



Environmental scanning in higher education: use of digital sources for the renewal and updating of design project teaching resources

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Abstract

In France, design training in any field, graphic design, product design or social design for example, is provided in universities and higher education institutions. In universities and other higher education institutions, design teachers must continuously renew their resources for design project courses. Indeed, teachers must, on the one hand, select contemporary work topics and, on the other hand, accompany students in their design work. To acquire their resources, they conduct environmental scanning that includes, among others, documentary sources and other online sources. Our research is based on a qualitative study of fourteen teachers and shows the predominance of the use of digital sources, and the importance of creating a composite set of sources. This work contributes to the understanding of strategies for updating and renewing resources by conducting environmental scanning in an overloaded informational context.

Keywords: Environmental scanning, resources, digital sources, design teaching

1. Introduction

In French higher education, design teachers train students to create design projects. In design, the project is at the same time an intention, a process, and an outcome in the form of an artifact or system of artifacts. Creating projects is considered as the core activity in this discipline (Parsons, 2007). Depending on the level of teaching, the

teacher defines the “problem-project¹” situation more or less precisely (Roumy Akue, 2019-2) and accompanies students in their design work during the project. This work is conducted during the project courses.

Teachers propose and accompany design situations in line with the constant evolution of human activities (Archer & al., 1992) in complex environments (Broadbent & Cross, 2003). Indeed, “in design, [...] there is an inevitable component of change at work. Other facets of life, such as social or religious practices, may remain largely the same. But design [...] involves people in the deliberate making of change. There is an intentional ‘before’ and ‘after’”(Julier, 2017, p.175).

Defining “problem-project” situations requires that teachers grasp “[...] demands that have not yet been formulated”, to be “attentive to the deep tendencies of socio-cultural dynamics [...] and social actors” (Manzini, 1991, p.93). Ezio Manzini asserts that emerging tendencies appear in the form of “[...] ‘weak signals’, often ambiguous and contradictory, but which can be perceived as the seeds of the ‘new’ [...]” (Manzini, 1991, p. 93). This requires sustained attention to the environment and the selection and collection of resources in an overloaded and labile information context.

“Environmental scanning” is the process of monitoring and gathering information within the environment to identify signs that can anticipate what is going to happen (Lesca and Lesca, 2011). It is a suitable framework for studying all the steps that teachers follow. The process includes defining the monitoring perimeter, selection, and use of resources used in designing project situations and accompanying students. This study is about design, but we may identify the same processes for project courses in other academic disciplines.

2. Research problem

In this article, we study the choice and management of digital sources used in the process of renewing and updating resources by teachers of design during their environmental scanning practice for teaching. The issue of source selection is important insofar as the sources are “a carrier of information” (Xu et al., 2006, p. 1667).

¹ A project situation in which one or more students are in a learning-by-doing process, which takes into account curricular constraints, social practices of reference, and which response to a problem, which requires problematization and which has no pre-existing response.

Teachers use them to consult, update, and renew their resources. This behavior influences all the resources used in their practice.

The study focuses on a part of our work for a doctoral dissertation which deals with the problem of renewing resources through monitoring in the context of design education. We present here the results of our qualitative study comprising fourteen semi-directive interviews with design teachers. Concerning the sampling, the interviewed vocational education teachers had different numbers of years of experience (some of whom had only had access to computers and the Internet late in their careers), came from different fields of design, and belonged to different structures of higher education, both university and non-university.

To fully understand the monitoring process and the environment in which it takes place, we will first present the conceptual framework of environmental scanning and monitoring that we have built to analyze the use of sources called upon by teachers. We will also specify what the monitoring environment covers regarding the design activity and the specific activity of design teaching. In a second step, we will present our methodology and, in a third step, our results that show the intentions guiding teachers in their choice of sources for resource acquisition, which is the “very heart of teachers’ work” (Bruillard, 2019, p. 343).

3. Conceptual framework

Environmental scanning has been defined in two disciplinary fields: Management Sciences and Information Sciences. In Management Sciences, environmental monitoring focuses more on competitive and strategic aspects – the monitoring activity is carried out for product protection or differentiation. In Information Sciences, the focus is more on information management processes (Libmann, 2008). Given the nature of our research field, which combines the issues of information management by teachers and artifact design and entrepreneurial management in design, these two disciplinary fields are complementary. Furthermore, in order to understand the process of creation of a “problem-project” and the choice of associated sources, we use the CK theory², which defines the process of knowledge expansion (Hatchuel & Weil, 2003).

The use of these frameworks calls for the similarities and differences related to the context of design education to be made explicit at different stages.

² The CK theory is explained in the 1.4 section.

3.1 Environmental scanning process

The monitoring process is a cycle of information research that includes different phases. We rely here on the strategic intelligence process described by Amabile (1999) in Management Sciences, which takes into account listening as a factor in defining the intelligence perimeters, which opens the search for relevant signals. It is important for the context of design education in which this process is transferred, insofar as design requires taking into account societal evolutions to which answers might be proposed.

The monitoring process includes an identification phase, with the definition of the scanning and monitoring environment. This includes the identification of sources, a research phase, a collection and filtering phase, a collection exploitation phase that includes analyzing the resources collected, and a dissemination phase linked to integration into decisions and then action (Ibid.).

In the context of teaching, the management of the scanning and monitoring process is linked to project courses. Teachers define topics and monitoring areas autonomously according to their needs. The practice is dedicated to their course preparation. The collection is used to define the incentive to create and the reorientation of students' creative work. Dissemination takes place in working documents and during exchanges during the projects (Roumy Akue, 2019-2).

3.2 Environmental scanning environment

The information environment is inherently complex and unstable because it is part of a mesh of multiple elements and relationships and is "changing, volatile, marked by discontinuous evolution" (Lesca & Lesca, 2011, p. 17).

The environment was originally defined as external (Duncan, 1972) but can now include the internal environment. The external environment includes the macro-environment, meso-environment, and micro-environment (Giboin, 2015).

At the macro level, it includes political, economic, social, technological, ecological, and legal issues (Ibid.). At the meso-scale, it is divided into sectors, some of which are particularly important for the company (Choo, 1999; Hambrick, 1982). At the micro-environment scale, it includes the people or firms that have direct commercial links with the firm and have a regular influence (Daft & al., 1988; Giboin, 2015).

The internal environment includes the reference firm or organization.

This breakdown enables the environmental scanners – that is, the people who monitor the information environment – to define the segments that may influence the organization and therefore must be monitored.

In the framework of design education, the external environment at the macro-scale corresponds to the PESTEL (political, economic, social, technological, ecological, legal) issues already defined; at the meso-scale, teachers can define the sectors that are close to the fields of design and/or the issues addressed in the training; and at the micro-scale, the people and entities with whom teachers frequently work, including partners involved in projects, or suppliers for example. The teachers' internal environment is their school (Roumy Akue, 2019-2).

After this classification of the environment scanning in design teaching, it should be stressed that environmental scanning in companies is conducted differently. Companies monitor anticipate major competitive risks (Lesca & Lesca, 2011) and any analysis conducted outside the organization often comes from a sponsor or from a single third party.

Teachers establish their monitoring perimeter much more freely and according to the idiosyncratic needs of students or their areas of interest (Roumy Akue, 2019-2). This changes the “sponsor”, particularly in the case of exocentric³ monitoring that does not come from a single third party. During self-monitoring (Roumy Akue, 2019) or “sui generis” (Canet, 2017), the teacher him/herself defines the scope of his/her monitoring.

3.3 Source for collection of resources

We have defined the environment as the space in which teachers identify and collect their resources, including digital sources. It is therefore necessary to define the terms of resources and sources.

For Bruillard (2019) & Loffreda & Bruillard (2017), who rely on work led in the ReVEA project⁴, “resources are alive through the communities that support and sustain them” (Bruillard, 2019). Furthermore, they are shareable materials updated by the teaching practice (Loffreda & Bruillard, 2017). We propose a definition inspired by these works, which is more specific to design. We define the term resources as:

“[...] an entity that can be material or immaterial on which the teacher relies for his or her teaching practice, whether it concerns the preparation of course work (design of the brief for example) and/or the exchange

³ Oriented towards the different orientations of the students' problems

⁴ ReVEA, in French “ressources vivantes pour l'enseignement et l'apprentissage” means “lively resources for teaching and learning”.

with students (critical phase for example). The resources can echo a variety of contexts, from the most personal to the most universal. Tangible resources, including digital resources, are made up of an assembly of grains, which include artifacts, visuals, videos, documents, while intangible resources include information exchanged orally.” (Roumy Akue, 2019-2, p. 187).

Therefore, which sources do teachers use to acquire their resources? Let us firstly define the term source in the informational context and within education.

3.3.1 What is a source?

An information source is a referential space where the environmental scanner can access information and knowledge (Xu et al., 2006). As part of their practice, teachers consult sources that can be characterized as repositories from which they will draw and collect their resources. These become resources as soon as what is extracted from them is used by the teacher as part of his or her preparation and/or coaching of students.

Sources are divided into interpersonal and impersonal, internal and external, human, and documentary sources (Keegan, 1974; Fidel & Green 2004; Yoo & Sawyerr, 2014). To this, we can add specialized online sources (Coutenceau, 2014).

Interpersonal sources bring information intended for the person receiving it (Yoo & Sawyer, 2014): for example, the information may come from a colleague or a supplier. Impersonal sources provide information that is not expressly intended for the watchers. They may reach the monitor through a report, memo, or survey result, for example.

Human sources are people in the external or internal environment. They require “intellectual/social effort” (Fidel & Green, 2004, p. 577). Documentary sources include paper and digital documents (Caro Dambreville, 2009), and can be called “written sources” (Fidel & Green, 2004, p. 577).

Concerning specialized online sources, Coutenceau (2014, p. 152) proposes the following categorization:

- “- Institutional sites: competitors, media, industry players, local authorities, trade unions...”
- Institutional sites: competitors, media, industry players, local authorities, trade unions
- Blogs and forums: consumer organizations, universities, scientists, etc.

- Social networks: identifying communities of interest, communities of practice, by field of activity, by product, by technology, by company.”

Agarwal, Xu, and Poo (2011) refer to “access channels”, which they categorize as physical-electronic, synchronous-asynchronous, and interpersonal and impersonal. Synchronous and interpersonal physical sources include face-to-face exchanges; interpersonal asynchronous include physical sources, such as letters; physical synchronous and asynchronous impersonal sources include book and manual.

Electronic or digital sources are online and can be accessed from many locations. Synchronous access is defined by the simultaneity of communication with the source, which leads to a time constraint. Conversely, asynchronous access refers to a time-shifted communication, i.e. a consultation that can be postponed to a time of availability for the environmental scanner. The classification of Agarwal, Xu, and Poo (2011) identifies interpersonal synchronous digital sources, such as telephone and online chat; impersonal synchronous digital sources, such as information acquired online; interpersonal asynchronous digital sources such as e-mails and forums; and impersonal asynchronous digital sources, such as information acquired online.

In education, Maître, Huchette & Bruillard (2018) characterize “source collection” in the broadest sense, i.e. as physical or digital – that is, according to where teachers collect the resource – and refer to “source production” as the location where the source is created or produced.

Mochizuki & Bruillard (2019, p. 136) define what they call resources but which can be understood as sources. In our case, we would consider this to be the place of acquisition of resources, or a source collection place (Maître, Huchette & Bruillard, 2018). For us, some of the interesting categories of source collection are “multimodal resources” – that is, for example, videos, websites, blogs – “learning environment” – which includes MOOCs or social networks – and “resources by opportunity and open data for education” – that is, the use of a source that has not been designed for education but that is used by teachers (p. 39). For design teachers, these systems are an important source of resources.

Identifying source typologies is of interest insofar as we wish to understand the use of digital sources.

3.3.2 Criteria for choosing sources

Regarding research about the choice of sources, several factors are highlighted, including ease of access and ease of use (Fidel & Green, 2004). Fidel and Green (2004) studied engineers in the manufacturing industry according to three aspects: the type of information sought, the sources for finding it, and source selection factors.

To them, the accessibility factors in source selection are:

- Sources are familiar, rich in varied information, provide a level of detail appropriate to the need, save time, and have a format that limits the transformation required to use the collection. Sources are pleasant to consult, they offer keyword access and allow for interaction. Sources are accessible at all times and are physically close when not online.

Factors related to the quality of the sources are:

- The presence of information related to the needs of the project carried out; the source most likely to offer the information sought; the information sought is only present in the source consulted; the source offers recent information, is reliable, provides precise information and does not require speculation or additional interpretation.

Agarwal, Xu, and Poo (2011), who questioned 325 professionals working in Singapore, evoke the selection criteria related to the quality of the source: the timeliness, reliability, scope, and relevance of the information that the source offers. They also define the difficulty of access as the time and effort required and the difficulties encountered in reaching the source's information.

Kim and Sin (2011, p. 7), who conducted a study of undergraduate students in public universities, state that the criteria for selection are: (1) accessibility, (2) cost, (3) familiarity, (4) ease of use, and (5) comprehensiveness.

In this study, factors related to accessibility and quality are included.

However, the studies we have just presented did not include freedom of access, as quoted by Mochizuki & Bruillard (2019), which is relevant to our study of the context of teaching, in which teachers do not have direct funding for monitoring.

We should also consider the security of source spaces, which helps teachers in their preparation work. Regarding “resources by opportunity”, the high quality of resources of the source is an important factor. For example, a teacher could be interested in a resource proposed by a museum.

Given the various research conducted on sources, it seems relevant to investigate the scope of the sources used and to study the distribution of digital sources concerning physical and human sources, that are people, as well as the synchrony or asynchrony of their access.

The following criteria have been used as criteria for the accessibility of sources: familiar sources, sources that save time, sources that provide access to resources whose format limits transformations for use, sources that are pleasant to consult, sources that are always available, sources that provide resources that are free of charge.

The following criteria for the quality of sources can be retained as criteria of quality: the recentness of the information offered by the source, as well as the reliability, precision information, richness, variety, completeness, and quality of the information.

The choice of sources also seems to be linked to the acquisition of knowledge that facilitates creativity. As this aspect is not dealt with in the literature on sources, we will use the framework of the C-K theory.

4. The C-K theory

In the C-K theory (C for concept and K for knowledge), there is a process in which the expansion of knowledge is intrinsic (Hatchuel, 2001). Thus gives rise to “expansive designs”, i.e. designs that create something new. The designer has archipelagos of knowledge composed from different fields, such as scientific, technical, or sociological. This space is always expanding by integrating new knowledge during the creative process (Le Masson, Weil & Hatchuel, 2015).

According to Hatchuel and Weil (2003), disjunction is the starting point for a creative situation. Existing knowledge is disjunct to stimulate creativity. In this theory, the contribution of new knowledge is central to opening up new questions. This theoretical framework is useful in our case to identify the expansion process through the choice of sources to nourish a “problem project” in the long term.

Before presenting our methodology, we will summarize our research question: we raise the question of the use of sources to collect resources in design project teaching, which requires anticipating uses and therefore actively

monitoring the information environment. This anticipatory and creation-oriented situation raises the question of the change of the choice of sources by design teachers.

5. Methodology

5.1 Data collection

We used a qualitative approach to access the particular discourses of teachers regarding their management of sources. We relied on semi-directive interviews conducted with fourteen design teachers from different higher education backgrounds who teach the project course.

The teachers chosen primarily teach students who are close to entering in the labor market in the third to fifth years of training. They teach project courses or research support courses that led to the project, but logically most of them taught at several education levels. In addition, they teach also other courses as for example history of art or technology.

We selected teachers from two higher education institutions and two separate training courses within a university, which gave us access to different fieldwork. In order to achieve maximum diversification (Guba & Lincoln in Huberman & Miles, 1991), we conducted interviews with teachers whose only activity was as teacher-researchers or teacher-designers. They also taught different fields and approaches to design, such as graphic design, product design, social design, pedagogy, and design didactics.

The average duration of the interviews was 1 hour and 39 minutes. The shortest interview was 32' and the longest 2h15'.

Our interview guide included reminders about the triggers for the search for resources.

Regarding sources, we oriented our reminders in order to identify the sources (interpersonal or impersonal, internal or external, human or documentary), the type of sources (institutional, blog, forum, social network, press, exhibitions, shows, events, symposiums, seminars, other schools); and the level of automation of collections, or place of social networks in the collection. The questions also addressed the tools used and serendipity in accessing resources.

5.2 Data processing

For the coding, we have listed the sources cited and the environmental issues to which they relate. We evaluate the use of sources through interviews in a quantitative part.

We also identified in the teachers' interviews the elements related to the selection and use of sources, which covers the issues of accessibility and quality presented in the conceptual framework:

- Accessibility: familiar sources, time-saving sources, sources that provide access to resources whose format limits transformations for use, sources that are pleasant to consult, sources that are always available, sources that provide resources free of charge.
- Quality: the recentness, reliability, accuracy, richness, variety and completeness of the information.

We followed an inductive-hypothetico-deductive approach by successive loops (Paquay, 2006). Initial coding categories were modified and extended as the work progressed (Van Der Maren, 1996) in order to clearly articulate the choice of sources during the monitoring and design teaching activity. During the analysis work, we noticed that the temporal issue also needed to be taken into account, to reflect the extent to which teachers practice monitoring throughout their careers.

6. Results

In this section, we present our findings regarding the use of sources in the acquisition of resources for the teaching of the design project.

First, we present the scope of the sources cited by the teachers, which enables us to identify the area of teachers scanning. Second, we present the range of their set of sources. Third, we sketch the landscape of the evolution of this set over time. Fourth, we reveal the strategies of access to sources, allowing an updating and renewal of the problematic-project issues. Finally, we describe the strategies of access to sources.

6.1 Use of composite sources: physical and digital with a predominance of digital sources

First, we note that design teachers use both digital and physical sources of information. In our interviews, in all of the documentary sources cited, we note a predominance of digital sources. Teachers also use physical sources, including bookstores and libraries, media, exhibition spaces, and print publications. There is a predominance of asynchronous and impersonal sources which are permanently accessible.

For digital sources, these include thematic sites such as blogs, individual websites, newsletters, and emails. A few teachers report using email to exchange resources. The themes they scan are related to teachers' self-monitoring.

For example, Renaud receives newsletters related to his activity as a researcher, while Gauthier and Samy's are related to their activity as designers. This is the only reference to an automated acquisition, showing that the teachers' environmental scanning is very handmade.

Social, technical, technological, scientific, political and ecological issues are all cited.

Transversal sources that cover various issues provide access to numerous resources open to various disciplinary fields. For example, France Culture is consulted online as well as via the radio. Teachers also consult other transversal information sources such as *Le Monde* or the Encyclopedia Universalis.

In terms of social issues, sources oriented towards design are frequently cited such as *Étapes Graphiques* and *Intramuros*, but it should be noted that paper distribution preceded digital publishing. Here, analogous to France Culture, digital and physical consultations are not mutually exclusive and are based on both paper and online consultations.

Victorine: "we use all sources at our disposal on the Internet. we can draw on from all that is editions Intramuros news, *Étapes graphiques*⁵."

The predominance of consultation of design sources by the teachers seems logical because they need to be aware of developments in their discipline to avoid directing students towards answers that have already been proposed by designers.

Next, come pedagogical sources. It should be noted, however, that two teachers cited schools. Lolita explains consulting "the ENSCI, I sometimes look at the ECAL, there is also Reims, the fine arts of Reims [...]" Élixa regularly visits the websites of "the ECAL, the ENSCI, the Polytechnico-Milan, the Saint-Etienne School of Design, the UQAM, the Design Academy Eindhoven."

Teachers also cite artistic sources.

The transversal orientations of the sources show how teachers need access to resources that are open to different issues and that mark out societal evolutions.

⁵ *Intramuros* et *Étapes graphiques* are quoted here as print-edition design magazines.

6.2 A range of trusted sources

The teachers explain that they look for rich, reliable and up-to-date sources. They consult “major name” websites whose quality is a matter of consensus and with a clear informational offer.

Élisa consults a range of sites that include numerous resources such as the CAIRN platform and reference websites in the design discipline that can be considered as high-quality sources of resources: “I browse CAIRN, *Encyclopédia Universalis*, there are a lot of articles, I browse Cité du Design, sanctuaries, that’s what I call sanctuaries, which means [...] classic design websites.”

Samy also talks about websites that he considers to be landmarks: “So there are some who say there are expectations, there are media supports that are a little expected, for example in France Culture.”

The teachers consult a range of known sources that they consider important to know about current events in design. Transversal sources such as CAIRN or France Culture offer scientific content that does not need to be verified.

An important factor is the regular updating of the information in the sources. Yoann says “Designers who tend to update their website regularly, especially Michael Place [...] is someone who is very demanding when it comes to finishing and printing and who follows up very closely [...] on the manufacturing process.”

The monitoring and consultation factor regarding this source is on the one hand related to its frequent updating, but also to the quality that the teacher attributes to the content that he/she will be able to access, in order to show the resources to the students.

Renaud, for his part, makes “regular press reviews” to stay up to date regarding specific topics in line with his interests: “News, for example, people like Hubert Reeves, who is an astrophysicist who wrote a book on plants [...]. Renaud monitors updated cross-cutting sources and use the resources acquired during his courses. He also monitors people in fields close to his, such as Georges Didi Huberman (philosopher and art historian) and Marie José Mondzain (philosopher and specialist in art and images).

Like Renaud, six teachers in our sample of fourteen say that they regularly consult the sites of people who interest them. For example, Yoann is on the lookout for changes to the Front Design (design collective) and Droog Design (design collective) websites, Gauthier keeps up to date on the work of Pierre-Damien Huyghe (aesthetic

philosopher), just as Louise keeps up to date on the work of Fanette Mellier, Patrick Nadeau and Benjamin Mazoin (all designers).

This echoes the result already revealed in 3.3, which showed that the environmental scanning area of design teachers was far from overlapping.

The range of trusted sources is therefore a set of sources on which each teacher relies to conduct his or her monitoring. According to the teachers, this includes well-known websites in the field of design and more transversal sources.

These sources offer numerous resources that can be trusted. This security is based on confidence in the organizations that provide information and resources that do not need to be re-verified.

Beyond that, these are sources that bring together different criteria listed during the literature review: which are familiar, always available, free of charge, and which offer scalable and reliable content. To these criteria must be added the possibility of use the resources collected in the sources for project courses.

It should be noted that the “sanctuaries” website that teachers believe is consulted by all the teachers do not meet with consensus in reality. While sources such as *Étapes Graphiques* and *Intramuros*, for example, are known to the design community, only four teachers report consulting them. This raises the question of the common cultural base of the teams.

6.3 Evolution of the range of sources over time

Two of the fourteen teachers who have been in the business long enough to have experienced the transition to the Internet expressed a major difference in terms of resource acquisition and source management. They have gradually switched to digital sources and incidentally to digital resources.

Victorine: “So there’s a before and after digital and an after internet for me, [...] all my studies I did them in public libraries [...] It was very difficult to find up-to-date information. [...] because the Internet arrived and there was enough referencing so that we could use it, that’s it, and that completely changed my job.”

Teachers adapt their sources to changes in, or even the disappearance of, the websites from which they collect resources.

Anne: “I used to go a lot on something called ubuweb, where I found a lot of interesting things about artistic movements.”

Yoann: "So I stopped consulting the 12:50 train website, it broke down."

These are rather sources that do not come from large groups, but that give access to more contemporary and specialized developments. These sources come from individual publishers or less dominant communities. The main criterion for choosing this type of source is more related to recency than reliability. Ultimately, teachers' source packages include both long-term and short-term sources, and the selection criteria are modulated if the source provides the teacher with resources that anticipate their practices to some extent. In this case, it is the teacher who is in charge of evaluating the source.

6.4 Disjunctive sources

Design teachers identify sources to access resources to enlighten them on issues to be addressed in projects. They are on the lookout for sources that offer resources that reflect societal emergences that may be outside their usual monitoring spectrum. They use what we call disjunctive sources about the disjunction of C-K theory (Hatchuel and Weil, 2003). Teachers consult sources that they know will bring them unexpected content.

These are broad-spectrum sources that provide both weak and strong signals. Amèle by reading "Médiapart"⁶, *Le Monde*⁷ or *Libération*⁸ every day, says that it is easier to identify the "fields of forces that cross society".

Yoann declares that he repeatedly uses a range of generalist sources. He is "a very big fan of radio", particularly Radio France and France Culture, which he listens to live and in podcasts. He also uses their websites "via the integrated search engines" or "their page for updating the subjects addressed" because he is "curious about subjects [] it is a form of monitoring and discovering conferences, Collège de France courses, interviews, etc., which are on subjects that would not necessarily have the surprise of the day before."

Samy adds: "So there are some, we'll say that there are some expectations, a there are media supports that are a bit expected, for example, in France Culture, magazines that are a bit specific to the discipline. But I'm not closing myself off [...] something that could be considered as non-academic references or what do I know, I'm interested, you can't be a designer without being interested in the world as a whole."

For teachers involved in preparing students for competitions, it is a matter of anticipating the issues likely to appear in the competition subjects so that their students are ready to take the tests.

⁶ It is a daily newspaper

⁷ It is a daily newspaper

⁸ It is a daily newspaper

Lolita: "I try to see what has fallen into the subjects of the competition because it doesn't happen twice in a row. I try to identify what can currently be in vogue that I can find either in magazines or technology monitoring. I also look at the matters addressed in schools, projects, things like that, the exhibitions that there may be, also what they talk about, etc. So, I orientate my classes on different questions that are likely to come up."

Other teachers see the Internet as a meta-source that allows them to reach resources that are not tagged in advance.

Gauthier: "Yes, so more precisely, I don't know because I think it's very broad ... I mean I spend whole days looking for references to give the information sometimes I don't even know where I'm going, but it doesn't necessarily allow me to have the right information, but to open up a field of reflection."

The teachers interviewed expressed the need not to expand their monitoring perimeter. Cross-sectional sources play this role and often lead to other sources through source-to-source bounces.

Design teachers organize a source monitoring system that facilitates the identification of emerging and unfamiliar issues in the long term.

6.5 Bouncing from source to source

The paths that teachers follow in their search for and collection of resources are not linear; they rely on rebounds that take them from one source to another until they find the resources that are right for them.

In Figure 1, we give two examples of the paths deduced from the interviews of Gauthier and Renaud.

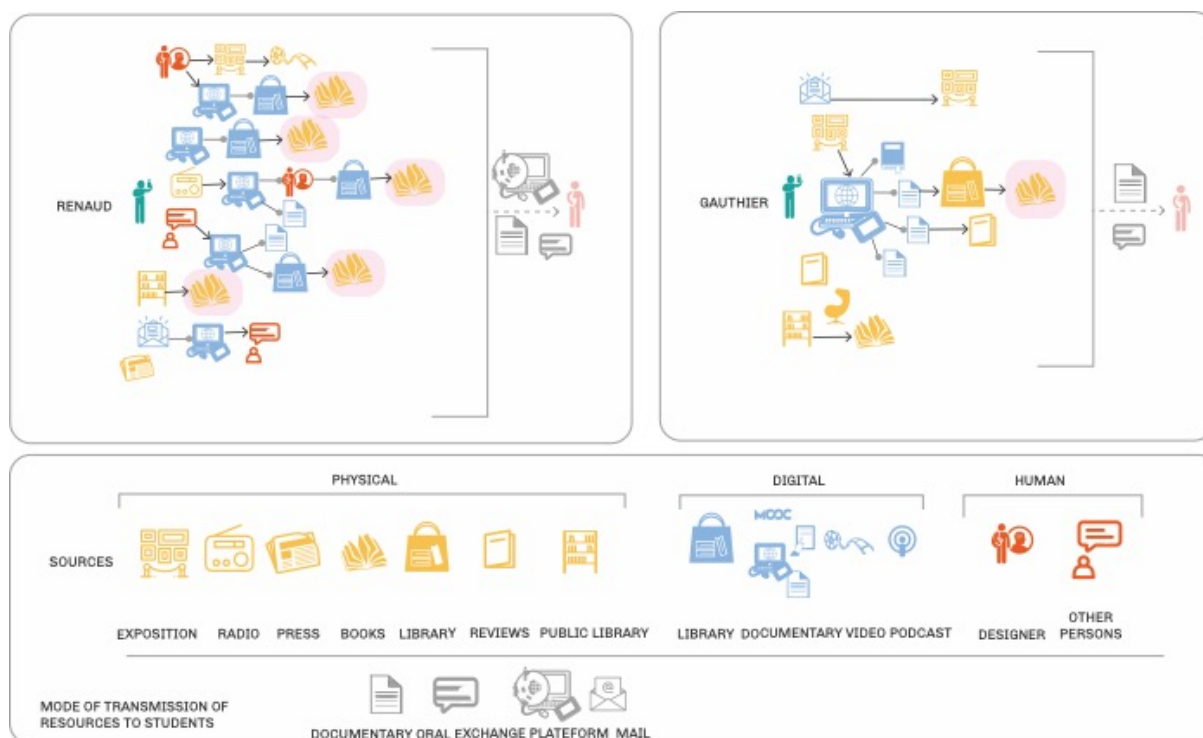


Figure 1: Process of access to the resources of Renaud (left) and Gauthier (right)

The access modalities differ according to the research trigger. The trigger is sometimes human, sometimes digital documentary, sometimes physical documentary. The bounces lead to other sources of information until finding the resource. In this case, Renaud initiates his research in contact with human and documentary sources, whether digital or physical. The same source can lead him to several other sources. The sources he uses are both synchronous and asynchronous and mostly impersonal. Renaud's research most often leads to the "book" resource. Gauthier cites only documentary sources. He particularly enjoys visiting exhibitions and collecting documents during these activities. Once at home, he makes online requests to collect resources.

These two examples are representative of teachers' behaviors and allow us to establish that access to sources is indeed the result of networking and that what triggers the search are multiple and composite.

7 Discussion

Design teachers, because of their discipline of design, are faced with the need to identify societal evolutions in order to set project subjects and guide students in their research during project classes. To carry out this constantly evolving task, they scan the external environment at macro, meso and micro levels, as well as the internal environment, and consult various human and documentary sources (physical or digital). We have identified

that their monitoring includes composite sources that are predominantly digital but it is also handmade in the sense that it is not automated, apart from newsletter subscriptions. The monitoring is mainly oriented towards sources that provide access to design resources. Transversal sources that open up many fields are also widely used.

Our results regarding the criteria for design teachers to select their sources confirm the results of Agarwal, Xu & Poo (2011), and Fidel & Green (2004): teachers select sources that provide high quality, recent, reliable, relevant and rich information. Teachers use sources of high-quality resources, as Mochizuki & Bruillard (2019) suggest.

It should be remembered that some of the research cited in our theoretical section were not conducted in a teaching context and lay outside the context of design education. In this pedagogical design context, sources are also selected because they offer resources that can be used in design projects courses. Alternative sources are also solicited to access specialized and very recent resources that anticipate societal practices. In this case, the reliability is assessed by the teacher him or herself.

We found that in order to access resources, teachers use a range of sources that they trust. This confirms Quentin's (2017) findings from the ReVEA project on resource use, which also reported on trusted sources used by teachers in banking sector. Nevertheless, in the context of our research, the issue of anticipating practices is important in the choice and use of sources to reach resources.

Design teachers' source packages include sources used over the long term, which come from the mainstream media and, at the same time, the use of more alternative sources that provide access to resources that are more underground and that often end up disappearing. Teachers must therefore renew on a permanent basis the identification of new sources. The use of stable sources provides security.

We have also highlighted the evolution of the practices of the most experienced teachers who began teaching before the era of the Internet. These teachers radically changed their practices in favor of adopting digital sources and abandoning physical documentary sources. These teachers explained that they unsubscribed to certain magazine subscriptions they had previously taken out, in favor of online sources. In further work, this result could be consolidated with a larger number of interviews with a sample exclusively based on teachers who started teaching before 2000.

A strong result of our research is the identification of what we have called disjunctive sources, referring to the C-K theory of Hatchuel and Weil (2003). These are sources that bring unexpected information. With disjunctive sources, teachers use strategies for consulting sources that open up new fields of reflection and, as a consequence, make easier the definition of problem-projects and limit blindness. This is a key point that opens up the possibility to renew the problems addressed during project classes. This is essential for a design practice anchored in current issues.

Regarding the process of access to sources, teachers respond to triggers that lead them from one source to another in a rebound process. We have shown two examples of pathways defined from two interviews, which underline the composite dimension of access to resources and consultation of sources.

In this article, we have chosen to focus on the use of digital sources, but digital sources cannot be considered exclusively without considering physical human, as colleagues for example and documentary sources. Digital sources have indeed become the majority and the pillars of resource acquisition for teachers. They enable a permanent updating and access to contents which, if they were to be published in print, would arrive too late for the anticipation of practices. However, it should rather be considered that resource acquisitions are made in a network of sources that lead from one to the other, and in which human and physical documentary sources are fully integrated. Moreover, our dissertation (Roumy Akue, 2019) highlights the central importance of human sources.

Human sources give access to grey and fresh information, especially when working partners have access to exogenous environments that are difficult for teachers to penetrate. These sources also provide professional knowledge and skills that are essential for students' acculturation to the professional environment.

8 Limits and perspectives

The method of semi-directive interviews gave us access to the teachers' explanations concerning their monitoring behavior and enabled us to better understand the habits and logic of consultations. Relying on teachers' statements is both the interest and the limit of this work. To gain a more precise and exhaustive list of all the sources consulted, research work could be carried out by recording all browsing activities. Further analysis could use the documents that establish the problem-projects to identify the sources of the resources used by teachers and communicated to students. The understanding of source management by teachers is an important issue for

design didactics and more broadly for teaching based on project pedagogy. Mastery of their management could be part of a source management policy in teachers' teams. This greater consideration would make it possible to improve the efficiency regarding the monitoring effort and to better identify the sources to be transmitted to students for their monitoring practices.

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