"I Keep Collecting": College Students Build and Utilize Collections in Spite of Breakdowns

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Abstract. As people become more and more involved with digital information, they grow proportionally involved in situated practices of collecting. They put together large sets of information elements. However, their attention to those information elements is limited. They use whatever means are at hand in order to form representations of their collections. They need to keep track of the elements in these collections, so they can use them later. We conducted a study with 20 college students. A major concern for the students during collection building was collection management and utilization, particularly as the size and number of their collections grows. They experienced breakdowns in these processes, yet continued to engage in collecting. They developed strategies such as informal metadata schemas and hierarchical organization to try to cope with their problems. We consider the practices observed, and their implications for the development of tools to support digital collection building and utilization. Collection representations that support cognition, collaboration, and semantic schemas are prescribed.

1 Introduction

Dick is a graduate student in industrial engineering. As he is a research assistant, his work involves writing research papers. He regularly searches for and collects relevant prior work from the internet and digital libraries. He collects articles and URLs on his own computer. He utilizes this collection regularly. Jane is a visualization lab student. She collects many images and pictures for class work such as animation, and also for fun. Some of these are photographs she has taken; some come from the internet. She is also a student worker in the university newspaper. She collects images to support this activity, as well. These examples illustrate the contexts in which students are making collections, and provide a sense of the scope of collections and collecting activities addressed by this paper. We define *collecting* as people's practices of putting together archives of information elements, such as hyperlinks, documents, images, audio, and video, with the intention of creating and supporting meaningful, engaging, and useful experiences.

Due to popularity of digital media devices and the abundance of information on the web, a broad cross-section of society becomes more and more exposed to large numbers of digital documents and media elements. People are confronted with the

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problem of how to keep track of significant elements within the stream of this experience. They begin collecting, and again due to the preponderance of meaningful digital information and media, the collections become larger and larger. This trend is further promulgated by the increasing availability and capacity of inexpensive digital storage devices.

However, a wealth of information creates a poverty of attention [19]. The disparity between the growing amount of information and media that people are collecting in practice, and their fixed amount of attention, is leading to breakdowns in their collecting experiences. According to Winograd and Flores, breakdowns occur when there is a discrepancy between our expectations and actions, and the world [22]. Breakdowns can serve as an opportunity for learning, because they identify important parts of tasks and activities, and can provoke the articulation of new user needs and design requirements. The present research investigates breakdowns in collecting practices.

The study has been conducted with college students. College students tend to be fast movers in the face of ongoing technological transformation. 81% of them go online. Many of them can scarcely imagine what the world was like way back when people weren't always connected to the net, "Always on" [14]. The Pew Internet and American Life Project, reporting on 2054 students from 27 college and university, says that nearly 73% of college students use the internet more than the library, while only 9% said they use the brick and mortar libraries more than the internet for information searching [15]. College students typify the category of *power creators*, which Pew has identified as an important constituency of internet users [16]. Power creators are twice as likely to engage in content creating activities as other internet users [16].

The intention of this research is to develop understanding of current practices and resulting breakdowns in building and utilizing digital collections. We have investigated the practices of college students by interviewing them, and observing the collections that they build. We also gathered quantitative data about collection building and utilization practices. From this understanding, we will infer implications for the design of new tools to support these processes. This paper begins with a review of related work. Next, we describe the study and its participants. The subsequent section presents data and analysis. We conclude by discussing current collection practices and tools, and infer design implications for future research and development.

2 Related Work

Prior studies have investigated the usage of tools for building and utilizing collections in specific media, such as email [3], bookmarks [1][12], and files [4][5]. Some studies have offered classifications of user behavior with various collection tools. Malone identified two fundamental strategies in office management: filing and piling [13], focusing on the organization activities. Whittaker and Sidner [21] observed three email management strategies: frequent filer, spring cleaner, and no filer. Balter [3] extended this classification by dividing the no-filer class into folder-less cleaner and folder-less spring-cleaner, depending on whether items are deleted from the inbox on a daily basis. Abrams *et al.* [1] described four bookmark management strategies: no-filer, creation-time filer, end-of-session filer, and sporadic filer. Barreau and Nardi [5]

looked at the types of information manage by users, identifying three types based on lifetime and use: ephemeral, working, and archived. They noted the relative importance of ephemeral/working items retrieved by location-based browsing over archived items and the use of search. However, as the information age matures, it seems that the importance of archiving grows.

While each of the previously mentioned works addresses utilization of a single collection medium, Jones *et al.* conducted a study that traverses collecting practices involving e-mail, images, document addresses (URLs), and documents [12]. They investigated various methods people use in their workplace to organize information for re-use. They found that people differ in their collection building practices according to their job position and their relationship to the information. Their study is similar to the present research in its addressing of multiple collection media, as well as in the number of experimental subjects, and the social proximity of the subjects to the researchers. Boardman *et al.* [7] also collected cross-tool data relating to file, email and web bookmark usage. They found that individuals employ a rich variety of strategies both within and across collection tools, and discuss synergies and differences between tools, to guide the design of tool integration. The data underlined the challenge of the collection tool design by addressing that future design work must take account of the variation in strategies by providing the flexibility to manage different types of information in distinct way. They observed that people usually browse rather than search to find relevant elements in their collections. In addition, they found that the slow-changing nature of hierarchical representations may benefit users by promoting familiarity with the personal information environment. Such familiarity, in turn, supports location-based finding for which users expressed a clearer preference.

The present research focuses on human experiences of collecting and the role of collections across a broad range of meaning-making activities and digital media. Some prior work has addressed particular media, such as web pages or email. Some has focused on well-defined scenarios regarding information filing, finding, and management. This study investigates processes of collection building and utilization across media and tools through open questions about participants' situated practices, in order to discover how they engage in collecting throughout their everyday activities. We use a hybrid data collection approach, in which qualitative data from open questions is augmented by quantitative data about collection building and utilization.

3 Study Description

To investigate power users' collection building and utilizing practices, we performed a study consisting of interviews of 20 college students. The study brought together narrative accounts, interview questionnaires, and examples of their digital collections in order to investigate how they currently build and utilize collections as part of everyday life. Students were informed that they were participating in a study, and that their responses would be recorded, and anonymously recounted in a research paper.

Participants were distributed by gender and academic concentration. Ten students were male and the other ten were female. There were eight undergraduate students

and twelve graduate students. Students' majors were diverse, including computer science, visualization, aerospace engineering, statistics, landscape design, industrial engineering, and history. The interviews were conducted with participants at their offices or homes, so they could show artifacts from their personal computers.

The interviews were semi-structured and open-ended. We did not limit the dialogue to our pre-formulated questions. We also did not place any limits on the media type or representational forms of the collections we investigated. Rather, we considered any type of personal collection. We spent 60-90 minutes with each participant to explore the kinds of collections they made, their processes of using and organizing the collections, the collection tools they used, and their overall experiences of collecting.

While conducting the study, the interviewer was guided by an agenda of relevant research questions:

- To what extent do you think intentionally about your needs for collecting digital information prior to actually doing so?
- What activities are involved in your collection building processes?
- How do you feel about spending time through collection making processes?
- How many elements are in your collections?
- Which tool(s) or mechanism(s) do you use to build collections?
- How often do you make / refer to / organize collections?
- What types of inconveniences and breakdowns do you encounter during building and utilizing digital collections?
- What are your strategies for coping with breakdowns in your experiences of building and utilizing collections?
- What are your suggestions for future collection tools?

We recorded and screen-copied examples of collections participants built, and took notes of interviews. After each interview, participants filled out a survey questionnaire.

4 Results

We analyzed the study data in terms of the distribution of activities, significance, type, and quantity of information elements involved, as well as the kinds of mechanisms people used for building and utilizing collections. We also investigated their frequency of involvement in collecting. Quantitative and qualitative data and its analysis will show participants' collection building and utilizing practices and behavior.

4.1 Collection Building and Utilizing

We looked at collection building and utilizing practices in terms of the stance participants brought into the process of collecting, the patterns and expectations that occurred in these processes and the ways in which users perceived success and failure.

Intention and Need
Participants were asked whether they thought about the need for collecting prior to engaging in processes of seeking digital information. All participants expressed awareness of a personal ongoing deliberate intention and need to be involved in collection building and utilizing practices.

Activities and Significance
The participants reported collecting digital media materials that support a range of personal and work-related activities. The personal media included photographs taken by themselves and friends, as well as popular media elements such as music, movie star pictures, and art images. As the subjects were students, their work is learning and research, so the materials here included class notes and research papers. Students whose majors are related to design collect many image files as part of their school work. From this data, we see that the participants' collecting activities are conducted in relationship to the span of significant activities in their lives.

Frequency and Time Period
One hundred percent of participants report that they build and utilize collections regularly. Of these, more than half utilize collections more than one hour per week. In more detail, 18% of participants said that they spend more than one hour per day on collection building; 10% spend one hour per day engaged in the collection process; 27% said that they spend more than one hour per week and less than one hour a day; while 27% spend one hour a week; and 18% of participants spend one hour per month. However, participants do not have a specific time frame scheduled for collection building and utilizing. It is something they do spontaneously, as part of a range of tasks and activities (P3: *"I build and utilize collections regularly, and I engage in this process during spare time and while I am taking rest."*).

Worthwhile or Useless
Participants were asked how they feel about spending time on collection building and utilization. 46% of participants said that they experience the process as meaningful and worthwhile. 18% of participants answered that they find it somewhat meaningful. 9% of participants answered that their experience is neither worthwhile nor useless. 27% of participants said that they experience collecting as rather useless. Those participants who answered rather useless said that they nonetheless continue to engage in the collection building process; they experience it as necessary and meaningful initially, but after a while, their engagement seems to be performed in vain. They said that a collection is not worthwhile if they do not utilize it well, and they seldom utilize most parts of their collections because of the huge volume of collected information.

Collection Types
All participants said that they build image, music, and/or movie collections. The sources of the images are from digital cameras, camera phones, and the internet. Twenty-two percent of participants have 50-100 images in their collection; another 22% keep 100-500 images; while 56% keep more than 5000 image collections. Participants said they mostly obtain music from music downloading services or their friends' collections. Thirty-three percent of participants keep 50-100 music files, 33% keep 100-500 files, and 34% keep more than 500 music files in their collections.

Movie files are obtained through similar means, such as downloading services or creation with a video camera. Twenty-two percent of participants keep 10-50 movie files; another 22% keep 50-100 movie files; another 22% keep 100-500 movie files; while 34% keep more than 500 movie files in their collections.

Participants also collect documents such as Word files and PDF files. 56% of participants keep 100-500 documents; 44% keep more than 500 documents in their collections. They also collect web documents in the form of hyperlinks (URLs). 11% of participants keep 1-10 URLs, 33% keep 10-50 URLs, 45% keep 50-100, and 11% keep 100-500 URLs in their collections. Compared to the other media collections, participants keep fewer URLs, because web documents are easier to search for.

Collection Mechanism

In terms of what is stored, there are three ways to build digital collections: (1) save the files themselves; (2) extract some parts from files and save only those parts; (3) save the location of files. Participants use whatever tools and structures are at hand to build their collections; for example, files, folders, bookmarks, and e-mail.

All participants said that they make file folders for file collections. There are also within-file collections, in which small elements of information from diverse sources are gathered into a single file. Participants said that they used Excel, Word, Photoshop, and Notepad to build this type of within-file collection. They used drawn lines, tables and newline characters (vertical whitespace) to spatially distinguish elements in a within-file collection. When participants save URLs of web pages, they usually use bookmarks, but they also use e-mail, so that those URLs can be utilized from the other computers (P9: *"I am not using bookmarks at all. Instead I keep URLs in my email because I use three computers; my office computer, my home computer, and my laptop, so I can look at important URLs from any of my computers."*).

Levels of Engagement with Collections

We observe that in general, people collect information and media with the intention of later referring to the collected elements for use. Sometimes, they actually get to this process of referring. Further, sometimes, with collections that are important, they take steps to organize the form of the collection. Referring and organizing are aspects of collection utilization.

While participants accessed the internet daily, their activities of selecting elements to add to their collections, referring to the collections, and organizing them occurred less frequently (See Figure 1 Left). The frequency of these activities can be categorized in three tiers. All of the subjects accessed the internet daily. At the same time, 43% of them engaged in collection building and referring on a daily basis, while 36% did so on a weekly basis, and the remaining 21% engaged in such activities monthly. The difference between internet access frequency and collection building/referring frequency was statistically significant [$F(2,26)=3.67$, $p<.01$]. While distribution of the participants' collection building frequency and collection referring frequency were the same, these distributions are independent and do not necessarily refer to the same participant. The third tier of engagement with collections is to organize them; 36% of the subjects did this weekly, 57% did it monthly, and the last 7% reported they never did it at all. The last group corresponds, for example, to Abrams, "no-filers" [1]. The frequency of engaging in collection building/referring was again greater than that of

collection organizing in a statistically significant manner [$F(2,26)=3.45$, $p<0.002$]. This shows that people refer to their collections as much as they build the collections, but they rarely organize their collections.

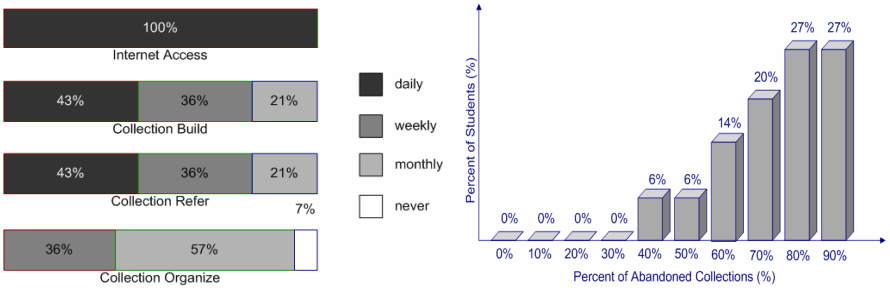

Fig. 1. Left - participants' internet access and collection building/referring/organizing frequency; Right - rate at which participants' collections are unutilized and abandoned

Collection Sharing

The study data shows that participants share their collections with other people, and also across several computers. 85% of participants said that they have their own blogs or personal web sites and publish some of their collections to share with others. These published collections may in turn function as source materials for others' collection building processes.

As mentioned above, one participant (P4) keeps URLs in email in order to access them from different computers. All participants said that they use several computers in different places. Participants use portable devices to carry their digital media materials or store them in network accessible spaces in order to share among different computers and as well as with others.

Breakdowns in Collection Practice

We investigated discrepancies between participants' expectations, and their experiences in practices of collecting. Our goal in identifying these breakdowns is to articulate user needs and design requirements. The most common breakdowns that participants experienced during the present study arose during their practices of referring, organizing, and finding things in their collections (P15: *"I initially made URL collections using bookmarks without any folder structure and renaming. Later, I had trouble finding a specific URL in it, so I deleted all my bookmarks and made folders with renaming. After this experience, I became more cautions about adding and renaming URLs to the collection."*). They said that they initially didn't have trouble finding elements in collections they built, but as time elapsed after collection building, it became more difficult to remember what is in the collections, and where. Recall, a problem of limited human attention, becomes a problem (P12: *"I had really important data in my collections, but I cannot find it! Could you make a program for me?"*). As the set of collections they own grows larger, it becomes difficult to remember all of them. Even though they sometimes don't have any clue of where the elements are, they said that they start browsing their collections first rather than searching. When they don't find the elements in the expected location, they use a

search tool (P13: *"I seldom organize my collection very well, so I went through all folders one by one sequentially trying to find a certain file. Sometimes, I forgot what I saved, so I searched the web instead of the collections, and saved the same thing again."*). However, they may not even remember what to search for.

As mentioned above, 27% of participants said that collection building is somewhat useless because most parts of their collections are not utilized, and thus abandoned. Participants were asked what percent of their digital collections remain unutilized. At least 40% of the participants' collections are abandoned (See Figure 1 Right); 27% of participants said that 90% of their collections are abandoned; another 27% of participants indicate that 80% of their collections are abandoned; for 20% of participants 70% of collections are abandoned; 14% of participants have a 60% abandonment rate; 6% of participants have 50% abandoned collections; another 6% have 40% abandoned collections. Nonetheless, participants continue to engage in collecting (P4: *"Even though I am not using most of my collections and I sometimes think what I've built is useless, I keep building collections."*).

The participants initially build their collections with the intention of using them later. However, most collected material is not utilized because of trouble remembering and finding what has been collected. They lack effective means for referring to their collections. Collections are abandoned not because the information and media they contain are useless, but because of breakdowns in utilization practice.

Reasons for Collection Building

Participants were asked why they still build collections even though they do not utilize most parts of them. Like P14 (*"Wow, I realize that I am not using most parts of my collections, around 90%"*), they are often unaware that they are not utilizing most of what they collect. However, all participants still build collections from some sense that they will need the collected information elements later (P6: *"I want to save time on searching when I need a document in the future. That is my main reason for continuing to build collections."*). They collect media files to enjoy and also to share with others. Participants collect information that seems meaningful, useful and needed. They collect media that seems fun, unique, and consonant with their personal tastes. They make collections not for the definite promise of later utility, but from some intuitive sense of meaning and value.

4.2 Using Semantics to Represent Collections

Through the study, we observed that participants create semantic structures to organize their collections using any available affordances. They build their own structures for meaningfully representing their collections for usage later.

Developing Informal Metadata Schemas

All participants said that they make hierarchical directory structures to organize and manage their collections. They make folders based on contents, dates, semantic identifiers related to tasks or activities, or other categories that are somehow significant to them. Participants said that folder structures are created and changed because collections are added and deleted continuously.

Participants said that they rename files and file folders using metadata such as date, location, title, or author in order to help find them later. Renaming is important for

search also. They seek to remember which words they used to rename files, in order to reuse them later when they browse and search their collections. Several participants mentioned strategies other than renaming for keep tracking of collected material. For example, they create index files inside of folders so that they can know what they contain (P6: *"Inside file folders, I make a 'readme' file to look at it later. This will help me to remember what the collection is about. In the individual file, I rename the file, and in addition to that, I put an explanation about the content in the first line."*).

We identify participants' practices such as renaming elements and creating hierarchical folder structures for representing important and large collections as the development of *informal metadata schemas*. They found ways to develop informal metadata schemas even in the absence of tools that support extensible field creation. They used the single accessible field afforded by existing tools that is the file or link name, to store the metadata. This practice was mostly spontaneous, occurring without an ontological plan. It was conducted informally and incrementally, as a series of situated actions [20]. This is an example of incremental formalism [18].

4.3 Suggestions

Participants were asked what new functionalities would be helpful in tools for collection building and utilization. Categories were not specified. Participants could mention whatever was on their minds. Participants' suggestions addressed areas such as collection utilization statistics display, filing assistance, and collection privacy support. They wanted help in renaming their collection materials in order to make the structure consistent, to make it easier to find materials later. They also asked for cues such as a 'visited count,' which shows how many times the owner read the file, in their collection representations and search and browsing environments to support finding specific materials. They liked the way desktop search is moving to assist collection utilization, however, they wanted their private files to be processed differently (P13: *"I have a big paper collection, but it is hard to find the paper I need when I need it using search tools supported in Windows. I tried Google desktop search, and it is pretty good, but one time I was a little embarrassed because a file that I wanted to keep private was retrieved as a search results when I was with my friend"*).

5 Discussion

Study participants invest substantial personal effort and resources into processes of building and utilizing collections. Their persistence in collecting in spite of breakdowns conveys the sense that they need to keep collecting to support a range of activities that span personal and work-related parts of their lives. In this section we examine participants' engagement with collections and the needs they express, and extrapolate from these, while considering human cognitive facilities and emerging technological capabilities. The result is to derive implications and ideas for designers of systems that support collection building and utilization.

The data shows that participants' breakdowns were centered in processes of collection utilization. They had trouble finding specific elements in their collections, and even though they built collections of elements that were useful, most of them are not

utilized in the relevant context because of limited human attention and memory. They forget what to look for and where. Abandoned collections consume disk space, and more importantly, human attention during browsing, which is people's first choice for how to refer to collections.

We propose prescriptions to address breakdowns discovered in this study. Since the discovered breakdowns generally involve limitations of human understanding of collections, the prescriptions involve making better use of individual cognitive resources, sharing collections, and the definition of collection semantics. The first prescription addresses breakdowns that involve forgetting what has been collected, by using representations for collections that better cue human memory. The next proposed solution is based on ambient displays that use peripheral attention and changes over time for individual and collaborative interaction with collection visualizations. Other user needs that result from analysis of the breakdowns involve distributed tools for collection sharing, and the automatic generation of metadata schemas.

We can take steps to help people track of their collected information, by making better utilization of human memory capabilities. It is a well-accepted principle of cognitive science that in the working memory system, the visuospatial buffer, which store mental images, and the rehearsal loop used for text are complementary subsystems [2]. Thus, dual coding strategies that represent the elements stored in a collection with images as well as text will improve memory utilization [2][8], and contribute to helping people find elements while browsing. Thus, we can provide users with tools that support them in developing and generating visual index representations of their collections, which integrate images and text. These representations will be easier to remember, promote recognition, and facilitate the formation of mental models [10]. Since collection representations function as visual communication, either from a user to her/himself or between users, visual design principles must be applied during processes of collection organization..

Developing representations during collection-building and explicit organization activities is one solution. But people don't have sufficient attention to always work on representing their collections. Another prescription develops peripheral ambient visualizations that gradually display elements from collections over time. Ambient visualizations use time as a dimension in collection visualization. They can represent personal and group collections, engaging human attention without requiring it. Ambient visualizations can be deployed on a dedicated display, or as a screensaver. The set of collections that get visualized can be specified explicitly by users, and/or by an agent that uses clues, such as recency of access. For example, a large display in a collaborative environment such as a research lab or departmental work area can visualize collected materials that represent information relevant to current projects and research. This method can jog memories and promote serendipity, to facilitate individual and collaborative utilization of meaningful, useful and important elements in collections. Affordances that enable privacy will be required.

Additionally, we have seen that sharing with others is an important motivation for peoples' collecting practices. People utilize and collect information on multiple computers and devices in different locations. This can cause access problems, when the person is in one place, and the needed information is somewhere else. One initiative that addresses this is 'del.icio.us', which supports URL collection sharing [17]. del.ico.us enables users to tag URLs while collecting. It shows the metadata that

others have used, and enables social browsing through these relationships. We believe this is a start for sharing collections and their semantics. New collection tools need to consider people's social and distributed collection-sharing intentions and enable collecting actual objects as well as references, while considering accessibility and privacy. Deeper semantic structures than single tags will also add value. These functionalities need to be integrated with editing, saving, browsing, and searching in order to best use limited human attention.

Users who are organizing collections by building informal metadata schemas need more powerful semantic structures. Easy to use extensible metadata systems will address this need. New collection tools need to use human attention effectively by supporting people's processes of semantic schema development in context, using content analysis, text pattern recognition, and image processing techniques. They can apply and extend collaborative filtering techniques for making suggestions about which metadata tags fit what is being saved [17][9]. Feature-based clustering and content analysis techniques can be applied to facilitate the semantic organization of collections by grouping similar information elements and building referential links. Users need to be able to override as well as accept the resulting suggestions. As part of this process, agents can track mutually relevant information elements scattered across the computer and the network, and inform the user about related information elements in diverse collection substructures using similarity measures.

6 Conclusion

Our study participants display tenacity in their involvement in processes of collecting. They explicitly express the intention and need to be involved in ongoing practices of collecting. They collect digital media materials involved in a broad range of activities, spanning personal and work relationships, which make up their everyday experiences. Their collection artifacts directly signify, relate to, and support these activities. Thus, collections and the process of collecting, itself, play important roles in how people create meaning in their lives.

Participants engage in collection building and utilizing activities regularly, even though it is not mandatory, and even though problems arise in the user experience. They keep collecting in spite of breakdowns. Better representations can help support these processes, by making better use of human attention. Tools for collecting need to be based in a sense of supporting individual and collaborative processes of meaning creation, while maximizing utilization of cognitive resources.

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