

Understanding Activity Documentation Work in Remote Mobility Environments

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Abstract. Activity documentation is a critical part of the work of many professionals. Documents are used as a means to store personal information, remind things to do, convey and generate new meaning, and mediate contact among people. In this paper, and based on the results of an observational study, we propose a model of how activity documentation work in remote mobility environments is performed. Further, based on this model and on some identified issues that remote mobility workers face while performing activity documentation work, we propose a set of design insights that designers and developers of support systems could use to inform their designs and developments. These results allow designers and developers not only to support a single activity documentation work phase if so desired, but also to envision the creation of comprehensive services for activity documentation work throughout its complete lifecycle in a seamless, effortless and secure manner.

Keywords: Activity documentation work, remote mobility environments, activity documentation lifecycle, design implications.

1 Introduction

Documents are extensively used in the execution of professional's work and to share information with others. These professionals are specialists in the subject of work and are characterized by putting their intellectual skills, learned in systematic education and through experience, to work in organizing their work, making sense of things, and passing judgments. Hertzum [1] identifies six roles that documents play in professional work, including their use as i) personal files, ii) as reminders of things to do, iii) to share information with someone, yet withholding it from others, iv) to convey meaning, v) to generate new meaning, and vi) to mediate contacts among people. Thus, activity documentation is a critical part of many professionals' work in various application domains. Even though the application domains are different, they share basic features that could be used to characterize activity documentation.

Let us consider an approach to the classification of application domains from the perspective of "worker's mobility" and "scale of the environment" where the activity occurs. Worker's mobility refers to the property of actors to move from one location to another to get access to a resource (e.g. knowledge, artifact, or subject) to actually performing the work; while the scale of the environment refers to the property of an

actual work setting that defines the spatial bounds of that environment. Both dimensions of this classification are intimately related, as actual mobility of an actor will be bounded by the limits of the environment. Particularly, we are interested in the following types of domains.

Workers with micro mobility in "at-hand" bounded environments. Examples of this domain include people working at a meeting room, classroom or office. Luff and Heath [2], refer to micro-mobility as the way in which "an artifact is mobilized and manipulated for various purposes around a relatively circumscribed, or "at-hand", domain". Here we will de-emphasize the definition of micro-mobility on the mobility of the artifact and center it into the mobility of the individuals carrying and manipulating the artifact in the circumscribed places.

Workers with local mobility within an environment with a number of workspaces. Examples of this domain include people working at an ensemble of offices and rooms, such as in hospital work. In this latter case, hospital workers move around to specialized places (e.g. bedrooms, meeting rooms and offices) that are distributed in space, and which hold specialized resources (people, artifacts and knowledge). Bardram and Bossen [3]) define local mobility as occupying "the intermediate space between working together over distance on the one hand and working face-to-face in an office or control room on the other". Further, they consider that it takes place "in cooperative settings where actors constantly are on the move to get ahead with their work". In this case, we will highlight the limited and well-defined nature of the environment, enclosing a number of defined spaces or activity centers [4], and where the local mobility of the individuals takes place.

Workers with remote mobility in wide open environments. Examples of these domains include people performing fieldwork, such as field biologists. These workers travel to particular sites (field), and once there, they move throughout the place (even walking considerable distances) in order to perform their work. This kind of mobility is referred in [2, 5] as remote mobility, although they don't emphasize the extension of the environment; the main requisite was to move around different physical locations. This type of work is characterized by periods of micro- and local- mobility work at a local setting, and periods of remote mobility work in the field.

From the previous definitions, the "mobility" and "scale" features of these workers and environments may shape the type of technology that is, or could be, available to support activity documentation in those settings.

In this work, we are interested in investigating how Information and Communication Technologies (ICT's) could bring elements of a solution to the problem of activity documentation in remote mobility environments.

The rest of this paper is organized as follows. Section 2 describes the observational study performed, while sections 3 and 4 present the results of understanding Activities in Remote Mobility Work and Activity Documentation work, respectively. Section 5 continues with some of the identified issues faced by workers at remote mobility environments while performing activity documentation. Section 6 presents some designs implications for the development of systems that aim to provide support for activity documentation work in remote mobility environments. Finally, Section 7 presents our conclusions.

2 Observational Study

Our research interest is in specific practices that compose activity documentation work in remote mobility environments. In order to provide the best register and details of the activities, remote mobility workers work individually and collaboratively to ensure that all the information regarding the performed activities is properly documented. This is also why efficient and accurate recording, organization and later access to the information about the performed activities are so important.

Methodology. We performed an observational study of a group of biologists executing an environmental impact study on the creation of a new ecological park in town, to acquire an understanding of how these remote mobility workers document their activities (e.g. how information is gathered, which media and artifacts are involved, how information is organized and how it is later accessed, among others).

Participants. Participants in our study were sixteen biologists (one teacher and fifteen students) of a master's program on the Management of Ecosystems of Arid Zones (MEZA) of the University of Baja California (UABC). There were 6 male and 9 female participants. Their ages ranged from 23 to 51 years. For clarity we will refer to the participants as biologist regardless of their being the teacher or a student.

Setting. Observations were carried out on the places where participants performed their work, both in the field (fieldwork) and at the university facilities (pre- and post-fieldwork). Fieldwork was conducted at the San Miguel Creek, the place where the construction of the ecological park is proposed. Figure 1 shows the layout of the facilities where most of the workers' local activities were performed. These include, a classroom and a meeting room, where most group work occurs before and after a fieldwork trip; the teacher's office, where the teacher worked individually and students joined her for informal discussions and consultation about the project; and the two students' cubicle areas, where most of the students' individual work occurred before and after meetings and fieldwork.

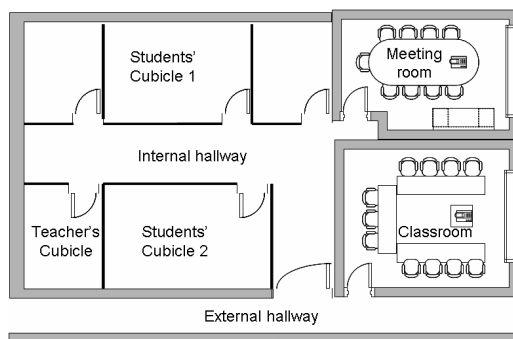


Fig. 1. Layout of the facilities where local-mobility work was performed

Procedure. To obtain a through understanding of the current activities and documentation practices of these workers, an observational study of their activities during the execution of the project was conducted. It combined direct and indirect observation of

work at the university facilities during group and individual work (e.g. formal meetings and lectures, informal hallway meetings, and information gathering, processing and deliverable generation activities, among others), shadowing of three teams during fieldwork, and informal interviews. Seven observation sessions were conducted (21 hours) during pre- and post-fieldwork activities and 3 observation sessions were conducted (8 hours) during fieldwork activities. Observational data were recorded using a video camera, pen and paper. In addition to the observational videos and notes, we collected samples of documentation artifacts, such as notes, photos, and written deliverables that were used and created by workers during the study. We also asked them, whenever possible, for descriptions and explanations of their use of the artifacts, and how they used them during their work documentation activities. Particularly, we were interested in identifying the kind of artifacts they used or created during their work sessions, the way they prepared, transported and used them before, during and after fieldwork in a remote mobility environment.

3 Understanding the Activities of Remote Mobility Work

The main activities of remote mobility workers identified in the study are shown in Figure 2. They are arranged following a sequential life-line that is more or less followed (and repeated) each time fieldwork activity in remote mobility environments is conducted. These activities are also arranged to denote the activities that are performed before (pre-), during (at-) and after (post-) fieldwork activities. A brief description of them follows.

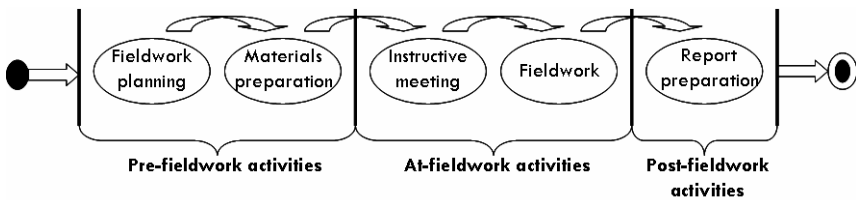


Fig. 2. Activities performed by workers before, during and after fieldwork activities

Pre-fieldwork activities. They include Fieldwork planning and Materials preparation. Fieldwork planning includes all those activities related to establish what is going to be done during the fieldwork trip, where it is going to be done, how it is going to be done, and by whom. Thus, specific instructions and responsibilities are given to the workers. Documentation activities include taking notes, identifying topics for further reading, and obtaining digital or written documentation regarding the activity to be performed. Laptop and desktop computers, along with projectors and USB devices are usually utilized to perform these activities. Fieldwork planning activity usually occurs at the classroom or meeting room during a group session.

Materials preparation includes all those activities related to gather the required material and information resources that will be used during the fieldwork trip. Concerning documentation activities, information resources are gathered in paper and in

digital form from personal copies of books and journals, from the Internet, or the central library. This information is brought in paper form, either printed or hand-copied. Regarding documentation artifacts, they brought notebooks, pen and pencil for note-taking, analog and digital cameras for video and picture taking, and even tape and digital audio recorders. Materials preparation activities usually occur at the personal office/cubicle, the library, or even at the participant's home.

At-fieldwork activities. They include Instructive meeting and actual Fieldwork. Instructive meeting, as its name implies refers to an in-site meeting where up-to-the-minute information concerning the planned activity is provided and highlighted, including coordination and safety issues not previously emphasized. It is performed as a group activity. Concerning documentation activities, information resources are brought into play, distributed and stored for at-fieldwork use; note-taking is the primary method of recording the instructions and coordination issues given.

Fieldwork, as its name implies refers to actually performing the planned activity at the visited site, i.e. performing the work and documenting it. Fieldwork can be done individually or as a team. Regarding documentation activities, users take notes, annotate the materials they brought, take pictures and video of the studied subjects, and record audio of interesting events (e.g. characteristic sound of a bird).

Post-fieldwork activities. They include Report preparation and delivery. It refers to the actual organization and sense-making work on the fragmented information in order to create deliverables for the fieldwork activities. It requires individual and collaborative efforts, as each party has to contribute the part they are responsible of. Thus, it is performed both at the individual offices/cubicles and at the meeting rooms. Documentation activities include the transcription of the raw collected data, its analysis and interpretation, sharing and merging of the fragmented information (data, notes, pictures, etc.), and the writing of actual drafts and final reports.

4 Activity Documentation Work in Remote Mobility Environments

From the previous description of activities of workers in remote mobility fieldwork, we identified the flow of activities that is followed for Activity Documentation Work. This is illustrated in Figure 3.

This flow is organized following a similar pattern to that of the main activities of remote mobility work, with Pre-, At- and Post-Activity Documentation Work phases.

In the *Pre-Activity Documentation Work* phase workers basically gather initial information related to the activity that is going to be performed. Based on this initial information, they capture and search for, select and retrieve information relevant to the planned tasks of the activity, and finally, they store, organize and prepare documentation that they could take along with them to support their actual Activity Documentation Work while at the remote mobility environment.

During the *At-Activity Documentation Work* phase workers basically retrieve and consult information on the planned tasks (such as instructions and references), and capture information regarding the activities performed at the remote site (notes, pictures, audio and video, among others). The fragmented nature of the information on this phase should be highlighted.

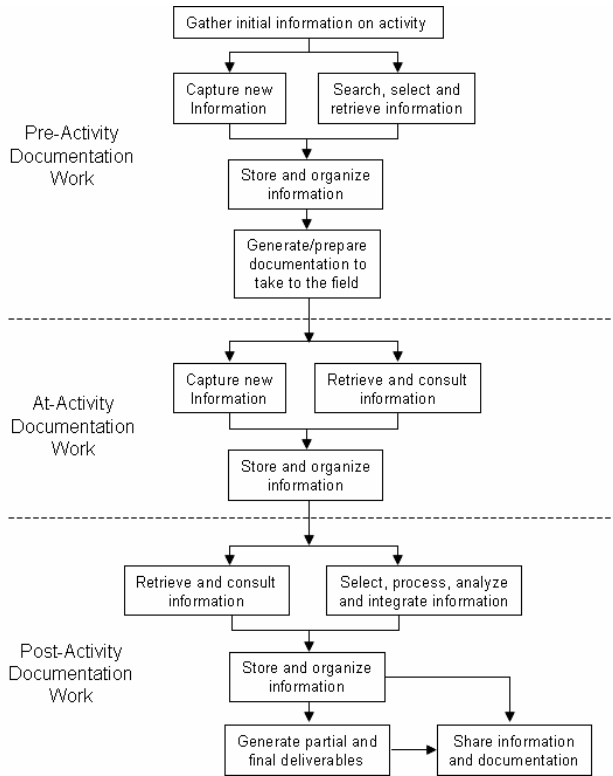


Fig. 3. General flow of activity documentation work as performed by workers in remote mobility environments

Finally, during the *Post-Activity Documentation Work* phase workers need to retrieve information from the two previous phases, transcribe the data that so requires it, select specific information to be processed, analyzed and integrated to generate additional written documentation. It should be highlighted that all data, information and documentation gathered and generated in this phase are usually shared with the other participants of the activity (and with people outside the group, e.g. stakeholders and external advisors), so that actual deliverables could be generated and submitted.

5 Issues Faced by Workers Performing Activity Documentation Work in Remote Mobility Environments

In addition to the identified general activity documentation practices, the study also allowed us to identify a set of issues that affect these documentation practices for the particular domain. Some of these issues are briefly described next.

Imbalance in the effort spent in the phases of activity documentation work. From the study we noticed that the effort required for activity documentation work is different

among the three identified phases. Pre-Activity documentation required in average nearly a fifth (21%) of the total effort, while At-activity documentation required nearly one third of it (30%), and Post-activity documentation required nearly half of the total effort (49%). According to the observations a possible explanation for this has to do with the nature of the documentation work in each phase.

Need to access information and documentation products of previous phases. From the study it was clear that remote mobility workers needed to document their activities, as well as to prepare documentation to support their documentation activities across the multiple phases. These information and documents are gathered, captured and generated in one phase and are used as inputs to the processes of another phase. Thus, information and documents are accessed through the boundaries of the three identified phases (Pre-, At- and Post-Activity Documentation Work).

Information capture using non-digital media. From the study it became evident that the participants still heavily depend on non-digital media (e.g. paper and pencil, non-digital cameras) to capture and store information regarding their activities. Yeh et al. [6] argue that this is due to affordances of the non-digital media (e.g. paper notebooks that are portable, lightweight, readable outdoors, robust to harsh conditions and have infinite “battery life”). This, although convenient while performing At-Activity Documentation Work on a remote mobility environment, introduces an ensemble of limitations that become more evident at a later phase of the process, i.e. during Post-Activity Documentation Work phase. One of the main limitation of capturing information on non-digital devices is that in order for information to be easily shared with others and included into own and others reports, it has to be re-captured (e.g. transcribed). This introduces additional work overload to the documentation process. Participants reported that 49% of the effort invested into Documentation Work is spent during the Post-Activity Documentation phase. Further, as stated by one of the participants “*When capturing information using [non-digital media, such as] paper and pencil, we miss documenting fine details of the information, such as when taking notes about instructions from the teacher at the Instructing Meeting or at Fieldwork when trying to capture verbal interactions*”.

Fragmented nature of the information captured in different media and lack of effective mechanisms for linking related information. During the study, we also noticed that some information and documents that are captured or generated during Activity Documentation Work basically represent entities that are “isolated” from the other elements captured on the same media, and even more from those captured or generated on another media. Let us take for example the case of notes and [digital] photos. On one hand, notes are usually written (and stored) in a notebook or on a piece of paper (e.g. notebook). Photos, on the other hand, are taken (captured) and stored in a film-roll (or in a digital memory). Both notes and photos are sequentially organized, which allows finding series of related notes or photos. On the contrary, this sequential organization poses the problem of how to determine whether two sequential notes or pictures relate to the same or different object of study. A further problem relates to being able to link materials from different sources, such as notes and photos. Although participants might remember enough contextual information as to be able to associate specific photos with the right notes and vice versa, it is not unusual that photos and notes end up paired in an incorrect manner. A participant stated it in this

way “Sometimes, while assembling the report from the contributions of all team members, we notice that information from notes that do not correspond to pictures have been associated together”.

Need to share the collected information among colleagues, and to collaborate in the creation of deliverables. Also, in the study we observed that information and documents are gathered or generated in different phases, most notably at the At- and Post-Activity Documentation Work phases. Even though information and documents were captured or generated by individuals or small teams, they are shared among all members of the project team, and used to document and enrich the joint production of deliverables. While in the local work area, information and documents are mainly shared by means of the facilities installed in the environment (e.g. email, and instant messaging file transfer features) or through face-to-face exchanges of USB disks and actual documents. While in the remote mobility environment, lacking a supporting infrastructure, information and documentation exchanges are limited to printed documents, handwritten notes and verbal exchanges. Regarding the joint generation of documents and deliverables, participants go beyond information exchange. In these meetings they require to establish coordination protocols, such as for the assignment of authoring responsibilities on documents and sections of documents, for the integration of partial and complete documents, or the actual production of deliverables. One example of such a protocol was the formation of three smaller teams, and the designation of a scribe within each one of these teams. The scribe entered what other participants were saying, and who was in charge of integrating the diverse fragments and sections provided by other members of the team.

6 Design Implications

In our study, we found that Activity Documentation Work in Remote Mobility Environments involves managing an ensemble of information, documents, and artifacts in several locations. Information and Communication Technologies (ICT's) could be introduced in order to supplement current practices in a way that enables or improves actual activity documentation work. Based on the proposed model and on the identified issues and features of Activity Documentation work, we identified a set of design insights for the development of applications that provide support for activity documentation work in remote mobility environments (see Table 1). A brief description of the implications of introducing supporting technology follows.

Support for fixed and mobile modes of work (insight 1). Designers and developers should consider the use of both fixed and mobile technologies, so that appropriate support is available at the right time and the right place. For instance, although PC's, laptops and projectors that are available at the students' cubicles, teacher's office, and classroom are adequate for activity documentation work during the pre- and post-activity documentation phases, these technologies won't be adequate during fieldwork at the At-Activity Documentation phase due to their specific features (e.g. weight, energy-consumption, etc.). Mobile and wearable technologies would be more appropriate for this.

Table 1. Identified insights for the provision of support for activity documentation work in remote mobility environments

Design Insights
1.- Support for fixed and mobile modes of work, according to the needs of activity documentation work phases.
2.- Seamless access to information across the phases and modes of activity documentation work.
3.- Digital capture of activity documentation information, so that even transient information (e.g. conversations between colleagues) could be persistently documented.
4.- Automatic linkage of different pieces of related information, even at capture time, to avoid additional classification work in the Post-activity documentation phase.
5.- Information sharing among colleagues, and collaborative creation of individual and group deliverables, regardless of the time and place where participants are.

Seamless access to information across the phases and modes of activity (insight 2). In a similar fashion, designers should consider the use of services that allow accessing information across the three phases of activity documentation. For instance, information gathered and generated during the pre-activity documentation work phase, is used through out the whole process to the post-activity documentation work phase. In this case, dedicated messaging or file-transfer services among participants could suffice. However, a shared repository which provides support for intermittent or disconnected operation would be a better option as discussed later.

Digital capture of activity documentation information (insight 3). Reports and deliverables are generated in digital form, based on information gathered or generated during the three phases of activity documentation work. Designers and developers should consider the provision of services to gather, generate, organize and access information of several types, including notes, pictures, audio and video. Further, these services should manage the information in digital form from capture to integration into a final report or deliverable. The main idea behind this is trying to reduce the overload of having to re-capture (e.g. transcript or scan) the information that is not captured in digital form (e.g. handwritten notes).

Automatic linkage of different pieces of related information (insight 4). Information capture by different people, from different sources, and at different times generates information that is very fragmented. Organizing and making-sense of this kind of information usually requires an additional effort, often made during the post-activity documentation work phase. Designer and developers should consider the provision of a mechanism (e.g. GPS or semantic tagging), either manual or automatic, that allows linking related information (even) at capture time, when contextual information about the relation of the objects is certain.

Information sharing among colleagues, and collaborative support for the creation of individual and group deliverables (insight 5). Being informed and having access to all information sources across the whole lifecycle of Activity Documentation Work is vital for the creation of deliverables. Further, the success of the activity heavily depends on the participants' ability of integrating the gathered and generated information into final reports for the stakeholders of the project. For this reason, designers

and developers should not only consider the inclusion of a shared repository, messaging and file transfer features to achieve this, but also, the inclusion of features of a system for computer supported collaborative writing, which assists them in the three different axes of collaborative work: communication, coordination and production of the expected deliverables.

7 Conclusions

Activity documentation is a critical part of the work of many workers in various application domains, including those that perform activity documentation in Remote Mobility Environments. In this work, aiming at understanding the practices and issues faced by activity documentation workers in these environments, we present a characterization of these activities, and present a process model for it. Also, we identified and described a set of issues faced by workers in this domain. Finally, based on these results, we identified a set of design insights and implications for the development of applications for activity documentation on remote mobility environments. The importance of these results rely in that they allow designers and developers to concentrate on essential features of an application, not only to support a single activity documentation work phase if so desired, but also to envision the creation of integrated (fixed and mobile) services for information capture, classification, retrieval and processing. Further, these services should be available and interoperable throughout the complete lifecycle of activity documentation work and this in a seamless, effortless and secure manner.

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