Writing in the workplace: Constructing documents using multiple digital sources

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Abstract: In today's workplaces professional communication often involves constructing documents from multiple digital sources—integrating one's own texts/graphics with ideas based on others' text/graphics. This article presents a case study of a professional communication designer as he constructs a proposal over several days. Drawing on keystroke and interview data, we map the professional's overall process, plot the time course of his writing/design, illustrate how he searches for content and switches among optional digital sources, and show how he modifies and reuses others' content. The case study reveals not only that the professional (1) searches extensively through multiple sources for content and ideas but that he also (2) constructs visual content (charts, graphs, photographs) as well as verbal content, and (3) manages his attention and motivation over this extended task. Since these three activities are not represented in current models of writing, we propose their addition not just to models of communication design, but also to models of writing in general.

Keywords: professional communication, multiple sources, searching processes, document design, workplace writing, information design, cognitive processes, writing from sources, keystroke logging

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1. Introduction

Professional writing seldom starts from a blank screen. Like most writing today—whether at school or in the workplace—professional writing takes place in a digital context in which professionals[1] have easy access to a wide variety of sources that are only a mouse click away. In fact, professional writing processes are now more than ever characterized by features of the digital workplace. Professional communication involves intense collaborations with others (both face-to-face and electronic). Professional communication is also characterized by dynamic interactions among evolving texts and graphics, previously produced documents, and a plethora of additional digital sources (both internal and external to the organization). These interactions involve constructing and reconstructing one's own and other's texts—refashioning and reusing content from multiple sources.

Most of us are familiar with creating texts by starting with a previously created document. For instance, when writing a recommendation letter, we often start not from a blank page, but from a letter we have previously written for another person in another context. Probably, we will not only reuse the layout of the existing document, but we will also partly reuse, paraphrase, and delete existing information. When adding new information, we will likely also access the email in which we were requested to write that recommendation, and then look over the candidate's resume to further personalize the letter. Maybe, we will contact a colleague or search the Web to get some additional information. And, depending on our style of working, we might be "distracted" during writing by an incoming email or an online alert calling for our immediate attention. In our characterization of professional communication we do not exclude these sorts of distractions, but consider them as an essential and inherent part of the writing and design process. We claim that these distractions are so embedded in work environments that they are a familiar and consequential part of a professional's activity. Although constructing documents from multiple digital sources typifies much of document design, it is especially pervasive in the production of rhetorically complex and lengthy texts. And as professionals engage in multimodal document creation, they also learn to deliberately switch among different digital environments and applications as they work, interleaving the activities of generating text, designing visuals, making calculations, or considering meta-communicative issues.

Professional communicators need to juggle both what tools to employ and what digital sources to access. These demands result in continuous decision making about their own texts and other people's texts as they work toward a document's completion. In other words, professionals do not rely solely on their own long-term memories to create new content, but instead, constantly search for available information that serves their communication needs and facilitates their writing process (McCarthy et al., 2011). Document reuse and adaptation now pervade the practice of professional communication (Swarts, 2010).

Of course, these characteristics also hold for other types of writers. Some studies of composing from sources, for instance, investigated what students do as they carry out high school or college-level writing assignments (Flower, 1990; Kirkpatrick, 2012; Penrose, 1992; Spivey & King, 1989). However, most writing research in the area has focused on the production of short academic texts (Bazerman, 2008; MacArthur, Graham, & Fitzgerald, 2008). Few researchers have explored the activities of professionals as they create lengthy texts while drawing on multiple sources in digitally networked environments (O'Hara et al., 2002). Additionally, there are few frameworks that attempt to model the writing and design processes of such multimodal texts. Our purpose here is threefold:

- To characterize the process by which professionals construct texts using multiple digital sources and to present a framework that depicts this process,
- To define the processes and demands of professional communication through a case study of a professional at work, and
- To specify how writing models might be adapted to better account for the cognitive and social demands that impact professional communication in particular, but other sorts of writing as well.

We contend that writing from and searching for information in multiple digital sources has fundamentally changed the way in which professionals approach communication design. Moreover, digital composing allows for multimodal collaboration, enabling writers to continuously interact with their colleagues and other experts. To account for these phenomena and the pragmatic realities of workplace communication, we examine the existing literature to identify important features of professional communication in digital environments. Next, we present a case study in which we observed a professional as he produced a lengthy proposal. We captured the professional's process with keystroke logging, onsite observations, and retrospective interviews. In the course of consolidating the process data, we offer novel visualizations for aggregating fine-grained logging data and for representing complexity in a comprehensible way. Finally, we suggest some ways that existing writing models might be modified to better reflect key features revealed by professional writing, such as those characteristic of writing from (digital) sources.

2. Writing from Sources

Previous researchers have focused mainly on understanding writing from sources as a discourse synthesis task. For example, Spivey and King (2011) studied writing from sources as junior high-school students worked on various writing assignments. They found that writing from sources called on students to select, connect, and organize content from source texts as they composed their own new texts. Studies of college-level students writing from sources have emphasized the idea that students' goal in writing from sources is to first produce a text akin to a summary, which then positions

them to extend that summary, making a unique argument or contribution to the ideas under discussion. As Schumacher and Gradwohl (1991) point out, discourse synthesis requires writers to transform others' ideas conceptually en route to generating their own perspective on the topic at hand. The pedagogical goal, as Flower (1989) suggests, is to realize writing's epistemic potential to transform knowledge rather than merely to report about it (p. 26).

For the most part, teachers and researchers have been interested in the writer's transformation of knowledge and have explored writing from sources as a way to learn about subject matter and gain facility in critical thinking (Greene, 1993; Penrose, 1992). Though researchers and teachers have emphasized writing-to-learn as a way to enhance knowledge transformation, students may view writing-from-sources tasks as content assembly. For example, Nelson (1990) found that college students writing from sources did little knowledge transformation as they considered whether to use various sources. Instead, students tended to access the library for the source texts, place the optional sources around them on a table as they composed (using hardcopy), and typically structured the text using quotes from sources in the order that they found them, merely stringing together clusters of quotations. Overall, research suggests that students from junior high school to college need a better idea of what writing from sources entails and better strategies for accomplishing knowledge transformation. In short, studies of academic writing tend to focus on students' learning and discovery.

In contrast, workplace research has not focused on the writer's personal transformation and growth as they write from sources. Instead, research on professional communication tends to examine how writers transform others' content as they draw on various paper or digital sources and on how doing so requires sensitivity to the rhetorical situation. This sort of transformation is less about discovering novel ideas about the topic and more about acts of strategic integrating, sampling, and recontextualizing of source materials. The communicator's goal is to use the resulting "bricolage" (Turkle, 1997) as a starting point for generating "new" text or graphics. As Slattery (2007)—who studied writers working for a technical documentation service—observed, texts were "not so much written as assembled—a pastiche of contributions from multiple individuals over the duration of a project" (p. 315). We suspect that when professionals employ digital resources, they do so not with an eye toward summary, though summarizing could be part of what they do (Solé et al., 2013). Rather, professionals writing from sources tend to focus on analyzing what others have done textually and visually, distilling best practices for the genre and gleaning ideas for invention. As professionals do so, they may engage in paraphrasing source documents and sampling other professionals' visual or verbal content. Professionals may also compare their proposed strategies for solving a communication problem with the strategies and tactics of other organizations.

A convincing illustration of the role of paraphrase in professional communication was presented by Van der Mast and Janssen (2001), who studied how policy makers generate consensus as they draft policy documents. Using text analysis and think-aloud

protocols, Van der Mast and Janssen analyzed the textual and strategic changes policy makers made during revision. One strategy they identified was 'elaboration'. They found that experienced policy makers were able to satisfy the various stakeholders for a policy and reach consensus among diverse groups by paraphrasing and elaborating the opinions voiced by those who had opposed the policy. In short they were able to gain consensus for policies by paraphrasing and reframing ideas held by the opposition.

Spinuzzi (2007) has suggested that *coordination* is key to many technical professionals who write in the workplace. Similarly, Slattery (2007) refers to this activity as *textual coordination,* calling on expertise in identifying, selecting, staging, and recombining bits of existing texts in order to form new ones (p. 318). Such activity often means using multiple software programs and accessing many types of electronic documents in networked distributed environments. When professionals write from digital sources, their tools (software, internet applications, hardware, phones, etc.) mediate their activity. The myriad of tools professionals rely on not only both foster and constrain their perception, they also shape and organize writing and design activity in fundamental ways (Swarts, 2013).

But as Johnson-Eilola (1996) argues, this sort of coordination is merely the means by which technical communicators work rather than their rhetorical goal. *Textual transformation* of content is the goal of professional communicators' as they carry out what Reich (1999) has called "symbolic-analytic work." In some cases, this textual transformation involves coordinating multiple texts in order to create a new one. In other cases, multiple texts are coordinated as a single resource, serving as a rhetorical repository of reusable chunks. These textual and graphic bits are then dynamically coordinated and assembled on demand, often using sophisticated content-management systems. As Hart-Davidson (2013) suggests, making something new and adding value to an organization's content are hallmarks of today's professional who often works as an information designer and as a decision maker. Today's experienced professionals both define what content needs transforming and direct how information design activity will be carried out.

3. Expertise in Professional Communication

To better understand how information designers develop the skills and sensitivities required for creating effective communication—especially while making use of extensive digital resources—it is useful to consider the research on expertise in professional communication more generally. Schriver (2012) reviewed this literature and indicated that skilled professionals possess rich schematic knowledge about writing and design processes. Experts are also rhetorically savvy about the social and semiotic resources they can draw on and of ways to orchestrate them. And although it is difficult to specify precisely how expert information designers accomplish what they do, research has started to profile some of the cognitive and social processes professionals engage in as they work within organizational settings. Research on the nature of skilled

performance and expertise is also emerging in areas such as journalism and translation studies (Ehrensberger-Dow & Perrin, 2013; Perrin, 2013; Schrijver et al., 2014).

Expertise in professional communication calls on the ability to skillfully shape textual and graphic content for multiple stakeholders (audiences, critics, bosses, clients, and colleagues) whose diverse expectations must be met. To do so depends not only on the professional's extensive knowledge and experience in the processes involved in creating effective communication (such as planning, coordinating, writing, designing, evaluating), but also on their ability to negotiate the social and cultural space of the workplace environment. Professional communicators need to make their work visible to coworkers and other insiders within organizations, people who may not recognize the value of audience-centered design and research, but who may exert considerable power over the design process.

Schriver (2012) characterized three interactive processes that are important to professional communication activity (see Figure 1):

- Constructing content (creating artifacts that are rhetorically appropriate and follow conventions for well-designed text and graphics)
- Connecting content to stakeholders (making sure the content meets the needs and expectations of both internal and external audiences)
- Contextualizing design activity (helping both internal and external audiences value the knowledge and skills of the communication design team)
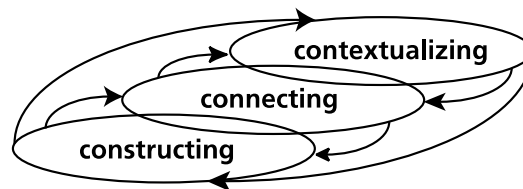

Figure 1: Three interactive processes in professional communication (from Schriver, 2012, p. 292; used with permission from author).

For an expert in professional communication, creating an artifact involves more than just constructing texts and graphics. It also involves knowing how to manage social and physical resources. These management activities frequently contribute to shaping the communication. For example, the designer may *connect* the text by including suggested phrasing deemed important by a collaborator or by employing the graphic preferences of a client. However, sometimes the management activities have no direct effect on the communication itself. Instead, such activities connect the content by paving the way for acceptance of the artifact by the stakeholders. For example, in staff meetings, expert designers may be careful to distribute credit for the artifact so that contributors feel that their work is appreciated. In client meetings designers may make certain to explain how the communication meets or exceeds the client's expectations.

We propose that as communicators acquire deep knowledge and experience in the field, these processes of constructing, connecting, and contextualizing may function as a type of *task schema* for carrying out professional communication—that is, the processes are interactive parts of a system of activity. As such, the processes index global activities that could be modeled (on macro- or micro-levels) by observing the activities of communicators working alone or in groups (e.g., employing qualitative and quantitative methods from keystroke logging to surveys to protocol analyses to participant observations).

We hypothesize that expert communicators possess rich interconnected knowledge for each process that would influence how they set goals, select strategies, search for information, carry out procedures, and reflect on what they do. Professionals' experiential and rhetorical knowledge would inform their social interactions and shape their effectiveness in producing and evaluating artifacts. Moreover, professionals' keen understanding of the work context would give them insight into how best to *contextualize* their activity, enabling others to see the value of their work.

4. Ethnographic case study

To better understand the nature of writing in the workplace, we sought out a company to study that took information design and interdisciplinary collaboration seriously. To show both the possibilities and complexity of information design, we also wanted to study a company that paid considerable attention to the visual aspects of their products. These criteria lead us to the Design Consulting Agency we will call Nova, located in Brussels (Belgium). Nova is a midsized Design Consulting Agency founded in 1987. Its main goal is to help organizations create products, services, or tools based on principles of user-centered design. Nova's core expertise in Human-Computer Interaction (HCI) was augmented by expertise in engineering disciplines, cognitive ergonomics, visual design, and the social sciences. This mix of skills helped Nova understand and solve problems for a variety of complex business domains.

4.1 Participant recruitment

The first author of this paper held an initial meeting at Nova to identify members of its design team who might be most suitable to participate in this study. Nova was organized into multidisciplinary groups, with members whose backgrounds were in computer science, economics, language, history, communication and journalism. For this case study, we recruited a professional who designed a range of business genres, but who focused on proposal writing. As Schriver (2012) noted, professional communicators typically write and design as their primary work or as part of their work in another field, for example, engineering, law, or computer science. The participant in the present case study was a professional who was not trained in technical or professional communication, but he was quite experienced in writing on the job. We will call him Aiden. He was a 45-year old project manager and proposal writer who

had worked at Nova for 15 years. Aiden had studied economics and management, but found he also had skill in creating winning proposals.

4.2   Procedure

First, we spent a full day onsite at the company to get a better sense of Nova's professional communication processes. This allowed us to gain insight into the variety of document types that were used to organize the company's internal and external communications: emails, reports, proposals, posters, instructions, presentations, web pages, etc. We also attended various meetings with team members and external clients.

During a first meeting with Aiden, we enlisted his consent and participation in the study and discussed his future projects that might be suitable for follow on inquiry. We explained that we would track his process by capturing the keystrokes he made, by observing him onsite, and by interviewing him afterward. During this meeting we also installed the keystroke-logging program *Inputlog* (Leijten & Van Waes, 2013) and instructed him in how to use the program to log his activity. We also asked him to fill in a logbook that documented his logging sessions with basic information such as the dates of his activities, the names of files he used, and any technical problems he ran into. The logbook helped us to merge the data later. In total Aiden logged four proposal-writing projects, one of which will be discussed in this article (the written instruction on using Inputlog and the logbook can be downloaded from www.writingpro.eu > search term 'writing from multiple sources').

At the beginning of the study, Nova granted the principle researcher a workspace located next to Aiden. This allowed her to spend some days in his office to gather additional observational data related to meetings, telephone calls, and discussions with colleagues. She also had the opportunity to ask questions about the project's background and meet Aiden's colleagues. This gave her a better understanding of the workflow and the personnel. Additionally, Nova approved her access to the company's wiki and relevant Google Docs documents.

Throughout Aiden's proposal writing and design process, we captured his keystrokes using Inputlog (described later). Once he finished the proposal, we conducted a retrospective interview with the goal of getting his opinions about the experience and verifying the sources he had used for the project.

4.3   Communication task

The proposal that Aiden worked on was developed after Nova and another company teamed up to respond to a tender (a call for proposals) by the Flemish Government. The objective was to create and implement a content management system to support answering questions via the Flemish Info line, an electronic hotline/telephone line that provides information on topics such as property taxes, road taxes, scholarships, and other questions to and about the government. The main priority was to develop a database that would integrate info-line content, which had been scattered over many different websites affiliated with the Flemish Government. The proposal then was a

collaboration between Nova and a company that offered tools for content management systems. Nova operated as a subcontractor.

Aiden collaborated with another project manager within Nova during the project, but Aiden took the lead in being responsible for the proposal's design. This was an ordinary way to work at Nova. For some proposals Nova was the main contractor who hired subcontractors; in other cases it was the other way around. Nova's subcontracting status in this project influenced both the proposal's design and stylistic choices because Nova sought to incorporate the visual and verbal style of the main contractor. In total Aiden worked over 8 hours on the proposal, dividing his process over several sessions.

4.4   Data collection

As mentioned earlier, we collected data by using a combination of research methods, including personal observation, interviews, and logbooks. As a complement to this qualitative assessment, we employed keystroke logging to collect fine-grained and time-based data, with the goal of shedding light on the intricacy of Aiden's writing process. To track the details and time course of Aiden's work, we used Inputlog, a software program that captures keystrokes (Leijten & Van Waes, 2006; 2013). As Aiden worked on the proposal, we tracked his writing process data over the 8.5-hour period, totaling roughly 55,000 lines of keystroke data. (As a way to benchmark this number, consider that the traditional five-paragraph essay results in about 2500 lines of keystroke logging data.)

Keystroke logging is a familiar research technique in contemporary writing research, but it is more commonly used in other domains. Unlike previous keystroke logging programs (e.g., TraceIt, Scriptlog), which operate inside a self-built, limited word processor that is designed for experimental settings, Inputlog allows researchers to log data directly in MS Word and all other applications designed for Microsoft's Windows. Inputlog is a freely available tool (www.inputlog.net). Earlier versions of Inputlog required users to always start from an empty Word document (in which they could copy information from an existing document). Each time the user logged on, the software assumed a new document was underway.

For this project, we introduced two new logging options to the program. First, we updated Inputlog so that professionals could start either with an empty document, an existing document, or a template. Second, we changed Inputlog so that users could continue working on a document that was used in a previous logging session, without having to return to the beginning of that document. These updates to the software facilitated the collection of data considerably and were important because our participant worked autonomously with the program and spread his writing process over several sessions, picking up where he left off in a previous session.

Currently, Inputlog consists of five modules: (1) a data-collection module that registers the fine grain of digital writing processes; (2) a pre-processing module that allows filtering and grouping data; (3) a data-analysis module that offers basic and more advanced statistical analyses (e.g., text and pause analyses, revision analyses, source

analyses); (4) a post-processing module that converts data and merges data files from previous logging sessions and other observation tools, and (5) a "play" module that replays the recorded writing session.

In the context of our work here, understanding the source being used during text production was crucial. Therefore, it is important to note that Inputlog not only registers the input from a keyboard, a mouse, or speech actions (in combination with a start/end time stamp in milliseconds), but it also logs switches between Windows' applications (e.g., Word to Excel). These switches are called *focus events*.

With Inputlog's "source analysis," all of the windows that the user opens are identified, and it logs them accordingly (e.g., as different Word documents, webpage URLs, or graphical applications). So, when Aiden decides to Google certain information, Inputlog logs the identification of the web browser used (e.g., Google Chrome), the active URL (e.g., www.google.be), the page title, the keywords used to activate the search, and the resulting web pages accessed subsequently (together with a so-called epoch timestamp in milliseconds). This makes it easy for researchers to track writers' search behavior and how they interact with sources in real time.

Table 1 (next page) shows a 10-second excerpt of Aiden's writing process generated as a general analysis in Inputlog. In this example Aiden navigates via the Windows Taskbar (ID 88) to Google.docs (ID 90), and then returns to his proposal, an MS Word document (ID 96) to create a new paragraph heading, "mental model" (ID 97-110). The other columns add more specific information that is logged: position of each character in the main document, resulting document length, start and end time of each action (in ms), related actions and pause times, identification of pause locations (e.g., 1 = within a word; 2 = between words; 3 = between sentences; 7 = not classified by the program), and finally the X-Y value of the screen location when a mouse click occurs.

Complementary to this detailed general analysis, Inputlog also generates a source analysis. This analysis measures the interactions between sources by presenting a summary of the time spent viewing each of the sources. Inputlog then creates both a matrix and graphic output of the interactions (shown later in our results).

4.5   Data preparation

In order to prepare the raw data for analysis, we first merged the individual data files and then filtered them to remove what we deemed to be noise in the data files. Activities were considered noise when they occurred either at the beginning or the end of a log file and consisted of activities that did not directly or indirectly relate to the main task of creating the proposal. For instance, Aiden started the 3rd logging session with an email to a colleague about another project. As a consequence we removed this episode (and similar ones) to eliminate such noise from the final data set.

However, breaks in the middle of the sessions were not filtered. They were recoded as 'other activity' and have been incorporated as such in the data analysis. In our perspective breaks are part of the process and can be considered as more or less natural interruptions of a proposal generation process.

Table 1. Excerpt from Inputlog's general analysis output of a proposal writer's process

ID	Event Type	Output	Posi-tion	Doc length	Start Time	End Time	Action Time	Pause Time	Pause Location	X	Y
88	focus	TASKBAR			239602	239602	0	0	7		
89	mouse	Movement			239743	242223	2480	63	7	1027	1185
90	focus	XXX_ XXX - Google Docs - Mozilla Firefox			239743	239743	0	0	7		
91	mouse	Left Click			242301	242379	78	78	7	1027	1185
92	focus	TASKBAR			242301	242301	0	0	7		
93	mouse	Movement			242395	243081	686	16	7	1019	1070
94	mouse	Left Click			243284	243346	62	203	7	1019	1070
95	mouse	Movement			243393	243908	515	47	7	551	949
96	focus	XXX_2011-04-08-XXX .docx - Microsoft Word			243393	243393	0	0	7		
97	keyboard	LSHIFT	315	307	244610	245062	452	702	7		
98	keyboard	M	315	307	244969	245109	140	359	7		
99	keyboard	e	316	308	246497	246575	78	1528	1		
100	keyboard	n	317	309	246965	247106	141	468	1		
101	keyboard	t	318	310	247137	247215	78	172	1		
102	keyboard	a	319	311	247293	247355	62	156	1		
103	keyboard	a	320	312	247433	247574	141	140	1		
104	keyboard	l	321	313	247527	247621	94	94	1		
105	keyboard	SPACE	322	314	247636	247730	94	109	2		
106	keyboard	m	323	315	247917	247964	47	281	2		
107	keyboard	o	324	316	248026	248151	125	109	1		
108	keyboard	d	325	317	248182	248245	63	156	1		
109	keyboard	e	326	318	248354	248416	62	172	1		
110	keyboard	l	327	319	248463	248525	62	109	3		
111	keyboard	RETURN	328	320	248666	248759	93	203	3		

Table 2 shows a summary of the data collection related to the proposal Aiden created. In our interview with Aiden, he pointed out that this was a proposal of average difficulty, written under medium time pressure and with moderate constraints. He regularly had to write proposals that required over a week of his time.

Table 2. General overview of the document construction

Session	Date	Duration	Duration % Cumulative	Duration % Sessions
Session 1	Monday	5:32:41	64	64
Session 2	Monday	0:19:20	68	4
Session 3	Tuesday	1:29:59	85	17
Session 4	Thursday	0:34:45	92	7
Session 5	Thursday	0:41:09	100	8
Total		**8:37:54**		**100**

Aiden started his writing process with a template offered by the contractor (based on a template by the Flemish Federal Government), which had a length of 241 characters. By the end of session 1, the document contained 12,529 characters (approximately 2,000 words). The final version of the document contained 15,530 characters (2,590 words). The difference in pages between the first and the final draft was 14 pages: the first draft was 3 pages; the final document was 17 pages.

4.6   Results

This section reports on how Aiden constructed his document over the five sessions. We describe the way he managed this task, how his writing process evolved, and how he dealt with various digital sources. After a more general description we elaborate on a few episodes in more detail, focusing on instances that relate to the framework and functions mentioned in the introduction.

Figure 2 is a temporal representation of Aiden's writing process. Based on the general Inputlog output file (Table 1), this graph plots a time-based progression of the writing process (x-axis) against the number of characters produced (y-axis). A solid vertical line separates each writing session. Session 1 is further subdivided in three parts. The upper black line shows the *text production* represented by the number of characters produced in the document during the recorded session. This includes typed and copied characters as well as deletions.

The black dotted line represents the actual number of characters in the document at every moment in the process (*document length*). The document length increases when new text is added; remains the same (e.g., when a source is being consulted); and drops when part of the text is deleted. Notice the deletion of a large chunk of text after 4h20m.

The dotted gray line shows the cursor position within the document at each moment of time. A lower position indicates changes in the beginning of the text-and-graphics-produced-so-far. The places where the black and the grey dotted lines coincide indicate new text has been produced at the end of the document. The outlined squares represent comments created with the review function of Word during writing. The numbered black circles mark "points of interest" (POI) in the writing and design process. These POIs will be discussed later in our description of Aiden's process. Finally, at the bottom of the figure, we represent the interaction (vertical lines) between the proposal (bottom horizontal line) and the other sources (top horizontal line).

General overview

As mentioned previously, Aiden wrote his proposal over 5 sessions. The first session—by far the longest—was the one in which he constructed most of his text. He copied and pasted information from related project proposals and rewrote those bits and pieces seemingly instantly. In the second session Aiden reread the text and made some changes. The next day he continued with the budget section of the proposal, for which he used project management tools. Two days later he had to finish the proposal. In the two last sessions, he focused on selecting his team and considered how to present his choices to his project manager.

Session 1a: Aiden first opened a *task-related source* (cf. infra) in the form of a template provided by the Flemish Government, which had been used for a previous proposal project. He decided to use this document as a starting point for his current proposal. It contained two topic headers and a table of contents derived from the two headers. So initially, the document contained 241 characters. Figure 2 shows that the text production and document length did not start from zero.

During the first 15 minutes Aiden planned the content of the proposal by *searching* for adequate pieces of information in other documents (Google Docs, MS Word documents, Excel sheets, emails). During this time he began to develop the text structure by inserting major headings. He also added some comments, which functioned as a kind of reminder of things he needed to address at a later stage (cf. infra w*riting schema*). The next 15 minutes were spent reading a related document, followed by a meeting with his main collaborator: the project manager.
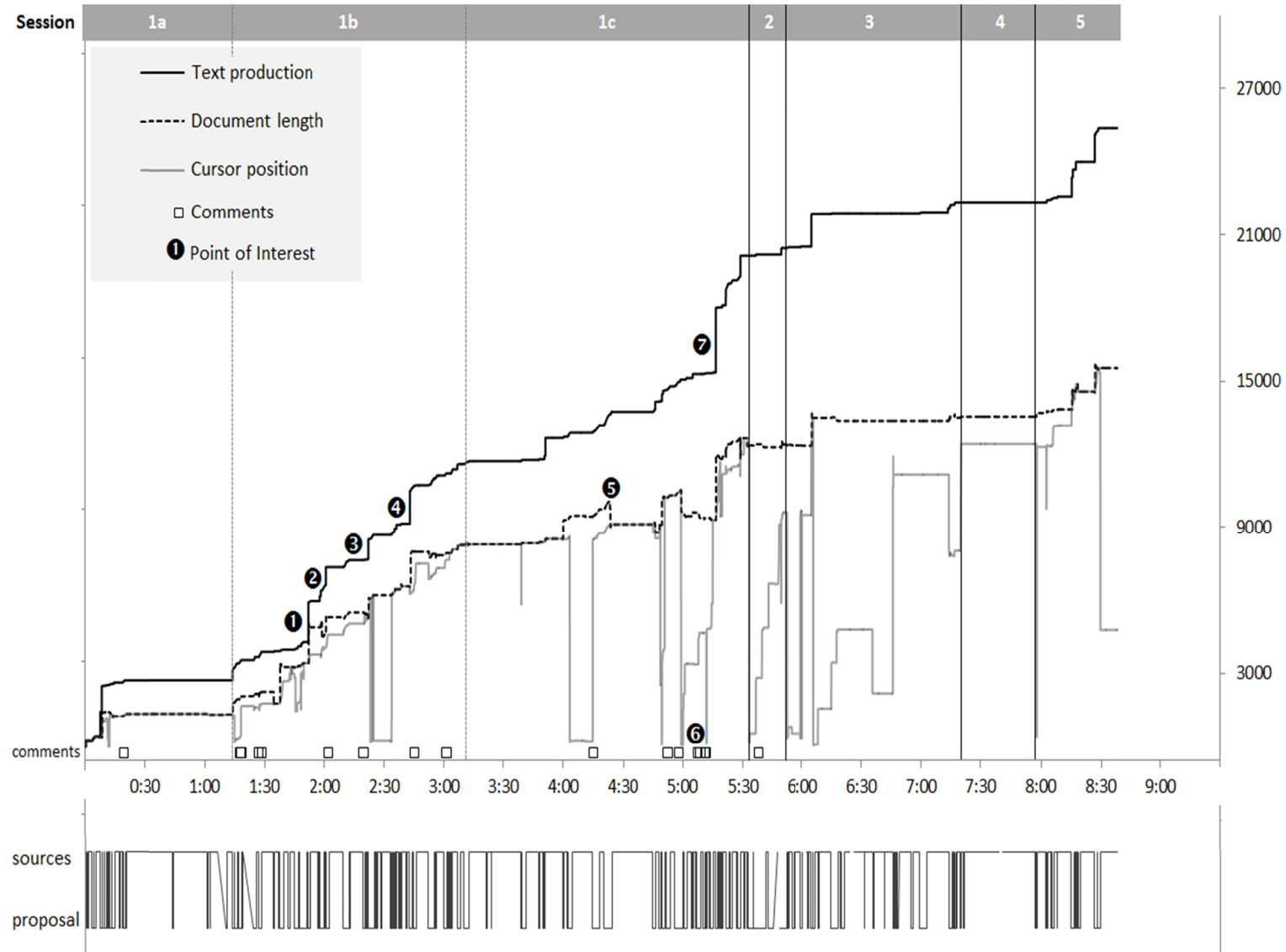
Figure 2. Graph showing the time course of writing a proposal (top) and the frequency and duration of consulting digital sources (bottom).

Gathering the appropriate information to construct this sort of proposal was a fairly well defined process for Aiden. During the retrospective interview he described the initial stage of document design as a "decision process." Here is how he explained his manner of drawing on other's documents and information sources:

"I usually start working from a template-based document. I also use Excel or MS Project for the budget section. In this case I used Google Docs also quite a lot. I made a distinction between Google Docs and our company Wiki. The Wiki holds more general company information and Google Docs contains more specific information relating to my projects. Because we have worked with this contractor before, we share a document in Google Docs that is constantly updated by the project manager. It contains all the agreements with contractor A and the information that needs to be included in a project proposal."

[translated from Dutch]

After one hour and a half, Aiden continued with another subsection of the text. Before continuing, he became distracted by taking a brief look at an online newspaper. He then continued with his task by searching through previous proposals, web pages, and Google Docs. Then he moved ahead with constructing the proposal by inserting text segments from other documents, indicating where further information was needed with placeholder quotes such as "blah blah" in his text, and by adding to-do's in MS Word's comment function. (These meta-comments to himself appear in Figure 2 as tiny white boxes on the x-axis.)

Aiden then opted to retrieve some necessary content from another recently written proposal. In the retrospective interview he described how he reused previously written content in this way:

"Ideally, we take a comparable proposal based on our proposal template, or a comparable project that contains a lot of standard wordings. (...) Sometimes the data is a bit outdated. (...) Standard text can be retrieved from the Wiki or from previous texts. However, nowadays the previous texts are more recent than the Wiki. Since I wanted the most timely content I chose a recent project proposal. It was a pragmatic decision."

Session 1B: In the next hour and a half (1:15 until 3:10) Aiden continued to construct his text by intensely searching for textual bits that he could reuse in his proposal (cf. infra *task-related-sources*). The text parts he inserted were comprised of general boilerplate content, discussing the flow of the software design process that Nova generally followed (e.g., conceptual design, detailed design, prototyping). Aiden proceeded to revise some of this recycled writing and formatted each of these text segments in succession. In session 1B the size of Aiden's document steadily increased (shown in Figure 2). The graph segment for the session clearly shows a pattern of alternately inserting and rewriting (staircase pattern of black top line). During session 1B the document length (dotted line) increased steadily with about 4800 characters

(940 words) in four discrete stages (see Figure 2: POIs #1 through #4). To realize this document growth, Aiden produced about 7300 characters (1400 words) in less than an hour. In other words he kept about two thirds of his generated text. This session was fairly typical in revealing how Aiden coordinated multiple source texts and then textually transformed them en route to constructing a new text. On the whole, 75 percent of the text production related to text that was copied from other sources and pasted into the text to be produced, whereas the remaining 25 percent was newly generated text.

Session1C: The text construction in 1B was followed by a long search for information about how Nova had described its "help documentation" in previous proposals. This search for old content led him to engage in an unrelated activity: responding to an email about a different project. After some time, he succeeded in his search, which prompted him to copy and paste the content he found, followed by rewriting it. This made him realize it would be appropriate to delete some of the text he had already produced (Figure 2: POI #5). He then switched his attention to a different section of the proposal and made some meta-comments, again using Word's comment function. He reminded himself, for instance, that he needed to search for adequate reference cases—exemplar success stories that would draw an analogy between Nova's prior successes and their current capabilities. Aiden's reminder led him to recognize other aspects of the text still needed major work and he wrote a few more comments tagging other issues. As we can see, Aiden tended to use Word's comment function as a way to elaborate his writing goals. His self-talk in these comments played the role of planning prompts, giving himself advice about how to proceed as he began drafting other sections of the proposal (Figure 2: POI #6).

In constructing the exemplar reference cases, he relied on a separate document with relevant case studies (cf. infra *task-related-source*). As Aiden reflected in the retrospective interview:

> "I use a different document in which I save separate cases. It is just a large Word document in which I include all the case studies that I have ever written (e.g., case on usability of Sony webpages). Just, so I know they won't get lost. This could also be done in the Wiki, but to save images in a Wiki is terrible. This document is on our server, so everybody can use it."

While some of the time Aiden used boilerplate text retrieved from the company Wiki, the examples he employed to make his central arguments were drawn from content he had created earlier, a kind of "mother" document that referenced persuasive claims about past success stories. Aiden's case study repository proved easy to access and easy to search since he had constructed it specifically to be mined and reused at a later point. His comment about the Wiki being unsuitable for saving images illustrates how professionals make judgments about the value of digital sources and their affordances

before they access them. It also reminds us that technologies shape not only what we do, but also what we do not do.

Once Aiden retrieved the case studies he needed, he spent some time updating the text and tweaking the source material. His inclusion of this case material created the big peak in text production shown in Figure 2 (POI #7). After this burst of production he continued rewriting the text. He finished this first logging session by editing the case studies.

Session 1 was characterized by Aiden's assembling of divergent content bits from a variety of sources to make a kind of bricolage that would guide his later writing. In constructing this part of the proposal he integrated texts from his case-study repository, Google Docs, the company Wiki, and a company-related website. To carry out this activity required making appropriate decisions not only about which sources to draw on, but also about which parts of texts were most relevant, which parts could be reused as is, which parts needed paraphrasing, and which parts had to be trashed and completely rewritten. In short, while his process appears a bit chaotic, his search behaviors and textual moves were driven by a good sense of his rhetorical goal, to compose a winning proposal, and to find the reusable bits that would help him do that quickly.

Session 2: Session 2 was rather short, during which Aiden reread the whole document. He began with the front end of the proposal and mostly focused on deleting text that did not fit. He also wrote several meta-comments to himself that referred to information he still needed in order to complete the case studies and make them coherent.

Session 3: In the third session, which started a day later, Aiden first reread his document (cf. infra *text-produced-so-far*). This rereading was often interrupted by search activities. After 15 minutes he inserted another case from his reference repository and adapted it to his working proposal (changing names of employees and formatting the text). Onsite observation showed us that Aiden regularly tried to get a sense of the gist of his text by displaying it as two-page spreads on his screen. He returned to rereading the request for the proposals, and this prompted him to communicate with two of his colleagues about forming a team (first he met with a contractor, then with the project leader). In the remainder of this session, Aiden spent most of his time examining other sources for content. For example, he looked for an adequate visual illustration that would strengthen his case. He interacted via email with a colleague to help him find the most appropriate example. He ended the session by making only minor changes to the text.

Session 4: Two days later, in session 4, Aiden focused on generating some project management files in Excel. He took a look at some old files from another project for ideas about how he might frame the budget and management team. He did not make any changes to the proposal.

Session 5: The focus of the last session was on detailing the composition of the team. For example, he added each team members' references, showed their relevant projects, and selected details about their credentials that would demonstrate how suitable each member would be for the project. This led him to move back-and-forth between old project proposals and the new one, inserting bits and updating content from various legacy documents. After each search and copy/paste action, he rewrote the borrowed text to integrate and connect the content so as to create a coherent and stylistically consistent text. This seemed to be a typical activity for him (see pages 20-21 for more concrete example).

As session 5 came to a close, Aiden spent time making sure the budget and team composition were appropriate. He ended the session by emailing his project manager with details about the team's structure. He wanted to make sure the proposal was as good as it could be prior to sending it to his supervisor for review, showing sensitivity to not wasting his project supervisor's time. By collaborating effectively Aiden "paved the way" for a quick decision about the team's composition, which once approved, allowed him to finish the proposal within the time constraints.

In line with research on expertise in professional communication (presented in our introduction), Aiden's design process could be characterized as one of interleaving the processes of *constructing, connecting,* and *contextualizing* (Figure 1). Throughout the proposal construction process Aiden strove to adapt the text so it would connect with his audience of Flemish Government decision makers. He recognized the need to contextualize Nova's proposed activity and worked iteratively to generate persuasive case studies so that decision makers would see that Company A (the primary contractor) and Nova's prior experience (as subcontractors) were more relevant and more valuable than the capabilities of the competition.

Resource switches

As described above, Aiden regularly chose to leave his text in search of suitable information elsewhere. Based on the data in the general logging file from Inputlog, we identified all of the sources Aiden accessed (called *focus events* in the general logging file). Inputlog identified about 280 unique focus events. We grouped these focus events into 31 categories, which were further recoded into nine main categories based on software or program types. For instance, various programs for email (Outlook, Webmail, etc.) were grouped into the main category 'mail'.

Next we calculated the switches and used them as input to manually construct a *source analyses matrix*. This matrix was then imported in the software application *Pajek[2];* it generates network graphs based on a source-analysis matrix (Leijten & Van Waes, 2013). In this network representation (see Figure 3) circle sizes indicate the percentage of time in the main document and sources; the arrows provide information about the number of switches between sources (a stepwise instruction on implementing

a source analyses matrix into a network diagram can be found on www.writingpro.eu > search term 'writing from multiple sources').

Figure 3 shows the main sources Aiden used to write his proposal and the interaction among these sources. The figure can be read as follows: Aiden took his attention away from the proposal (main document) 45 times to consult his email. See the number closest to the source (mail) for how many times it was consulted, and the number closest to the main document to see how often he switched back to the proposal. Looking over his email initiated other activities, indicated to us by his returning to email only 29 times. The arrows that leave from the source "email" allow us to follow his search path. So, from his email he not only returned to the main document, but he also continued his search process by accessing other documents, by consulting the Internet, and other sources.
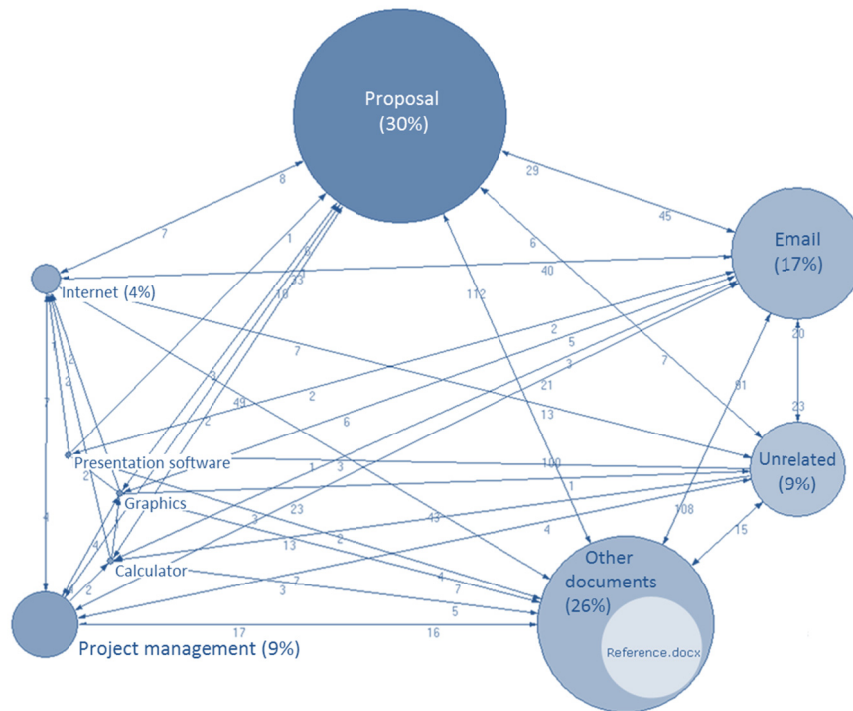

Figure 3. A node-network diagram indicating the number of times the proposal writer switched among various sources during writing and design. The number closest to the source shows how many times it was consulted (e.g., from proposal to e-mail: 45 times). The number closest to the proposal indicates how often the writer switched back to the proposal (e.g., from e-mail to proposal 29 times). Also shown is the relative time spent with each type of source (the larger the circle, the more time spent on that activity).

The network diagram in Figure 3 shows that during the writing and design process Aiden switched 1118 times between his proposal and other sources. The sources most used by Aiden were his proposal (30% of time); other documents (26%); email (17%); project management tools, such as MS Excel and MS Project (9%); and Internet searches (4%). Unrelated other activities took about 9% of the time (cf. the section, "Downtime in professional communication"). The remainder of the time—spent switching among using presentation software, graphics, and a calculator—took less than 5% of the time. On average, he made 305 switches per hour or 5 switches per minute. While this visualization does not represent all of the interactions among the sources he consulted (since we used an aggregated categorization), it does speak to the importance of his search process, to his continuous interaction with sources during writing and design, to the complexity of switching among sources, and to the relative importance of the different sources.

In the next section we zoom in on some concrete examples to further illustrate the importance of goal setting during his search process. We will look at Aiden's rhetorical goal of emphasizing Nova's strengths (*contextualization*).

Goal setting during search activities

In this example we focus on Aiden's search process. It shows the way in which he *contextualizes* Nova's expertise in the context of the current proposal. The graphical representation of Aiden's process (shown in Figure 2) reveals many instances of search across a variety of source materials. At the beginning of his work Aiden constructed his text in by intensely searching for textual bits that he could reuse in his proposal. As we mentioned in our general overview, Aiden's early work focused on revising this recycled writing and successively formatting each text segment. The graphical depiction of this part of his work clearly shows a pattern of alternately inserting and rewriting (see the staircase pattern of the top black line, POIs #1-4). After making these changes Aiden reworked the text segments in order to better integrate and connect them with the new textual context—optimizing their readability, coherence, and cohesion. This sort of expertise is called 'knowledge crafting' by Kellogg: "In the most advanced stage of knowledge-crafting, the writer is able to hold in mind the author's ideas, the words of the text itself, and the imagined reader's interpretation of the text" (Kellogg, 2008, p. 5). That is, professionals shape information not only by making textual decisions that are suitable for the text's comprehensibility and coherence, but also by connecting the content to the reader's needs.

As described earlier, Aiden began his search for supporting case studies in session 1 (after about 5 hours into the session). He returned to this same source "reference.docx", which was part of the collection of "other documents" (shown in Figure 3) 42 times over a time period of 3 hours and 16 minutes. In other words, he accessed this source roughly every 5 minutes. Professionals search for content for a variety of reasons. In the following, we detail some of the *goals* underlying *search* from our case study.

Retrieve content: In session 1 and session 3 Aiden retrieved case studies of two comparable projects. First, he retrieved content from his case-study repository about a project that Nova had done for Sony; the length was 2657 characters. Second, he retrieved a case based on a different project that Nova had done for the Flemish Government; here the length was 1348 characters. These case studies described the goals for the projects, the project duration, the people involved, and the deliverables (e.g., an onsite workshop and a round of usability testing). Searches for these cases went quickly, only taking about 30 seconds for each. Since Aiden had developed the reference document himself, the information in this document was highly accessible to him.

However, search activities were not always as fluent as this. In another instance (near the end of session 1) Aiden began by using the software's "find" function in the reference document but could not find the desired case study he was looking for (Service Design Toolkit). That led him to investigate multiple digital sources: Google Docs, Outlook, PDF, and Mozilla Firefox. He finished his search with the company Wiki, where he finally located the desired information for a third case. In contrast with searching for the case studies of Sony and the Flemish Government, this search took him about 2 minutes and 30 seconds, accessing 7 different sources and switching 19 times. Some theoretical issues about fluent and non-fluent search activity are elaborated in a later section (Search Process).

Structure and formulate text: After inserting the case studies, Aiden reformulated and structured them further by boldfacing the headers, deleting unnecessary information, and elaborating the itemized lists. In reusing text segments from other documents, Aiden applied different reformulation techniques to make the text more appropriate for the audience. Formulating and structuring seemed to be a very common task for him: it took him about 1 minute before he continued searching for another case study. This kind of rapid textual transformation likely indicates that Aiden had acquired deep knowledge of his task and extensive experience in organizing proposals.   In what follows we explain this in more detail.

For instance, after about two minutes into his work (segment 2:13.14) he decided to copy and paste a text block of about 1600 characters[3] from another proposal. (Although the text was not specifically related to this project, it provided a more recent example of a concept he wanted to discuss; see also quote page 15.) Next, using the "find and replace" function, Aiden substituted all instances of 'detailed design' with 'prototype', presumably to adapt this text fragment to his current context. Even so, once he made the substitution, he decided that the text he had inserted was not good enough for his purpose, and he searched in another proposal for a better description of the concept 'detailed design'. Again he inserted a text segment (2:19.51, length: 250 characters). Apparently, this text segment contributed to what he wanted to say since he chose to keep it. Again, by changing only one phrase he reestablished the text's cohesion and

related the proposal to the intended reader. He substituted the word *'application'* to *'management office'*, which was the name of the product the customer was developing. Although the change was small it does shift the meaning from generic phrasing to text that is more reader-oriented.

> Original text (translated)
> The prototype shows how the most important screens of **an application** are built functionally so decision makers are able to get an idea of what the application will look like.

> Revised text (translated)
> The prototype shows how the most important screens of **the management office** are built functionally so decision makers are able to get an idea of what the application will look like.

This example shows how a standard section taken from another source was optimized and integrated in the new textual context. In his next move Aiden revised another sentence to strengthen his argument.

> Original text (translated)
> In the prototype Nova shows an elaborate example ...

> Revised text (translated)
> In the prototype Nova shows **a realistic and elaborate** example ...

In Aiden's following revision, he inserted a text section from another proposal (about 750 characters), which only needed reformatting to make it consistent with similar aspects of his current text. As we can see, in about three minutes Aiden used a variety of writing techniques—changing the wording, modifying the text for cohesion, and changing the format—so as to optimally integrate the text taken from different sources in his current proposal. His main aim was to more adequately realize his goals by adapting the content and phrasing to his readers and their context.

Designing visuals and layout: In document design, the verbal text is critically important, but the visual display of artifacts play an equally critical role (Schriver, 1997, 2013). Based on his visual design schema, Aiden sought to add extra strength to the Sony case with a diagram that showed the method Nova used for human-computer interaction projects. He started his search for visuals in session 3 (after about 45 minutes into the session) by browsing visuals and diagrams he found in Windows Explorer (Photo Gallery), a related PowerPoint presentation, and a PDF document. After four minutes he found a good rendition of Nova's conceptual design process in a legacy PDF document, took a new screenshot of the conceptual design, and immediately inserted it into the proposal. He continued his search using the same documents and after four minutes he asked for some advice from a colleague using email. He explained to his colleague the type of visual he wanted to use in the proposal and that he was having

difficulty opening certain files from the server on his local computer. (Aiden had found an even better flowchart of the design process in MS Visio, but it would not open; hence he satisficed with a screenshot from the legacy document.)

After about five minutes he again communicated with his colleague, this time to further specify his search criteria: it should be a detailed picture of the case and it should show the interaction possibilities. Aiden checked his email some 13 times to see if his colleague had sent him the desired information; he received a response after about an hour and a half into this session. During his wait Aiden continued writing other sections of the proposal, a process he regularly interrupted to search for other relevant visuals and diagrams. Related activities were creating a table of contents for the proposal and integrating screenshots of budget plans from Excel and MS Project. This example from Aiden's activity underscores the importance of visual design as part of the professional communication process.

Build tactics and strategies: While constructing the document Aiden made strategic choices on various levels, particularly with respect to the way he mined the reference document he drew on. First, Aiden selected illustrative projects related to the current proposal, showing Nova's expertise in the domain. Second, he selected projects that showed the breadth and diversity of Nova's work. Third, he selected cases that showed the expertise of the team members over their careers. By consciously choosing cases for their rhetorical impact Aiden was able to demonstrate Nova's superiority over other design teams in three ways: show domain expertise, show diversity, and show team expertise. As we can see, this activity is a kind of *contextualizing*. And as explained earlier, Aiden also described the team composition in a strategic way to his project manager (an example of *connecting*).

We should also point out, however, that his searching behavior was not always a straightforward process. From time-to-time Aiden "looped" while searching for information. Search actions sometimes led to activities unrelated to his goals or work, such as responding to email or reading an online newspaper. During his search for case studies, for example, Aiden sometimes became distracted. Even during well-defined searches, he sometimes interrupted his own search activity, for instance, to check an email or peruse an RSS alert. For example, in session 3, Aiden opened the reference document and copied the section about the case he needed (this search action lasted about 26 seconds). However, before returning to the proposal to paste in this information, he decided to open Outlook and login to his Webmail. After skimming a few email messages, he briefly opened five other documents. Finally, he pasted the text from the copy buffer into the proposal. In other words, between the copy and the paste action, he switched 9 times between various sources. So even though Aiden had set the goal to insert a particular case into the proposal for further editing, he wound up interrupting his process by checking his email and other documents. Later we examine possible reasons for these interludes of downtime and consider the possible roles of activities unrelated to professional communication (see the section, "Downtime").

To sum up, this case study clearly illustrates that text production in today's workplace often involves constructing documents from multiple digital sources—integrating one's own texts/graphics with ideas based on others' text/graphics.

Although the process of professional communication has neither been sufficiently explored nor modeled, there is much we can learn about design activity from existing models of composing, which draw on a rich tradition of research (Bereiter & Scardamalia, 1987; Hayes, 1996; Hayes & Flower, 1980; Kellogg, 1996). In the next section, we examine a recent model of composing and hypothesize how it could be modified to accommodate the writing and design activities we observed in the current study. Although we realize the peril in generalizing from a case study, we contend that the writing activities we observed are quite typical for professional communicators working in organizational settings, particularly settings involving multiple digital sources. More than that, we are convinced that the activities we described in this case are indeed part of the landscape of most contemporary writing in educational and professional contexts. In addition to suggesting modifications to recent models of composing, we also propose a specific mechanism to describe how writers search for information, focusing on their goal setting and on the activation of ideas about optional sources to search. We end with a description of the concept of downtime.

5.   Modeling Writing Processes

In perhaps the most comprehensive cognitive model of writing to date, Hayes (2012) accounts for the processes that individual writers engage in as they plan, compose, and evaluate their texts. While focusing mainly on cognitive processes, the model considers some aspects of social processes as well. Shown in Figure 4, the model has three levels: a control level, a process level, and a resource level.

The *control level* includes motivation and the processes and structures that control the other writing processes. Motivation is essential to sustain the writing activity. Goal setting determines the kind of writing activity to be engaged in: creating written plans, writing formal texts, revising, and so on. The current plan is a set of goals for creating the current text, initiated by the goal setting process and stored in memory. The writing schemas represent the writer's beliefs about how writing processes and resources should be used to create the planned text.

The *process level* has two major parts: the writing processes and the task environment. The writing processes are the internal mental processes that the writer uses to compose. These include a "proposer" that generates ideas in non-verbal form; a "translator" that transforms these ideas into language; a "transcriber" that takes the language and creates written text; and an "evaluator" that critiques the outputs of the other three processes.

In creating a text, the processes that writers employ interact with the task environment, that is, with the physical, social, and cultural contexts of the writing

processes. The task environment includes critics and collaborators who may provide suggestions and criticisms for the text. The task environment is also comprised of the writer's culture—it norms, ways of knowing, ways of proceeding, channels for feedback, sources of power and authority over the text. Cultural cues can exert considerable force in how writers proceed. The task environment also includes physical source materials such as books, articles, and any written plans or outlines that the writer may have prepared. A very important part of the task environment is the text-written-so-far, which skilled writers consult frequently when composing. Finally, the task environment includes the transcribing technology. The writer may choose to compose with pen, keyboard, or voice recognition, and that choice makes a difference in how the writing processes are carried out.

The *resource level* includes resources that are used in writing but are also widely available for carrying out other activities, such as doing math problems, cooking a meal, repairing a car, and so on. These resources include long-term memory, working memory, reading, and the ability to focus attention.
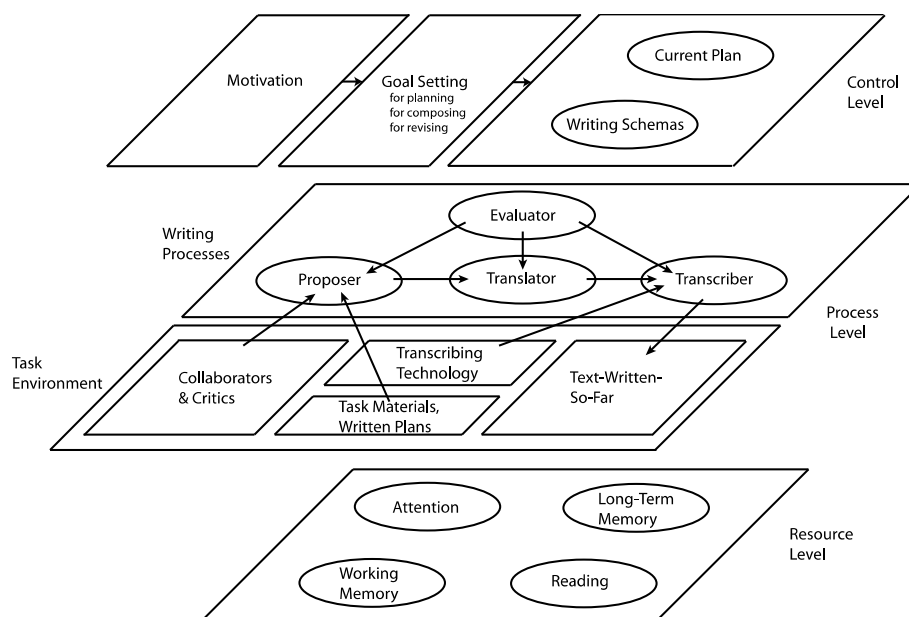

Figure 4. Hayes' (2012) model of writing (used with permission of author).

5.1   Model of skilled professional communication

As discussed in our introduction, Hayes' model identifies some of the basic processes of communication and suggests some of the activities professional communicators

engage in as they compose from multiple digital sources. However, to more adequately describe professional communication, especially the act of composing in distributed environments, several other important characteristics need to be accounted for.

We elaborated Hayes' model so that it can encompass the phenomena we observed in the present case study of a skilled professional communicator (shown in Figure 5). These additions are based on the research described here as well as that of Kellogg (2008) and Schriver (2012), who have both discussed expertise in professional communication.
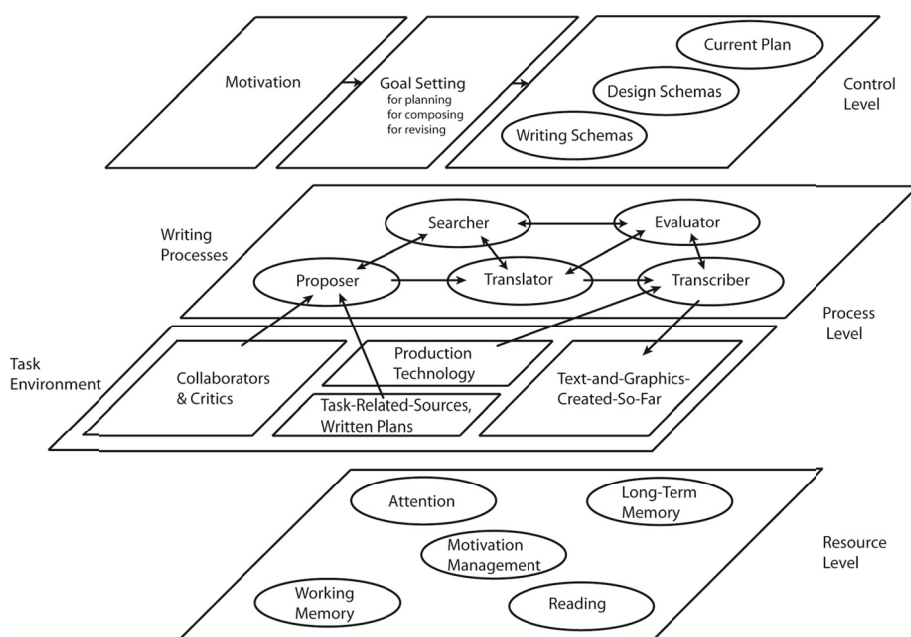
Figure 5. Model of composing elaborated to encompass activities of skilled professional communicators (adapted from Hayes, 2012).

As the present case study shows, professionals do more than produce verbal texts. They also create visual texts, collaborating with others to generate graphics, drawings, or photographs. Professionals working alone or in groups routinely make decisions about what to visualize and what to verbalize, drawing on a variety of visual models (both physical models and mental models of graphic conventions and schemas); for some examples, see Schriver (2013). To take professionals' visual *design schema*s into account, we have included them at the control level. Although visual design processes are critically important, we feel that we do not understand them well enough at this time to model them. However, we hypothesize that some of the processes of designing texts visually overlap with writing processes, but others are unique to visual design.

Second, the text-produced-so-far (part of the task environment at the process level) assumes the communicator is generating words and sentences, using his or her own text as a catalyst for invention. Professional communicators may often be as concerned with creating graphics as they are they are with generating text. We have elaborated this aspect of the task environment by expanding it to *"text-and-graphics-created-so-far"*.

Third, the phrase "task materials" was too suggestive of a traditional school task (see Figure 4 at the process level of the task environment). We think *"task-related-sources"* is a better choice because it captures the idea that the sources professionals draw on may be human, textual (e.g., printed or digital), graphic, or typographic.

Fourth, since the document design activities of professionals often transpire over the course of days and weeks, we wanted to account for how communicators manage their motivation, dealing with, for example, taking downtime to deal with fatigue or boredom. To account for these factors as the communicator works on tasks over extended periods of time, we added *motivation management* at the resource level. We placed motivation management at the resource level because it is used not only in extended communication design tasks, but also in any long, boring, or stressful activity. Motivation management is a skill that draws on a person's metacognition about his or her response to fatigue and/or boredom. For example, when a writer notices he is having trouble concentrating, he may recognize that he is not being productive and would perform better if he took a break. Managing one's motivation is different from motivation itself, which directs and energizes writing activities. For this reason we represent motivation management at the resource level and motivation at the control level. Of course the ability to manage one's motivation is important even in children's writing. We contend that motivation management is a general issue for all types of writers (academic, creative, professional) of all ages, not just adult professionals.

Fifth, and perhaps most importantly, missing was an account of the search process during content development. Because most writing activity (whether at school or work) requires the processing of both long-term memory (LTM) and external sources of information, we have explicitly added a *searcher* that looks for information in external sources as one of the basic writing processes. The searcher operates for any type of writing, whether academic, creative, or professional. In the case of professional writing, for example, if the writer needs to retrieve content that was produced for another project, the proposing process may be interrupted to search for that content in another document. If the writer doesn't know how to spell a word, the transcription process may be interrupted to search a dictionary. If the writer cannot find the right word to express a meaning, the translation process may be interrupted to search a thesaurus. If the layout for a text is problematic, the writer may search for ideas about layout in external texts.

We have tried to represent these various activities by including a *searcher* as a basic writing process that – in some instances – supplements the retrieval of information from LTM. Of course, when all the information needed for writing can be retrieved

from LTM, writing often proceeds without searching through external sources. However, when LTM fails (or is not the preferred 'source'), writing processes may be interrupted by the need to search external sources. In some instances, there might also be a potential conflict between domain knowledge stored in LTM and the information contained in external sources. When working memory capacities are limited, writers may try to avoid interference between the sources (Chuy, Alamargot, & Passeraut, 2012). We contend that the complex interactions among working memory, long-term memory, and the search process need more explicit treatment in writing models.

In the following section we elaborate different aspects of the search process by looking at models of search (or information seeking) in other domains. We also describe a basic model that characterizes the structure of the search process during writing. Next we explore the idea of source categorization and ask how divergent goals might guide the search process. Additionally, we illustrate how our long-term memory may be employed as we explore and select information.

5.2   Search Process

As shown in Figure 5 (model of skilled professional communication), we propose a *search component* as one of the basic writing processes, parallel to proposing, translating, etc. This search component is partly based on the influential search model that Kuhlthau (2005) proposed to describe information search in the context of library and information services. Although it is not strictly a cognitive process model, Kuhlthau's model shares a number of features with the search component we propose as part of the writing model. In particular, Kuhlthau identifies four criteria that influence search: the task to be accomplished, the time allotted to perform the task, personal interest, and the information available.

Each of these criteria can be represented in the search process we propose. The main function of search during writing is to retrieve information from external sources such as the Internet, dictionaries, thesauri, related documents from self and others, emails from collaborators, other software applications, etc. (see section on *source categorization* below). The relation of search to other composing processes is shown in Figure 5. Our proposal for the structure of the search process during professional communication is presented in Figure 6.
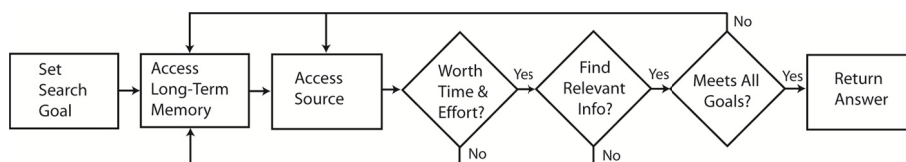

Figure 6. Model of the information search process.

Our goal with this model of search is to depict the professional's knowledge of the likely value of an information source and its alternatives. According to our model,

when professionals look for content using external sources, they typically set search goals to identify what they need. For example, a professional may want to find a word that is both a synonym for a technical term and also familiar to the intended audience. Given these goals, the professional would draw on her long-term-memory to find known information sources to meet those goals. (We will discuss a spreading-activation model of long-term-memory in more detail in a later section.) When professionals retrieve a source from long-term memory, they evaluate it to determine if searching the source would be worth the effort. Effort can vary with the user-friendliness of the source, the searcher's skill, the available technology, and so on.

Pirolli (2007) describes search as a type of information foraging. He suggests that because a searcher is often faced with overwhelming amounts of information, it is important to allocate one's attention and decide whether it is worth the time and energy to carry out the search. While some of the time professionals search with the aim of finding relevant information that meets all of their criteria for relevance, other times they satisfice with information they deem "good enough" for reaching their current goal.

In one case we observed, an individual attempted to search for a legal fact on Lexis-Nexis, found it too difficult to understand the information retrieved, and instead, opted for a different source, a colleague who was a lawyer. If the effort required by the source is judged acceptable, then information retrieved from the source will be evaluated for its match with the professional's (or more generally, the writer's) current goals. If all goals are met, then the retrieved information will be passed back to the process that requested it, such as the transcriber. We propose that professionals gauge the relationship between the costs and benefits of seeking external sources, and that this decision-making takes place throughout the writing and design process, from macro-level decisions to micro-level ones.

In other words, based on an (implicit) assessment of these criteria, professionals constantly decide whether to consult a source or continue working, relying solely on their LTMs and the text-and-graphics-produced-so-far. They may also decide to postpone the search process, for instance, as Aiden did, by adding a comment in the text reminding him to return and look for more information later.

Goal setting during search

Professionals initiate search when information they need cannot be retrieved directly or more efficiently from their knowledge and experience (stored in long-term memory). Search fulfills a variety of purposes; for example, professionals may want to
- Retrieve content,
- Compare optional structures,
- Consider alternative phrasings,
- Update visuals and layout, or
- Develop tactics and rhetorical strategies.

When retrieving content is the purpose, communicators may, for example, check a reference on Google Scholar, look for technical content on a government website, verify a fact on Wikipedia, enhance background knowledge by reading a blog, contextualize an argument by skimming through archives of journals, use a currency converter for calculating a budget, and so on. In other instances, the purpose of search might be to compare alternatives for the structure of an artifact, for example, by analyzing analogous documents globally—evaluating their use of genre conventions, assessing their rhetorical strategies, and so on.

Other times search is triggered more by micro-level considerations—such as Googling possible keywords for use on a homepage, looking for popular phrasings of an idea by comparing retrieved content from Yahoo or Bing, reusing "boilerplate" textual fragments from the company legal department, or translating a word using Babelxl.com.

As we discussed earlier, professional communicators typically interleave their design processes, switching from designing texts to designing visuals. Importantly, as they move from thinking about the text to the visual design, the "text-and-graphics-created-so-far" may prompt goal setting and search. For example, looking over the artifact and noticing poorly chosen visuals might prompt a search for relevant photography, perhaps looking on iStock.com for an image that will best achieve their rhetorical goals.

Search can also be related to building tactics and rhetorical strategies. For example, in many organizations it is common to "scope the competition" by "reverse engineering" the information design of other similar organizations. Here professionals' search is directed to identifying positive or negative characteristics of others' artifacts with an eye toward developing an improved model of what could be done. Professionals often spend considerable time searching both their own organization's internal artifacts as well as those produced externally by others. In this way, professionals' work is characterized by collaboration—drawing on shared knowledge, public artifacts, and communal documents—even when they not working together face-to-face or at a distance (cf., Janssen & Neutelings, 2001). Their assessment of others' work often prompts them to reuse others' texts and graphics to devise new plans, tactics, and strategies.

Spreading-activation and search

Figure 7 illustrates how John Anderson's (2009) spreading-activation model of long-term-memory can be employed to account for the retrieval of information from long-term-memory. Here we show how a set of search cues could lead to the selection of an information source. The right-hand column of the matrix represents a variety of sources, each of which is assumed to have a baseline activation (b_j). The baseline activation of a source is intended to reflect the professional's preference for that source based on its frequency, recency, or ease of use. Sources that are frequently used or have just been

used are assumed to have higher baseline activations than other sources. The bottom row represents a variety of search cues.
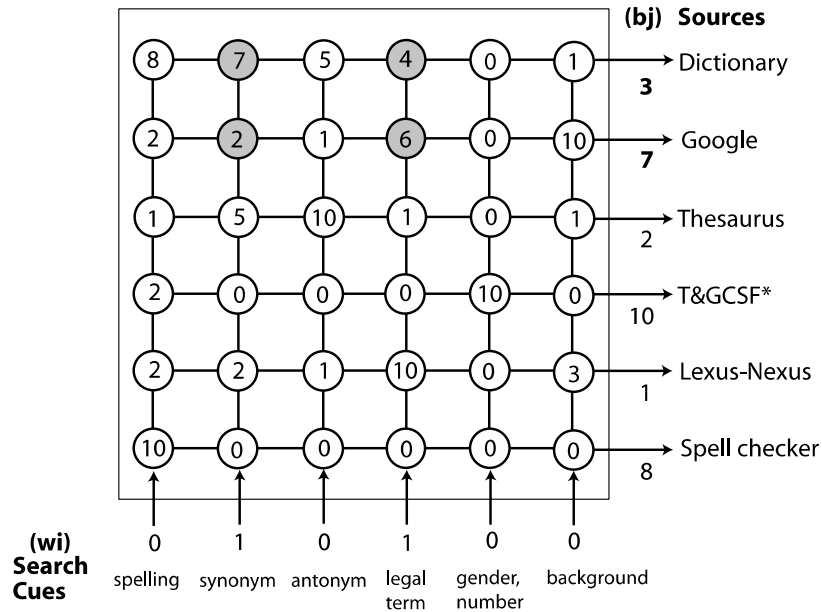

Figure 7. An example suggesting how a spreading-activation model of long-term memory might operate in choosing information sources. *T&GCSF indicates the text-and-graphics-created-so-far.

For simplicity, we assume that search cues activated will have an input weight (wi) of 1, and non-activated search cues, an activation of 0. Numbers within the matrix represent associations between search cues and sources. For example, the search cue "spelling" has a strong association to "spell checker" and "dictionary" but weaker associations to the other sources.

The total activation (A) for a source (j) is assumed to be the sum of its baseline activation (b) plus the product of the associations (a) multiplied by the input weights (wi) of the cues summed over the source's row (shown in Equation #1).

Activation of source j, $Aj = bj + \sum_1^n (aij * wi)$
Equation 1. How spreading activation works.

In the example depicted in Figure 7, we illustrate how spreading activation might operate if a professional was looking for sources in which to find a synonym for a legal term. This search would activate two inputs to long-term memory: *synonym* and *legal*

term, each of which is given an input weight of 1. The total activation for the source *dictionary* is 3 for its baseline activation, 7 for its association with *synonym,* and 4 for its association with *legal term*, for a total of 3 + 7+ 4 or 14. Similarly, the total activation for the source *Google* is 7 + 2 + 6 = 15. The other sources have substantially less activation and presumably would not be chosen.

If we consider baseline activation in relation to our case study, we saw that Aiden's personal "case-study repository" had high baseline activation, while other documents had lower activation. High activation of the case-study repository made it easy for him to step out of the flow of the writing process—proposing, translating, transcribing, evaluating—and search for the content he needed.

This hypothetical example, though small in scope, provides a crude representation of the workings of a communication designer's (or writer's) long-term memory during search. A professional's real memory would activate many more potential inputs, many more potential information sources, and a great many more associative links.

As we can see, writers' searching can proceed more or less fluently as they consider alternative sources. If the search cues strongly activate a single source that in fact contains the desired information, the search can be seen as fluent. A less fluent search would result if (a) the search cues strongly activate a source that fails to yield desired information, or (b) the search cues fail to strongly activate any source. In either case, the professional might have to forage through a number of less promising sources that may or may not contain the desired information.

We propose that as professionals gain experience on the job, they acquire more effective search procedures and their long-term memory becomes better developed. They grow more familiar with information sources, more sophisticated in evaluating them, and more skillful in determining if their search goals have actually been met. These improvements in the effectiveness of search procedures are an important part of a professional's expertise, particularly those who work in distributed environments.

We have seen that the search process might lead to distractions. Since communication design tasks may take hours, days, or weeks, and are carried out in complex physical, social and cultural environments, we felt it was important to also consider how professionals manage their motivation as they complete lengthy projects. We contend that *downtime* is part of the way that professionals manage their motivation during extended writing and design. In the next section we elaborate on the nature of downtime.

5.3   Downtime in professional communication

Earlier we attempted to account for the special skills and abilities of experienced professionals by adding both the process of search and the process of visual design to Hayes' 2012 model of adult writing (see Figure 5). We argued that these processes are integral to professional communication and are routinely part of what experts do as they carry out writing and design tasks.

In our case study, we noticed that Aiden devoted 9% of his time to activities that were not related to the primary task. Some of this so-called *downtime* was voluntary. For example, Aiden sometimes interrupted his work to fetch a cup of coffee, check email (session 1c), read an online newspaper (session 1a), or visit a favorite blog for the latest news (session 3). It was not always possible to identify what initiated his downtime. However, occasions in which he struggled with goal setting seemed to have had a trigger function.

We believe that voluntary downtime should not be interpreted as "noise," but—at least in part—considered as a result of professionals' meta-knowledge of their own motivational limits. They may pause because they know it will relieve fatigue or reduce boredom. They may pause to improve flagging ability to concentrate and stay on task. They may pause with the expectation of returning to the task with new energy or a fresh outlook on solving the problem at hand.

We suspect that a similar kind of meta-knowledge is acquired by many others experienced workers who carry out motivationally demanding tasks; for example, students, scientists, novelists, pilots, astronauts, lawyers, long-distance truck drivers, and so on. Because this kind of meta-knowledge is important for many tasks, *motivation management* is represented at the resource level of the model (shown in Figure 5). As discussed earlier, the resource level consists of assets used in multiple activities.

Of course, there are many situations in which downtime is *involuntary*. Involuntary downtime happens as a result of distractions—such as having to deal with unexpected visitors, emergencies related to other tasks, technology breakdowns, alerts on mobile phones, and so on. Involuntary downtime is driven by the social, technological, and cultural environment in which the communication design task is carried out. Fortunately, some designers are able to structure their task environment with an eye toward reducing the amount of involuntary downtime; others are not so lucky.

Many individuals and organizations have developed strategies for managing downtime. Professionals may prevent interruptions by closing their office doors or shutting down their email program when they want to work undisturbed. Teachers, for example, may post office hours to limit the times of student visits. Engineers may sit facing away from their office doors so they won't have to greet every passerby. Alternatively, some organizations view constant social interaction and collaborative downtime (such as shared game or exercise spaces) as ways to promote creativity and team building.

There is some evidence that downtime may have beneficial effects on productivity in the workplace. For instance, Coker (2011) identified 17 types of "workplace Internet leisure browsing" (WILB) and showed that most of these had a positive effect on productivity (self-reported). Employees who devoted no more than 9 to 12% of their time WILBing proved to be more productive than those who did not engage in WILB. He identified a point of inflection at around 12%, showing that a higher WILB percentage had a negative impact on productivity.

To summarize, downtime is substantially influenced by the task environment and by the meta-cognitive skills that professionals bring to communication design tasks. Taking downtime may have either positive or negative impacts on an ongoing task. On the positive side, taking a break could promote incubation processes that might yield new ideas and improved quality; for examples, see Hayes (1989) and Perkins (1981). On the negative side, taking a break may involve restarting costs. When coming back to the task after downtime, the professional may have to spend some effort to recall information and reestablish the orientation and momentum needed to move forward with the task. We have all asked ourselves after a break, "now what was I doing?"

6. Conclusions

In this article, we proposed an adaptation of Hayes' (2012) model to better account for the activities we observed in the current case study of a skilled communication designer. In particular, we added three new features to that model. First, we added (and modeled) a process by which writers search for external information or content. Second, we allowed for (but did not model) processes for constructing graphics; we consider visual design processes on par with the writing processes already included in the Hayes model. Finally, we included a motivation management function to take into account the observation that in an extended design task — like the one we presented in the case study — designers may elect to take breaks from their task (downtime). We recognize that these adaptations are based on the analysis of only one case and the existing literature. Even with these limitations, we suggest that these adaptations are relevant to better describing and understanding not only communication design processes, but also the activities fundamental to many other forms of writing and design. For example, search is essential as children learn to write from sources using computers. Constructing graphics is an important part of communication in science, engineering, and medicine. And managing one's motivation is important not just for professional writers, but also for students writing college essays, teachers writing comments on student work, or architects drafting a building layout. Although the adaptations proposed here will likely be more important in some communication tasks than others, we believe they are appropriate to include in a general model of writing. Further research on writing and information design is needed to refine and elaborate these concepts.

This research also provides evidence for Schriver's (2012) portrayal of expert professional communication by fleshing out her model of three interactive processes that benchmark experienced performance. These include constructing (creating high-quality visual and verbal content), connecting (shaping the content for the internal and external stakeholders), and contextualizing (positioning the value of good writing and design). The case study illustrated how a seasoned proposal writer engaged in each of these activities as he worked. His construction process, as we saw, relied heavily on assembling and revising previously written text (both his own and other people's work).

And although his construction process appeared fragmented and even chaotic, it was highly goal driven, as we saw when he struggled to find illustrative case studies that would convince decision makers that his company's prior experience was more relevant than the capabilities of the competition. Throughout the design process we saw the professional communicator trying to connect with his audience of Flemish Government decision makers by marshaling persuasive arguments and by finding the right visuals to support his case. He also recognized the need to contextualize his activity. He did so by positioning his company's approach in relation to other approaches to solving the problem, showing the uniqueness of Nova's design process.

From a methodological point of view, the case study showed that the use of keystroke logging allows for different perspectives in analyzing data from multiple sources. For instance, the time-graph visualization offers a general process overview of the development of the final text (although it is limited to production of verbal text). The network graph, on the other hand, represents the interactions between multiple sources accessed during the production process and the frequency of consulting these sources. The keystroke data not only provide a macro perspective on writing from multiple sources; their fine-grained character also enable researchers to investigate the process on a micro level. Pause data from the linear and general files, for instance, offer insight into some of the cognitive processes professionals engage in as they revise and integrate text from other sources.[1] This study shows that keystroke logging, in combination with other complementary observation methods, can be employed profitably in studying writing from multiple sources.

This article presented a case study of an experienced professional as he worked for more than eight and a half hours on a visual and verbal design project. The most striking observations in this case study concerned the way the writer distributed his time. He spent less than a third of his time (30%) in the proposal document itself. Most of his time (69%) was spent searching in a wide variety of external sources. He used about 280 different sources and made 305 switches per hour, or no less than 5 switches per minute. Clearly there was an intensive and continuous interaction between the text-and-graphics-created-so-far and the available sources. The remainder of the designer's time (9%) was devoted to downtime, both voluntary and involuntary. As we suggested earlier, we believe that the voluntary downtime reflects the designer's ability to manage his own motivation.

This study, while focused on just one experienced professional, suggested some methodological points of departure for future research on writing from sources and helped us consider some underemphasized theoretical issues about professional communication and writing more generally.

Note

1. When we talk about professionals in this study we are referring to professionals who need to create documents in order to do their jobs (Janssen, 2001). We opt not to

narrow the definition to only professionals who write for a living and who are experts in a genre. In our view, professionals who write as part of their jobs are found in most domains; for example, many professionals write proposals but that is not their primary job. While the case study presented here explored the processes of someone whose job was proposal writing, we are concerned with the broad range of activities most professionals engage in as they compose on the job.

2. To facilitate the use of keystroke logging in this type of research, we have updated Inputlog 5.2 to automate the source analysis (www.inputlog.net). This analysis generates a source matrix along with data about the time spent on each source, the frequency and proportion of consulting sources, the switches per source accessed, and a syntax file to generate a Pajek network graph (pajek.imfm.si).

3. To guarantee the proposal writer's anonymity, we have not included this text part because it contained business information his company prefers not to make public.

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