkins [16] presented an analysis of ‘small, specialist libraries’ with a focus on how the requirements for developing their digital incarnations differ from those of commercial and academic libraries. In particular they showed that the intermediation roles of the librarian are even more important and extensive for small, specialist libraries. They showed that librarians not only play the intermediation roles between information sources and readers described elsewhere [17, chapter 7], but also play a more social intermediation role between the readers themselves.

In a sparse network the effect of a social intermediary is dramatic: it turns a weakly connected or disconnected network into a much more highly connected network. A sparse network of users may contain several completely separate sub networks, or even completely isolated actors: a social intermediary connects all the sub networks and actors together. In theory, if the intermediary is in contact with all the actors in a network, the effect is to render all the actors at most two relationships away from each other.

This effect is much more profound for a sparse network than for a dense one: for a librarian (or anyone) to play a social intermediation role in a dense network would not dramatically increase the interconnectedness of a dense network, because it is highly interconnected already. There are strong arguments in the literature [18, 19] against disintermediation, and in the case of digital library systems for sparse user networks we contend that disintermediation is particularly detrimental.

In the Accessing our Archival and Manuscript Heritage project it became apparent as we explored our potential users that the main way we could benefit them was helping them to link potential archive with their research questions. This relationship between research question and an archival collection that can be used to address that question is often not clear. Very often an archive can be used in very different ways to the purposes it was collected for. For example London University’s School of Oriental and African Studies holds an extensive collection of correspondence sent by 19th Century African missionaries, which has been used by a researcher to create a climate map of Africa in the 19th century. This was possible because the missionaries often wrote home and gave detailed descriptions of the local geography and climate.

## ISAD(G) description

**Context**

**Administrative/Biographical history:** Patrick Manson was born in 1844 and studied medicine at Aberdeen University, passing M.B. and C.M. in 1865. In 1866 he became medical officer of Formosa for the Chinese imperial maritime customs, moving to Amoy in 1871. Here, while working on elephantoid diseases, he discovered in the tissues of blood-sucking mosquitoes the developmental phase of filaria worms. From 1883 to 1889 he was based in Hong Kong, where he set up a school of medicine that developed into the university and medical school of Hong Kong[...]

**Content**

**Scope and content/abstract:** Papers of Sir Patrick Manson, 1865-1964, including Manson's diaries, 1865-1879, containing notes on the discovery of mosquitoes as carriers of malaria and patient case notes; bound manuscript notes of his discovery of filaria, 1877; original drawings of eggs of bilharzias and embryos of guinea worms, 1893; drawings by Manson of filarial embryos, 1891; correspondence with Charles Wilberforce Daniels[...]

## Use centred description

**Detailed usage description**

The London School of Hygiene and Tropical Medicine holds an archive of the medical examinations of people who emigrated to the British colonies and protectorates between 1898 and 1919. As well as giving a detailed account of the subject's health, each record gives a small amount of family history (parents, children and siblings) as well as some details about their current job, the job that they were intending to take up in the colonies and its location.

If you have a relative who apparently 'disappeared' at the end of the 19th Century, e.g. they're in the 1891 census, but not in the 1901 census, they may have emigrated, and this collection may give you a clue as to where and when they went[...]

**How to tell if the collection is useful**

If you know that a family member emigrated between 1898 and 1919 then this collection is clearly useful. If you don't know for sure, but suspect that you may have an ancestor who emigrated, you may email a query to LSHTM's archivist, giving as much detail as possible[...]

**Fig. 1.** A partial ISAD(G) [20] collection level description and partial use centred description of the Sir Patrick Manson archive held at the London School of Hygiene and Tropical Medicine (Both descriptions are edited for size)

A potential problem for a researcher is that the published archival descriptions objectively describe what is in an archive, who created it and when, but do not describe what can be done with the collection. To identify what a collection can be used for takes either lateral thinking, a lucky guess, or intermediation by the archivists who know what uses their collections have been put to in the past and can pass this knowledge on to other researchers. This social intermediation role of passing knowledge from researcher to researcher is crucial in sparse networks; if one researcher works out that archive *X* can be used for purpose *Y*, this knowledge is not likely to propagate around a sparse network without intermediation.

The disparity between what a published description of an archival collection says, (ie. what is in the collection), and what an archivist will tell you about their collections, (ie. what you can do with a collection) became one of the central points of the project. We set about interviewing archivists about what personal history researchers can use their collections for, and published these as a set of 'use centred descriptions' on the site developed by the project. (See the 'Helpers' site: [http://helpers.shl.lon.ac.uk/.](http://helpers.shl.lon.ac.uk/))

Again space precludes a full review of use centred descriptions (see [15, Section 6]) but as an example figure 1 shows part of a use centred description and the standard archival description of the same collection. The collection described is the Sir Patrick Manson archive held at the London School of Hygiene and Tropical Medicine. Sir Patrick was a founder of the School and was instrumental in

showing that malaria was transmitted by mosquitoes. His working papers form the basis of this archival collection. The standard archival description details Sir Patrick's life and lists the different materials held in his archive. If you are a family history researcher there is no indication in the description that the collection would be of any use to you. However the use centred description shows that in the collection is a list of medical examinations of twelve thousand people who emigrated to the British colonies between 1898 and 1919. As well as containing medical data these records also detailed where the subjects were going in the colonies to work and their immediate family. This information could be vital to family historians.

The common approach to repairing disintermediation gaps in digital libraries is to allow users direct contact with library staff, via email, discussion groups and chat rooms. (For example, see the People's network Enquire service<sup>3</sup>.) We attempted the same end by encoding the archivists' knowledge about which archives are useful to which users, and making it available online as a searchable database. Clearly no-one would claim that this is a replacement for the job that archivists and other front end library staff do, but it is a way of allowing knowledge about the uses that an archive can be put to to travel through a sparse network of researchers.

## 5 Conclusions

This paper has argued that there are classes of potential digital library users outside of tertiary education who are best characterised as sparse, unbounded networks. We argue that most requirements engineering techniques make the assumption that a system is designed for a bounded group of users, and therefore do not serve DL development well. Furthermore we have contended that intermediation is particularly important in a sparse network, and we have discussed how 'use centred descriptions' of archival collections act as an intermediation tool.

We believe that sparse, unbounded networks are much more common within traditional and digital library users than is suggested by the concentration on dense, bounded networks reported in the DL literature. We would propose further work, particularly looking at users of public libraries, to further draw out the characteristics of these user networks.

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<sup>3</sup> <http://www.peoplesnetwork.gov.uk/enquire/>

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