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1 INTRODUCTION

This report summarizes the work done for WP1.2 on Requirements Assessment. It starts with reviewing the current state of the art as reported in literature in fields related and relevant to supporting the early stages of the product design process. Next, several case studies are reported that examine in depth the specific challenges that teams of distributed designers encounter in everyday design practices. Finally, a meta-review is given, formulating challenges to be addressed by the COncEPT platform.

2 REVIEW OF CHALLENGES AND OPPORTUNITIES IN COLLABORATIVE DESIGN TOOLS RESEARCH

In this section the CONCEPT team discusses recent literature on the topic (e.g. state of the art surveys, and vision papers, or empirical analyses). Instead of giving a superficial overview of the field, a few papers have been selected that will be examined in depth here, as they are deemed important for informing CONCEPT, either by formulating design guidelines, or summarizing existing work and identifying what research questions remain open. In the following section the papers are described and relevant results and recommendations for CONCEPT are discussed.

Note that all statements between quotes (“ ”) are statements taken from the paper verbatim.

2.1 “ENHANCING CREATIVITY IN GROUPS”

Voigt and Bergener (2013) performed a systematic literature review in which they defined ‘recurring topics in design recommendations’, resulting in a set of design principles for GCSS (Group Creativity Support Systems). They argue that “Creative processes in general are understood as an iterative interplay of divergence and convergence” and subdivide these processes into six collaboration patterns:

- **Divergence:**
 - Inspire,
 - Collect,
 - Create and
- **Convergence:**
 - Organize,
 - Evaluate,
 - Select;

A GCSS should support all these patterns. Based on a review of the existing literature on GCSS, Voigt and Bergener establish the following five topics for which they define a set of design principles:

Topic	Design principle
Divergence	DP1: Foster mutual inspiration: In divergent processes of the CGP, provide the possibility to share ideas to foster mutual inspiration. DP2: Support anonymity: In divergent processes of the CGP, support anonymous contribution of ideas, to reduce evaluation apprehension. DP3: Invoke social comparison: In divergent processes of the CGP, invoke social comparison, to reduce free riding. DP4: Support different working modes: In divergent processes of the CGP, provide the possibility for individual and group working modes, to increase creative group performance.
Convergence	DP5: Support idea organization: In convergent processes of the CGP, the relation of ideas shall be facilitated, to foster common understanding. DP6: Support idea evaluation and selection: Support quantitative and qualitative idea evaluation and

	selection, to foster the selection of the best ideas.
	DP7: Trace decisions: Trace the decision-making processes, to avoid the exclusion of valuable ideas.
Communication - Trust	DP8: Support session histories: Provide session histories and dialogue mapping, to support idea reflection and information storage to build trust within the group.
Communication - Synchronicity	DP9: Support asynchronous communication: Support asynchronous communication in divergent processes of the CGP, to reduce process losses.
	DP10: Support synchronous communication: Support synchronous communication in convergent processes of the CGP, to reduce process losses.
Group awareness	DP11: Support group awareness: Support group awareness in the CGP, to avoid coordination problems and foster reciprocal inspiration.
Iteration	DP12: Prevent turn-taking: Prevent turn-taking between divergent and convergent processes, to increase the creative group performance.
	DP13: Facilitate comparison: Facilitate simultaneous comparison of alternative ideas, to balance group member contributions.

Finally, Voigt and Bergener state directions for future research and development:

1. Rigorous empirical studies (both qualitative and quantitative) on GSS design evaluations in creativity contexts are rare. Design heuristics, field reports, and experiments abstracting from potential design choices, prevail. Future studies should focus on systems features and evaluate in accordance with a rigorous methodology.
2. Empirical studies on GSS in creativity contexts could be useful for professional applications in a real business context. Overemphasizing evaluations in student classes could bring bias to the assessment of industry eligibility of GSS.
3. Industry field studies should also focus on the integration of GCSS into daily activities. One research setting could be the investigation of the influence of asynchronous idea generation on the CGP by observing R&D teams using a GCSS in their daily working routine.
4. Most design recommendations refer to interface design, stemming from HCI. More research should be conducted for the major areas of interest in CSCW (e.g. collaboration components) and IS (e.g. social-technical considerations).
5. In comparison to research on GSS support for divergence, convergence support is rather under-researched. Especially the area of decision support could bring a plethora of fruitful insights to research on GSS in creativity contexts.

2.2 “TEAMWARE: AN EVALUATION OF KEY TECHNOLOGIES AND OPEN PROBLEMS”

Georgakopoulos et al. (2004) have taken a close look at key technologies for team collaboration for distributed teams such as workflow systems, groupware tools and content management systems. Though the authors do not specifically address creative designers - as an example they provide the workflow of a team of distributed analysts responsible for various aspects of a foreign country - many aspects of the work practice are similar for designers (e.g. collecting relevant

information, discussing with team members, creating drafts, peer review, flexible project coordination, awareness provisioning).

Georgakopoulos et al. evaluate existing groupware technology with respect to requirements of a distributed team. They identify the following open challenges:

- **Advanced awareness provisioning.** Most groupware systems provide a (limited) means of indicating the (tele)presence of collaborators. However, the authors argue that more information should be provided to support awareness, e.g. not merely the fact that a team member is at his or her desk, but also what activities a team member is engaged in. Furthermore, team members should be able to customise, filter and constrain awareness cues.
- **Flexible coordination:** prescribing, suggesting and synchronisation of activities should be a flexible process that supports different types of activities, e.g. prescribed, optional, group, and ad-hoc activities. Currently open research problems include policy-based coordination, awareness-based coordination that involves combination of policy-based coordination with decision-making awareness, and hybrid tools integrating further the coordination capabilities of groupware, workflow and content management tools.
- **Scalable tools for joint activities and large teams.** Many current tools can support only small teams (10 or less) and they do not scale up well to accommodate larger teams because the human coordination to manage such teams grows exponentially in complexity. An alternative approach could be to automate coordination when possible.
- **Component-based team ware infrastructure** - Georgakopoulos et al argue that for distributed teams where the team size is less than ten members and the team process is simple, the best approach is to adopt a web-based collaboration tool that has been designed to provide an enhanced web browser. For larger teams, they suggest building a team ware structure on a content management system.

Georgakopoulos et al conclude that although there is significant progress in the development of groupware technology, there is still no single technology or tool that can address all collaboration requirements.

2.3 “CREATIVE PRACTICES IN THE DESIGN STUDIO CULTURE: COLLABORATION AND COMMUNICATION”

Vyas et al. (2013) have studied the everyday practices of designers in both academic as well as professional design studios, focusing on the collaboration and communication between the designers.

They observe that the work in design studios has a high material character: typically, office walls and desks are full of post-it notes, prototypes and physical models, sketches, clips etc.

Vyas et al conclude that collaboration and communication are supported by three broad themes:

- **Use of artefacts.** Material design artefacts (e.g. sketches, physical prototypes) play an important role in coordination of on-going work. Such artefacts are used in all stages of the design cycle, with different purposes, e.g. for exploration or communication. Also, the richness of the materials used is of importance. Typically, designers explore using several types of materials and play with different physical properties, before reaching the final version of the product.
- **Use of space.** “The function of project-specific surfaces is largely productivity-focused. Time-management, scheduling, work progress and division of workload were the most important functions of these artful surfaces”.
- **Designerly practices.** “By designerly practices, Vyas et al. mean practices specific to the design studio culture. These practices cannot be seen from a functionalist or task-based perspective, as they do not serve any immediate

purpose of solving a design-related problem. Designers apply these practices to enrich their design and stimulate creativity in their work.” These practices include:

- Use of body: Designers often use their body (gestures and other bodily representations/movement) to discuss design ideas. “It has been suggested that bodily movements are suitable as a design technique, as our bodies convey emotions as well as geometry and interactions (Hummels et al., 2007).” Non-verbal interaction might lighten the cognitive load when communicating design ideas, and verbal languages alone may not be enough to communicate issues related to complex technology.
- Thinking by doing: Designers often externalize their thinking by actually creating their ideas and concepts in physical form. The design process progresses while manipulating design representations that often involve different materials and modalities.
- Creative social practices. Vyas et al observed that designers do not follow a pre-defined way of working, as the projects they work on have a large diversity. Therefore, for each project the most suitable methods and tools for that particular project are picked.
- Ephemeral collaborations: Especially in academic studios it was observed that designers (students) would intentionally move around to setup new collaborative spaces and play with different things in the studio.

So far technologies developed for supporting design practices have mainly focused on the conversation paradigm of face-to-face interaction between meeting participants. However, as the observations in this study show, there are also material and physical aspects of designers’ collaboration that influence creativity.

Based on the observations above, the following implications for design can be drawn:

- Artefact-mediated interaction. Vyas et al. argue that a technology should be able to incorporate physical artefacts (at least partially) into its design space so that designers can still exploit its natural and experiential qualities. The research needs to focus beyond merely digitizing physical objects.
- Utilize spatial resources: Vyas et al. stress the importance of physical space in supporting communication amongst designers. Furthermore, while designing a new technology, inspirational thinking and supporting flexibility and portability of organizing work should not be ignored.
- Creative explorations: Designers spend a considerable amount of time exploring new ideas and concepts by utilizing different techniques and design representations. Though some research has already focused on supporting collaboration on separate creation of artefacts (e.g. collaboratively creating drawings), there is a need for an infrastructure to capture, integrate and arrange the artefacts. Also, currently there is little opportunity to associate the digital with the physical. For example, instead of sketching digitally, research could look into how to support digitizing physical sketches as a means of including them in a collaborative system.
- Social flexibility: Vyas et al argue that technology should be very easy to integrate in to the designers’ practice - it should not enforce tedious and unfamiliar practices for using it. The work of designers is heterogenic; different projects require different approaches, therefore a collaborative system should be able to support this heterogeneity. Typically, collaborative systems are focused on face-to-face communications; this should be extended to allow designers to reflect upon and discuss each other’s ideas, also in an asynchronous way.

2.4 “MECHANISMS FOR COLLABORATION: A DESIGN AND EVALUATION FRAMEWORK FOR MULTI-USER INTERFACES”

Yuill and Rogers (2012) review the work on multi-user interfaces for collaboration. Based on literature on psychology and social interactions, they identify three underlying mechanisms for collaboration in everyday interaction:

- Awareness of others—the degree to which awareness of users’ ongoing actions and intentions is present or made visible moment-to-moment;

- Control of action—the extent of each user’s control over actions and decisions;
- Availability of information—the ways in which background information relevant to users’ behaviour and to the task is made available or externalised.

Yuill and Rogers propose a framework of *mechanisms* and *constraints* to inform the design for multi-user interfaces. They argue: “The degree of constraint or freedom provided for each of the different mechanisms (awareness, control, and availability) helps designers consider what needs to be constrained or permitted, and for what reasons.”

Based on a review of the framework in three case studies, the authors provide the following recommendations:

- Sources of constraints include technical, physical and social constraints. Typically, the focus is on technical constraints, but it is beneficial to be aware of other, less explicitly designed in constraints that influence behaviours.
- Though the authors mainly focus on interactive surfaces, arguably the framework can be used for other collaborative technology as well, in which the mechanisms of awareness, control and availability influence collaboration. As such it is an interesting framework for designing and evaluating the CONCEPT framework.

2.5 “SUPPORTING CO-CREATION WITH SOFTWARE, THE IDSPACE PLATFORM”

Van Rosmalen et al. (2014) present the platform idSpace, a web-based platform that provides a creativity support environment. It features a toolset that allows distributed team members to collaborate, to create ideas and contribute to and preserve existing ideas. Furthermore, the platform allows the users to trace the history of ideas, concept maps, goals etc. Also, idSpace has a built-in context awareness system: based on information of previous projects, idSpace suggests relevant resources and/or people. The platform supports the idea that collaborating innovators should learn from each other, to foster creativity. Therefore, it was developed with a focus on pedagogical strategies. It is intended for use in an educational context.

The idSpace platform was developed adopting a user centered design-based approach, i.e. solutions were tested and subsequently evaluated. The results of the evaluations were fed back into the next development cycle of the platform.

The final evaluation of the platform brought to light a few interesting conclusions that may be of importance for the CONCEPT platform: The main strengths of idSpace are that it is accessible via the web - no installation on a local computer was necessary. Furthermore, the structured, distributed and collaborative approach to ideation is considered to be a key feature.

However, the idSpace platform is still under development, and the fact that not all functionality of the platform has been properly implemented affects the user evaluation greatly. For example, the interfaces of idSpace are not clear enough for most users, affecting the usability of the platform. Still, its users perceive idSpace as potentially useful.

Interestingly, the authors found that users who were geographically distributed responded more positively to the system. This might imply that users, having no other face-to-face opportunities to collaborate, are more open to collaborate using such a platform. Also, they were more inclined to look at the potential of the platform and less critical of its shortcomings.

Though idSpace offers an integrated toolset, learning a new platform might detract from the ability to be creative. Therefore, the authors suggest that extending existing platforms based on user choice should be considered.

3 TASK ANALYSIS OF COLLABORATIVE DESIGN PRACTICES

The “*Time-Space matrix*” is a common model to classify tools that mediate collaboration according to *when* and *where* interactions take place (Dix et al., 2004). This matrix outlines the settings of collaborative practices along two dimensions: *place* (co-located – remote) and *time* (synchronous – asynchronous). Figure 1 illustrates the model depicted by Dix et al. (2004) classifying non-computer communication technologies in the matrix.

	Same time	Different times
Same place	Synchronous, co-located (face-to-face conversation)	Asynchronous, co-located (post-it note)
Different places	Synchronous, remote (phone call)	Asynchronous, remote (letter)

FIGURE 1: TIME-SPACE MATRIX

Within this contribution, we describe 5 collaborative practices of design practitioners in consideration of the settings of this Time-Space matrix. Furthermore, we include details on the people and tools involved, techniques used, and advantages/limitations of these practices.

For this study, a total of 15 design practitioners and stakeholders of the design process were interviewed during August 2014. 10 face-to-face interviews were conducted with participants located in Belgium, and 5 online interviews with participants located across UK, US, and Portugal. Coming from different backgrounds and design disciplines, professionals were interviewed from Product Design, Industrial Design, UX/UI Design, Graphic and Visual Design, and Design of Learning Experiences. It is worth mentioning that four participants are not professional designers, but work in consulting and/or software development companies where they are in constant communication with design practitioners.

These interviews were conducted with a semi-structured interview protocol. Minor adjustments were made to the protocol to suit either the online or face-to-face setting. Face-to-face interviews were conducted in the workplace of each participant, while online interviews were conducted over a videoconference using Google Hangouts. In the introduction and warm-up sections of the interview protocol, participants were informed of practical considerations for the interview, such as privacy concerns and the general structure of the interview. Furthermore, the participants were asked questions regarding details of their current work position and company. For the main section of the interview, participants were asked to recall a specific project and describe their collaborative activities, giving details on the tools used, people involved, challenges, etc. To close the face-to-face interviews, a quick observation and photos were taken to document the physical workspace of the designers.

The audio transcripts of the interviews were analysed to reveal the recurrent tools, techniques, and limitations. In consideration of the findings presented for D1.3 and D1.6, the current section presents an overview of 5 collaborative practices, which are used to group and pinpoint the tasks of design teams:

- [1] Communication with team and stakeholders
- [2] Inspiration and design research
- [3] Create and share artefacts
- [4] Collaborative design with team and stakeholders
- [5] Project management

We present these practices distributed across the four settings of the Time-Space matrix (same/different times – same/different places), focusing on the virtual and physical spaces shared by design practitioners and key stakeholders. To conclude, we present end-user requirements and opportunities for the COncEPT platform based on the results of this task analysis.

3.1 COMMUNICATION WITH TEAM AND STAKEHOLDERS

Participants were particularly aware of the channel of communication that they select according to their intended recipient(s). Therefore, in the current analysis we roughly divide communication tasks between (1) internal communication and (2) communication with clients and stakeholders.

(1) Internal communication

People and settings	Designers are in constant communication (both online and offline) with developers, project managers, other designers, and other relevant stakeholders in their company. Communication spans across the four settings of the Time-Space matrix.
Techniques	Most of the participants preferred to talk face-to-face with their colleagues. In addition, depending on the purpose of the communication, they use a variety of synchronous and asynchronous IT tools.
Tools	<ul style="list-style-type: none"> • Face-to-face (formal and informal) meetings sometimes involve traditional design tools (e.g., pen, paper...) and/or devices (e.g., PC, tablet...) • Chat (Skype, Google Hangouts, Hip Chat, Lync chat, Whatsapp, and ad hoc tools) • Phone/VoIP, video calls, and screen sharing (Skype, Google Hangouts, Webex, Join.me, Screenhero and ad hoc tools) • Email (Google, Outlook...) • Daylite (https://www.marketcircle.com/daylite/) • Slack (https://slack.com/)
Advantages and limitations	<p>(+) Short, frequent interactions are a good strategy to keep awareness of the progress of the project.</p> <p>(+) Most participants mentioned that including visual elements during communication with colleagues (e.g., discussing a mock-up with developers, sketching together) helps them to build a common vocabulary.</p> <p>(+) Screen sharing features (e.g., in Skype) are widely used to complement online communication.</p> <p>(–) Difficult to keep a log of face-to-face interactions.</p> <p>(–) Difficult to trace back online conversations when distributed along different channels of communication (e.g., email, chat, social networks...).</p>

(2) Communication with clients and stakeholders

People and	Designers and project managers are in constant communication (both online and offline) with clients and stakeholders. Including a wide variety of people from different
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settings	backgrounds and disciplines, communication should be as clear and efficient as possible, spanning across the four settings of the Time-Space matrix.
Techniques	Face-to-face communication is considered the most efficient and effective way of communicating with clients, especially in the first stages of a project. In addition, phone, VoIP calls, share screen features, and e-mail are widely used to communicate with clients.
Tools	<ul style="list-style-type: none"> • Face-to-face (formal and informal) meetings sometimes involve traditional or IT design tools • Chat: Skype, Google Hangouts • Phone • VoIP, video calls, and screen sharing (Skype, Google Hangouts, Webex, Join.me, Screenhero, and ad hoc tools) • Email (Google, Outlook...) • Basecamp (https://basecamp.com/) • Slack
Advantages and Limitations	<p>(+) Tools such as Basecamp and Slack are referred as “tape recorders”, which are valuable for keeping a log of conversations with the client.</p> <p>(+) Phone is still a powerful tool since “most clients already use phones”, and it does not require extra setup or time to install software.</p> <p>(–) Text-based tools, such as e-mail or chat, are useful ways to keep a log of conversations, but can be difficult to organize, and it can be difficult to use text-based conversations to convey visual ideas.</p> <p>(–) E-mails can lead to misunderstandings and errors (e.g., forgetting to “Cc” somebody on an e-mail), and can take too long to write. Nevertheless, they still are the main communication tool for some designers with their clients.</p>

3.2 INSPIRATION AND DESIGN RESEARCH

Gathering sources of inspiration and researching similar products are important activities in the first stages of the design process. Therefore, designers invest a considerable amount of time, both individually and in teams, to create a common ground (e.g., colour schemes, interactions, etc.) for the project to evolve.

People and settings	Designers (both individually and as a team), sometimes including end-users and clients. Research activities can span across the four settings of the Time-Space matrix, but collaboration usually takes place at the same place, in same or different times (e.g., sharing links with a colleague at the office).
Techniques	For many designers this is a vital stage to understand and create empathy with end-users and clients. This is done either by involving people (e.g., user diaries, participatory design, interviews) or investigating them or similar products online. Mood boards are a valuable source of inspiration as they help to build a common vocabulary and a shared point of view among team members.

Tools	<ul style="list-style-type: none"> • Web browser (Google Chrome, Safari, Mozilla...) • Bookmarks • Ad-hoc techniques with end-users (e.g., printed/online user diaries) • Pinterest (mood boards) • Evernote • Physical walls for sticking photos, sketches, drawings, etc. (e.g., mood boards or communication boards)
Advantages and Limitations	<p>(+) Understanding client/end-user allows designers to have a starting point for the project. Mood boards are a valuable technique for this goal.</p> <p>(+) Online tools make easy to share with team (e.g., share links and images in chat, Pinterest).</p> <p>(–) Time and resources can be limited for research activities, especially for consulting firms.</p> <p>(–) It can be difficult to keep track and sort all the data gathered.</p>

3.3 CREATE AND SHARE ARTEFACTS

Participants made relevant distinctions between the way they create, store, and share (1) internal artefacts and (2) artefacts for clients.

(1) Internal artefacts

People and settings	Designers, working individually or in collaboration with other designers, project managers and/or developers. Collaborative tasks regarding artefacts span across the four settings of the Time-Space matrix.
Techniques	Most participants mentioned that usually there is a specific “owner” in charge of a specific deliverable or project. Therefore, while multiple team members may collaborate to create an artefact, there is usually one person in charge. Furthermore, most participants mentioned they do not have standardized formats or templates when it comes to creating internal artefacts, nor established rules on how to name/store each artefact. Most designers mentioned that when important changes are made to a deliverable, they start by sharing the file with the persons involved, and follow up with an appropriate way of communicating these changes (e.g., phone call, meeting request, face-to-face conversation...)
Tools	<p>Create artefacts:</p> <ul style="list-style-type: none"> • iWork (Keynote for templates, Pages for collaborative editing) • MS Office tools • Google docs (widely mentioned for collaborative editing) • SharePoint • Evernote • Features such as check in/out system, track changes, subscriptions (to updates), annotations, and comments

	<p>Share artefacts:</p> <ul style="list-style-type: none"> • Online communication tools (e.g., phone, VoIP, chat, e-mail) for communicating with colleagues, sharing screen and screenshots • File servers and web portals • WeTransfer • iCloud • Google Drive • Dropbox • SharePoint • Pinterest • Physical space: post artefacts on walls, storage areas
<p>Advantages and Limitations</p>	<p>(+) Collaborative tools that allow simultaneous editing, such as Google Drive, are regarded as very valuable tools.</p> <p>(+) Internal artefacts tend to be used to evaluate the feasibility of the projects (e.g., budget/time constraints).</p> <p>(–) Difficult to track changes and/or conflicting versions when collaborating or editing.</p> <p>(–) Deciding how to name, store, and share artefacts can be confusing and time consuming.</p> <p>(–) Compatibility of files across different software and platforms.</p>

(2) Artefacts for clients

<p>People and settings</p>	<p>Designers, working individually or in collaboration with other designers, project managers, and developers. Clients and key stakeholders are the recipients of the artefacts. Collaborative tasks regarding artefacts span across the four settings of the Time-Space matrix.</p>
<p>Techniques</p>	<p>When a deliverable is shared with the client, a common practice is to first share to file with a previously agreed tool (e.g., Dropbox), and second use either synchronous (e.g., VoIP) or asynchronous (e.g., e-mail) communication tool to confirm that the client received the deliverable. The client’s feedback is usually delivered using the same communication tool.</p> <p>An interesting consideration is that some participants mentioned that deliverables for clients are an integral part of their service, and therefore, make efforts to create polished, unique deliverables.</p>
<p>Tools</p>	<p>Create artefacts:</p> <ul style="list-style-type: none"> • iWork (Keynote for templates, Pages for collaborative editing) • MS Office tools • Google docs (widely mentioned for collaborative editing) • SharePoint • Evernote

	<ul style="list-style-type: none"> • Features such as check in/out system, track changes, subscriptions (to updates), annotations, and comments <p>Share artefacts:</p> <ul style="list-style-type: none"> • Communication tools (e.g., phone, VoIP, chat, e-mail) for communicating with clients • File servers and web portals • Basecamp • WeTransfer • E-mail (with attachment or link) • iCloud • Google Drive • Dropbox
<p>Advantages and Limitations</p>	<p>(+) Centralized application to manage deliverables and feedback was preferred (Basecamp was a clear favorite). Key stakeholders can subscribe to receive automatic updates by e-mail.</p> <p>(+) Most of the tools mentioned by participants allow them to generate a unique link or account for each client.</p> <p>(–) Client may not be familiar with some tools.</p> <p>(–) Web applications are preferred over stand-alone tools since they do not have to be installed locally</p> <p>(–) When there is no centralized way of sharing with clients, it can be difficult to decide what tool to select. Moreover, having more than one tool can lead to difficulty in terms of keeping a consistent history of communication.</p> <p>(–) Some clients have difficulty in navigating through interactive models, such as HTML wireframes.</p>

3.4 COLLABORATIVE DESIGN WITH TEAM AND STAKEHOLDERS

Collaborative design can include (1) Brainstorming and Ideation sessions, as well as (2) Collaboration mediated by different design tools.

(1) Brainstorming and Ideation sessions

<p>People and settings</p>	<p>Designers (often as a team), project managers, developers, clients, and end-users. These sessions take place at the same time, either on the same place (co-located) or different places (remote).</p>
<p>Techniques</p>	<p>The approach to brainstorming depends much on individual and organizational differences. Techniques such as co-creation workshops, war rooms, face-to-face meetings, online video-calls, were mentioned by participants. Photos and videos are widely used to document these sessions.</p>

Tools	<ul style="list-style-type: none"> • Face-to-face meetings using a PC with a data-projector and/or traditional design tools such as pen, paper, tape, whiteboards, flipcharts etc. • Google Docs (edit collaboratively) • PC for sharing screen (used in both co-located or remote meetings) • Ad hoc tools (e.g., for meeting with up to 15 colleagues in limited bandwidth)
Advantages and Limitations	<p>(+) Easier to convey ideas in a face-to-face setting, as using traditional or digital tools facilitates communication (e.g., sketches, HTML prototypes...).</p> <p>(–) Online tools are still a limitation when it comes to collaborative editing, sketching, etc. One reason for this is that devices, such as tablets or PCs, can be obtrusive while interacting face-to-face (e.g., resulting reduced eye contact with interlocutor).</p> <p>(–) It can be difficult to keep track of topics discussed, solutions, or agreements.</p>

(2) Collaboration mediated by design tools

People and settings	Designers (often as a team), project managers, developers, clients. Collaboration can take place in the four settings of the Time-Space matrix.
Techniques	Techniques for collaboration vary according to the setting of occurrence. Face-to-face collaboration is usually done sharing traditional design tools, PCs, mobile devices, or large displays. Remote collaboration can use synchronous communication tools, such as chat, VoIP, or screen sharing. Likewise, asynchronous communication tools, such as e-mail or annotations, are used by designers who collaborate in different times and places.
Tools	<p>UX/UI design:</p> <ul style="list-style-type: none"> • Chopstick, Flinto, Axure, OmniGraffle, Solidify <p>Code repositories/project management:</p> <ul style="list-style-type: none"> • Redmine, Confluence, TurtoiseSVN, GitHub, JIRA <p>Documents:</p> <ul style="list-style-type: none"> • iWork (Pages), Google Drive (Google Docs) <p>Academic projects:</p> <ul style="list-style-type: none"> • Dedoose, Atlas.ti <p>Visual design, inspiration, and sketching:</p> <ul style="list-style-type: none"> • Adobe, Sketch, GIMP, Pinterest, Mural.ly, Evernote
Advantages and Limitations	<p>(+) Easier to have control over the format of each file when all team members use the same tool (e.g., Photoshop, GIMP, etc.).</p> <p>(+) Participants mentioned a preference for traditional design tools for collaborative tasks such as sketching and doing quick prototypes in collaboration.</p>

(-) Not many tools offer collaborative editing, and fewer do it efficiently. Google Documents was one clear favorite in this aspect.

(-) Online collaboration can be difficult in locations with low bandwidth.

(-) Tracking changes and adding annotations is not always possible or well implemented.

3.5 PROJECT MANAGEMENT

We found that not only participants who described their role as project managers, but also those who described themselves as “core” designers, are frequently involved in project management tasks. This included activities related to both overall management of projects and relations with clients.

People and settings	Project management tasks usually involve project managers, product owners, designers, and clients. Collaboration happens on the same place and time (e.g., kick-off meetings), as well as at different places and times (e.g., e-mails).
Techniques	Depending on the business model of each company, designers are more or less involved in project management tasks. Designers and project managers use the following tools to track the status of projects, create to do lists, coordinate meetings, etc.
Tools	<p>Create/share/store files and documents:</p> <ul style="list-style-type: none"> • E-mail • SharePoint • File server • Spreadsheets and word processor (iWork, MS Office, Open office, Google docs) • Evernote • Illustrator <p>Team coordination:</p> <ul style="list-style-type: none"> • Daylite • Basecamp • Omnifocus • Trello • (shared) Calendar (Google, Daylite, iCal) • To do lists (Wunderlist, HiTask) • Doodle • TeamForge (http://www.collab.net/products/teamforge) • JIRA • GitHub • Redmine • ConceptShare (https://www.conceptshare.com/) • Evernote (central account for team)
Advantages and	(+) Project management tools are widely used to keep track of projects and milestones.

Limitations	<p>(+) Shared calendars are mentioned as a useful tool for keeping awareness of the time and availability of others.</p> <p>(–) Templates for project management tasks are useful, but not always available. Some designers mentioned that standardized templates are not required or too time consuming to use.</p> <p>(–) Difficult to integrate project management tasks with design activities.</p> <p>(–) Overwriting and conflicting versions can occur while editing documents at the same time (e.g., on a centralized account at Evernote).</p>
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3.6 CONSIDERATIONS FOR THE CONCEPT PLATFORM

While this analysis is not intended to be an exhaustive list of collaborative practices, it gives an insight into how designers collaborate, communicate, and coordinate with their team and stakeholders. Furthermore, this study pinpoints the tools used by designers, as well as the advantages and limitations perceived from their usage.

To conclude this section, we present some end-user requirements and opportunities for the CONCEPT platform:

- Customization and personalization of tools. Users should be able to select and prioritize the tools that they find more relevant for their activities.
- A centralized “news feed” can be useful for designers to keep track of the communication, artefacts, and status of projects. This feed should be organized and divided according to relevant channels of information (e.g., clients, projects, team members...).
- Smart search and tags to facilitate filtering and sorting information.
- Notification system carefully crafted, to allow designers to “skip a step” and send a notification of their updates directly, in a personal, yet automatic way.
- Possible to apply privacy restrictions (e.g., to view and edit) for artefacts and communication channels.
- If co-editing is not possible, consider a check in/out system to avoid overwriting documents.
- Possible to backup information from the CONCEPT platform to a local drive, providing the possibility of working offline.
- Photo editors to polish sketches, whiteboards, or other elements generated during face-to-face meetings.

4 REQUIREMENTS FOR COLLABORATIVE AWARENESS CUES FOR DESIGN TEAMS

Designing is in principle a collaborative process and traditionally, designers had to meet only in person in order to work together. However, the Internet and its wide adoption have provided new leverages for social interactions (Baym, 2010). Social networking sites, blogging platforms, forums, and emailing lists —are amongst the most common— allow people to interact and reach anyone having an Internet connection. Figure 2 visualizes an example of the diversity of commercial applications available on the Internet. The rise of online (web-based and mobile) collaboration tools has freed the designers from their spatial and temporal boundaries, opening up opportunities for new design practices. Since collaboration is not constrained any more to a fixed temporal and geographical event, the designer is confronted by the possibilities of reaching a mass group of collaborators in order to combine efforts to achieve a meaningful and well-formed solution.

Nowadays, the designer has a wide range of collaboration applications to choose from. Many of the available applications focus on enhancing collaboration at very specific and different levels — for example, remote communication, sharing documents, exchanging images, transferring media files, organizing tasks, time-tracking, managing the progress of the project and “monitoring” work of team mates, etcetera. Therefore, the design practitioner must use a collection of applications in order to interact with other individuals. Besides the supply of collaboration tools, the individual actively operates with the support of the other instruments. These instruments vary from Computer Aided Industrial Design (CAID) software to documents, images, sketches and prototypes.

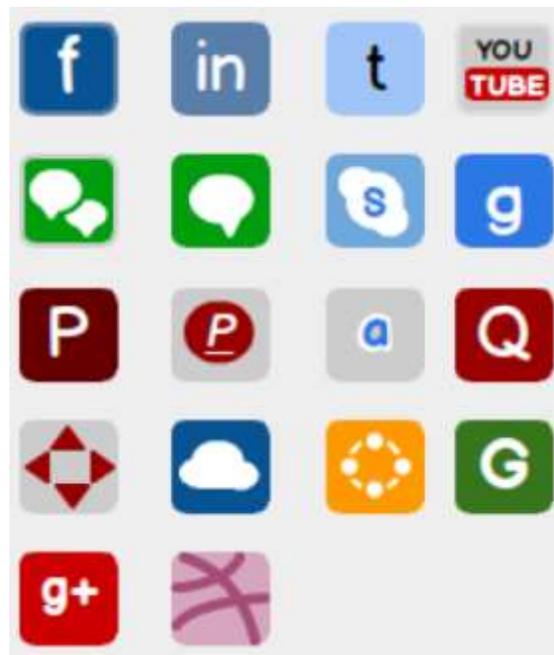


FIGURE 2: THE ICONS OF SOME OF THE COMMERCIAL APPLICATIONS ON THE INTERNET. ORIGINAL ICONS BY DESIGNYANTRA USED UNDER CREATIVE COMMONS LICENSE

The mere aggregation of tools does not provide a complete understanding of how designers work and how they perform their daily tasks. Designers do not share the same approach using the tools and applications that are currently available. They switch naturally from one application to another depending on the specific goal and activity. Furthermore, the individual engages with specific functionalities or features of these devices depending on the situation. For example, the designer uses a smartphone as a videoconference device to talk with clients. Simultaneously, the designer uses a tablet device to take notes and make sketches, which can be stored in the “cloud” for later review from a laptop. Furthermore,

the location in which an activity takes place and the number of people involved changes the way in which technology is used.

In order to understand how the current tools support the design activities, it is best to place the design process in the context of the social field in which it occurs: designers do not work in a vacuum. Rather, they operate throughout a dynamic stream of interactions with multiple tools and individuals. Designing is a social phenomena (Schön, 1983) and it is the patterns of these social interactions that provide value to the design process. For instance, the individual might relate to different stakeholders, such as clients, team members or managers during the course of a project. Furthermore, designers take the tools for granted while they explore the problem and its possible solutions.

4.1 THE CURRENT STUDY

The goal of this study is to explore how online collaboration tools support designers during the early stages of the design process. Specifically, the study is focused on identifying (1) what are the most frequently and popular online collaboration tools that support designers in their tasks, (2) what are the specific behaviours and activities that designers conduct in the context of online collaboration tools, (3) what are their most observable and useful repeatable practices and (4) what are the challenges that designers continuously face while using those tools.

Starting from the main research questions, the COnCEPT team aimed to get an understanding of how the tools and the provided functionalities support designers depending on specific activities and context:

- Project characteristics (duration, goal, roles, task interdependency, stages)
- Team composition: types, sizes and member distribution
- Location-based (only possible in special locations, e.g. desktop, special videoconference room, special collaboration room, etc.)
- Location-independent (possible in every random location supported by laptop, smartphone, or any mobile technologies)
- Channel-based (cases in which a specific platform provider only accepts interactions from the same platform provider e.g. specific instant messaging platforms)
- Channel-independent (interactions are platform or provider independent, e.g. email)
- Artefacts exchanged

The main assumption is that personal computers, tablet devices, and smartphones are used for collaboration purposes since they all have Internet access, support communication between peers, and they support multiple applications for very specific purposes. We expect that the results of this study will uncover any existing relationships between the designer, the team, the tools — devices, applications — and features used.

4.1.1 METHODOLOGY

Since the purpose of this study was to discover what online tools are currently in use by designers for the purpose of collaboration and their most observable practices, an exploratory approach was adopted. The present study consisted of a small web survey and a follow-up interview. First, the web survey was conducted to get a general overview of the tools and collaboration context. The results of this web survey have also been discussed in COnCEPT deliverable D.3.1. Next, respondents from the web survey were asked whether they would like to be interviewed. The goal of the interviews was to get an extensive understanding of the practices, and problems that designers face when using online collaboration tools.

4.1.2 PARTICIPANTS

15 participants from the web survey were selected with the purpose of covering all possible specializations and available experience within the design industry. Participants that indicated previous experience in developing collaboration tools were excluded from the interview in order to avoid biased results. The 15 selected participants were invited via email for a follow-up 30-minute interview. The individuals were given the option to visit the Eindhoven University of Technology for a face-to-face interview in case they were located in the Netherlands. From the 15 participants that were contacted, 3 did not respond to the invitation and 3 more declined to participate in the interview. Nine designers — 5 female, 4 male — were successfully interviewed. Their age was in the range of 30 years old or less. Five of the participants indicated their preference to be interviewed via Skype over telephone call; the 4 other participants preferred to be interviewed in person.

All the interviews were audio recorded and a second researcher took notes during the interview. Each interview lasted between 30 minutes and one hour. The designers were asked specifically about the most recent project in which they used collaboration tools. They were asked to describe the goal and context of the project, the size of the team, how the tools supported their activities and what difficulties they have encountered while collaborating — project wise, team wise and tool wise. Finally, they were asked about their overall experience of using collaboration online tools in specific scenarios: creative, conflict, emergency, uncommon super productive, and uncommon annoying situation.

4.2 RESULTS

For the analysis of the data gathered during the interviews all the audio recordings were transcribed verbatim. To uncover emerging practices of online collaboration tools, the methodology of “Grounded Theory” was followed using an “open coding” approach to broadly analyse the data. First, quotes were selected — 183 in total— that contain potentially relevant information in the context of design and collaboration. The set was divided between two researchers and each researcher grouped the quotes individually. Several clusters emerged based on each researcher’s criteria and they were iteratively compared and analysed. The emerging clusters were grouped into sets of initial codes, which represented meaningful practices with specific properties in their degrees of collaboration. Each code contained information about different activities and how those activities were supported by a collection of tools — e.g. Dropbox Facebook, Skype, etc. Several tools that appeared in one code were also present in other codes but the activity and the tool’s context of use varied in each. Consequently, throughout several refinement iterations, focused coding was applied. During the focused coding, all the initial codes with related activities were compared and combined into more relevant categories that revealed the underlying process. First, the comparison of the coding focused on finding relationships among groups based on the conditions, the consequences, the processes or mechanisms, and the context in which it occurred. Figure 3 presents the initial coding and the relationships between each activity.

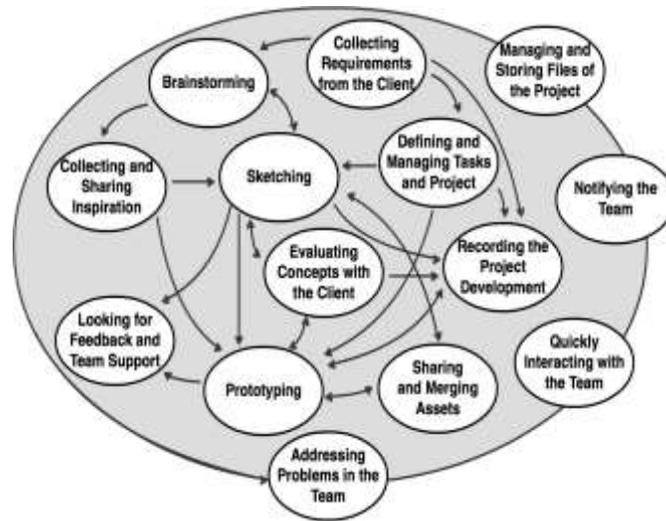


FIGURE 3: INITIAL CODING SET OF MEANINGFUL PRACTICES AND THEIR DYNAMIC INTERRELATIONSHIPS

The analyses of the coding focused on the identified phenomena by comparing the needs, choices and consequences of the choices. For example, the recurring codes that captured how designers craft their ideas into sketches or prototypes were grouped into a single phenomenon. Finally, we grouped the categories that emerged from the focused coding into high order conceptual constructs. Following Charmaz’s (1983) methodology, gerunds were used to identify each category. An overview of the categories is visualized in Table 1. The following section represents a summary of the findings that emerged from the coding process.

TABLE 1: RESULTING CONCEPTUAL CATEGORIES FROM THE INTERVIEW ANALYSIS

Initial coding	Focused coding	Conceptual category
Brainstorming	Discovering and gathering possible ideas and concepts	Creating ideas and concepts
Collecting and sharing inspiration		
Sketching	Crafting the ideas and concepts	Developing ideas and concepts
Prototyping		
Sharing and merging assets	Integrating efforts	Making sense of the material, resources and experiential knowledge
Looking for feedback and team support	Assessing, adjusting, and selecting the design	
Collecting requirements from the client	Gathering and clarifying evidence for the design	
Evaluating concepts with the client	Updating the team	Keeping the team on track
Notifying the team		
Quickly interacting with the team		

Initial coding	Focused coding	Conceptual category
Addressing the problems in the team	Resolving conflicts	
Recording the project development		
Defining and managing tasks and project	Keeping the project on track	Managing the development of the project
Managing and storing files of the project	Managing knowledge and resources	

4.2.1 CREATING IDEAS AND CONCEPTS

This category captured activities that support the generation of new ideas. It summarized how designers come up with new ideas through different strategies, such as brainstorming sessions or by exploring sources of inspiration. It also included how they gathered the inspirational material and how they shared it with their team with the purpose of triggering new ideas.

All of the participants described idea generation sessions typically undertaken together with other team members or stakeholders during face-to-face meetings. Whiteboards, post-its, and sheets of paper were mostly used to support the session. The process starts by writing down many ideas, after which the ideas are discussed in more detail. Finally, some sketches are created during the discussion process. The ideas and sketches are finalized on paper and later they are copied digitally using Illustrator or other sketching programs. At the end of the session, the team will take pictures of the whiteboard and upload them to the shared repository, such as Dropbox or Facebook Group.

An interesting approach that was mentioned by a designer was taking notes individually and simultaneously recording the audio of the session using a tool called Evernote. One advantage is that Evernote is available on the computer, the tablet and the phone. The designer can use it simultaneously, for example, to record the voice with the phone, and make notes with the tablet or the iPad. Recording the meeting was found to be useful as one designer comments: “One of the things I would like in times like that is to have a recorder because something is said and a lot is said after each other and it seems logical at the moment, but if you don’t write it in a bullet point or whatever, sometimes you forget stuff.” The person can listen back to the recording if needed. The interviewee also commented that he tried to share the notes with his team, however it was not really used by anyone since not everybody was a member of Evernote.

In some cases, the designers use Google Docs, Google Spreadsheets and MindMeister applications connected to Google Drive when brainstorming remotely. The process is similar to the face-to-face process: several ideas are written down, and linked to each other. Some ideas are further developed through discussions amongst the team by commenting on the main ideas. In some occasions but not necessarily in all, the team will discuss the ideas through videoconferences over Skype, a voice over IP program. Color-coding is used to mark when something is important or relevant. Links, images or videos are usually attached to the idea and other team members will comment on those resources.

During the idea generation sessions, designers are constantly relating to their potential ideas with examples of ideas and concepts from other designers or other sources. Search engines are constantly used to find examples of images or texts on the Internet. However, it is also common that designers might refer to their personal collection of inspiring material. The collection usually consists of a folder containing a large amount of resources and links relating to fashion, music, art works and interesting designs or concepts. The gathering process is normally an individual process. However, the

designers use Dropbox to intentionally share their own collection with other designers in order to trigger and support new ideas. Pinterest, an online discovery tool, is widely used to gather interesting images (library of characters, scenes, UI elements, etc.) in which the designer can easily find a specific topic of interest. According to one of our interviewees, Pinterest also allows for the easy creation of collections and sharing: “You can quickly build up a mood board and easily share it with people.” Several participants explained that they have a shared folder in Dropbox where all the inspirational resources are stored and shared among their teams.

Skype and Facebook are used for sharing inspiration, such as links, images and videos to each other. Facebook is particularly favoured for sharing inspirational material, because the individual can easily access it even if the person is not sitting at the computer, he or she can just open it using a mobile phone. Twitter is used to subscribe to specific news about design related topics that are also discussed with their colleagues.

4.2.2 DEVELOPING IDEAS AND CONCEPTS

During this process, designers elaborate on ideas or concepts with the goal of showing how the idea would look before further developing the end product. This process occurs after the process of idea generation, and it is characterized by the creation of sketches and prototypes containing different levels of detail and fidelity.

Sketching is carried out in the earlier stages of the project usually sitting together with other designers or while meeting the client. Our interviews revealed that no online tool was used for collaborative sketching. Sketches are mainly done on paper or with the iPad using software like Adobe Ideas or the Paper 53 app. When sketches are completed using paper, they are either scanned or subsequently they are later redrawn more formally in Illustrator. For example, a participant indicated his preference to create sketches on his tablet (e.g., iPad) as he could easily bring it along when meeting with the client or other designers: “it is easy to evaluate designs together with the client”. According to the designer, using the iPad is very convenient because the client can immediately get an idea of how the solution would look and how they might expect the final product to appear, “even though it is in low detail and it looks like a child’s drawing”. He explained that he could iteratively modify his design while discussing it during the meeting. They can easily make changes on the sketch and print it again. Furthermore, he explained that the tablet allowed him to share his sketches with his colleagues by sending them directly via email. However, the current applications for the iPad did not allow for the sharing of the sketch with other designers in a way that they could draw simultaneously over the same sketch: “They don’t allow you to simply say this is my colleague, share it with him, so we can also draw on the same thing”. He commented that he would find it valuable if he could remotely collaborate and draw on the same sketch. Currently, the designer would mainly sketch it in the iPad and send it via email to his colleagues and they would work separately on the drawing.

We found that of the designers who were interviewed, they often needed to work on the same assets while collaborating together with their colleagues. The main challenge is to ensure that the efforts of the designers, who are working on the same asset, do not nullify each other. Designers adopt different strategies for coordinating and integrating the work of their colleagues depending on the task and the type of asset and application. A common strategy is to plan and divide the time in which each team member can work on the asset. Another strategy is to notify the team when one asset is being used or not used.

Most of the participants used tools such as Dropbox and Google Drive when they were required to support collaborative efforts. However, several designers commented that sharing a folder via Dropbox or Google Drive was not always the best option if the designers needed to work simultaneously on the same file. Dropbox is used for working on files like Photoshop and Illustrator, since Google Drive does not support a preview of these types of files. The main problem with Dropbox is that the individual does not know if someone else is working on the same file. In order to avoid conflicted copies, our designers stressed that they usually make agreements with their colleagues on who can work on a specific file

at a specific moment. As some of the designers commented, it would be convenient to receive notifications every time someone else starts editing a file or when that person has finished modifying it.

Google Drive is the preferred option if several persons have to work on the same text document since it allows the team to see who else is working on the file. A participant indicated that she and her colleagues used different colours for the text while writing a design specification on Google docs. The different colours helped to identify each others' contributions and comments, and to take ownership of the parts that needed to be improved: "you can give and receive very specific feedback on each contribution, and track who wrote what". Several participants mentioned that they tried to use Axure to jointly design prototypes with the team but they did not succeed. The main problem, as they commented, had to be with setting up the sharing functionality in Axure: "The sharing option in Axure didn't work for us because we had problems with setting the environment like the server or something like that". Another common problem with Axure was that the type of license did not support parallel edition. At the end, the interviewees indicated that they worked separately in Axure and later merged each other's work.

Our interviewees stressed that they would usually prefer to use version-tracking systems like SVN, Github, or Bitbucket when designing collaboratively. These tools are commonly used amongst the software development community. SVN and Github are well known for allowing several individuals to work on the same file and to enable the tracking of changes and facilitating the resolution of conflicts between file versions. The main problem of version tracking systems, as our participants explained, is that "for non-technical people", they are difficult to set up, learn and use. As one of our participants' commented: "It should be like just press a button and it works, so I can focus on creating. And it feels more like a necessary evil than how it is really helping". To make this process less frustrating it should work automatically.

4.2.3 MAKING SENSE OF THE MATERIAL, RESOURCES AND EXPERIENTIAL KNOWLEDGE

This category describes how designers integrate the information coming from the real world into their design process. During this process the designer clears doubts, analyses and evaluates their designs, and makes specific decisions about their approach. The designer interacts with the team through active discussions about the design and the design process. This process includes talking to the client, gathering requirements and evaluating the design artefacts.

Part of the process consists of gathering and exchanging information through active discussions with the team, exchanging feedback about the design process and the outcomes. We identified that exchange files and comments support the process of assessment. Designers usually try to communicate the most important steps of the project, and receive feedback from their colleagues. They will share pictures or screenshots of their work or will meet personally with the rest of the designers and show the work directly to them. The discussion may or may not happen in real time. Team members provide their comments and the designer makes decisions after the discussion is finished. On several occasions, a designer who is looking for support from colleagues initiates the interaction and discussion. For example, one interviewee details how she was trying to understand the goal of her assignment: "And then if I have some doubts, I write them down and say these are the doubts that I have, the client sent this and my interpretation is this and this, is it correct or not?"

Depending on the context and the geographical distribution of the team, designers might meet Face-to-Face or use various tools for communication like Email, Skype, or other instant messaging platforms. The results showed that even though email is used in all the organizations, it is not the most popular tool for collaborating. The main context of use is when the designer needs to have some formal text written by a colleague or a stakeholder, for example a formal confirmation. Group mailing lists is another context in which email is used, which is useful for building conversations around a topic. However, our designers complained that they wish they could be able to unsubscribe from a discussion when the topic is not interesting. One of the most positive features of email is that it can be archived and "saved for later" and the designer can always refer back to the specific email. The most common complaint about email is the slow pace of communication: "you sent an email today in the morning and maybe by the end of the day you will get a reply or maybe not at all."

Skype, Lync, Facebook Chat and Google Hangouts are some of the tools that are used to have direct discussions with other team members. Direct communication mostly occurs between individual peers. However, chat groups are also used when distribution and size of the team is large. The general perception is that chat is preferred over email, as one of our participants explains: “I find chats very convenient. It is fast. It feels faster than email. You can basically do the same things as email. You can send files, links, pictures and actually it looks like a real conversation.” Another designer adds: “I think that the chat is very valuable because I can talk more easily to my colleagues on the other locations and also because you don’t have to send an email if it is just for a one line question.” The adoption rate of a tool is one of the biggest issues for using it. For instance, Lync is used within big corporations, but one common issue shared by our participants is that the whole team is not connected via Lync. Facebook chat has several features that are very valuable according to our participants. The first feature is the possibility to leave a message to an individual through Facebook chat even if that person is not available or online. A second feature of Facebook chat is that the person that sent the message can check if the other person has already seen the message. The last feature is the possibility to read your messages directly from the mobile phone.

Skype video calls are used for getting more detailed immediate feedback or during discussions in which “typing takes too long”. Similar to chat, videoconferencing is usually done between individual peers. The duration of the call is short since the main goal is to solve specific questions and clear doubts. We found that our participants preferred to Skype rather than use email because Skype speeds up communication. Through Skype, the designer can get immediate feedback, something that is not possible via email. All communication tools, like email and Skype, present the constant risk of miscommunication and misinterpretation of information. As one of the designers explains: “a word can have multiple meanings”. In those cases, the designer sends an email explaining her problem in detail. Afterwards, she will use Skype to discuss the issue with her colleague.

Evernote was mentioned as a way to share directly with the group so that others can add their own notes. One downside of Evernote is that it requires individuals to have an account in order to participate in the discussion. Several designers commented that they prefer occasions in which they can immediately share what they are working on, in a way that it allows others to directly comment on it. According to them, having the possibility to easily share their work and immediately receive feedback enables them to “explore more and think of different ideas”. A problem that is often encountered during the discussion is being able to properly explain an idea to others or negotiate specific changes in the design. As a participant explains, the discussion can be hindered because “Sometimes it is quite difficult to communicate some ideas, maybe some improvements.”

This section is also related to the process of communication with clients and other stakeholders. Most of the interactions between clients and designers occur at the beginning of the design iteration while gathering the requirements. Furthermore, interactions happen during the revision and delivery of the resulting milestones at the end of the design iteration. Clients typically do not communicate with designers on a daily basis. Contact with the client is usually mediated by the team leader or project manager who filters, discusses, and prioritizes the information before passing it to the rest of the team. If there is any communication, it is done mostly via Email and Skype. Personal contact is not common but it is mostly preferred.

When the designer does not gather the requirements directly from the client, he or she will receive them from the project manager. The problem is that “listening from somebody else what the client wants” sometimes causes “things to go wrong” because “second hand” requirements usually include “an interpretation of what the client wants” from the project manager’s perspective. The designer tries to understand the goal of the assignment by defining their own interpretation and asking the client or the project manager to evaluate the result of that interpretation. The client will provide feedback about a (finalized or not) version of an artefact — e.g., requirements, prototype, sketch, image, video, interactive PDF or a document. The designer will share the artefact via email, or sending a link where the artefact is hosted online. The artefact

might consist mainly of a visual component — for example: pictures, wireframes, sketches, movie, prototype — and some brief description, which could be enclosed as a separate document, summarizing the main artefact. For example, one interviewee describes what the content of the shared files is: “The main work was in the interactive prototypes. And the word document was just ok, you have the menu there, you can select the different options of the applications... You can see the details there, then the prototype showed them what kind of information was there. So the description was really minimal, in the sense that this is the general idea of the application, now play with the prototype and let us know what you think.”

The process of receiving feedback from the client depends on the extent to which the artefact allows direct comments and how the file is shared with the client. For example, the client provides feedback by making annotations on the artefact, or through making a screenshot and making annotations over the screenshot using graphic editing software like Microsoft Paint. One of our designers explains this process: “The way they will usually send us feedback is by making a screenshot and in that screenshot they will make a circle in Paint and paste it in a Word Document and comment on it: ok here, you will see this and this, and we would like that and that.”

In some cases the client will print the screenshot and manually make the annotations, to later scan it and send it via email back to the designers. This is an iterative process until the client is satisfied with the result. Designers commented that it will be valuable if the software application that they use for designing would allow them to add comments and annotations as commonly used word processor programs do: “the client cannot as easily just click and place a remark here, like they have in Word.” Another example is the case of a designer who uses Microsoft Excel for creating wireframes. The emphasis of the advantage of using Excel was mainly based on the fact that it is widely used in the office, it allows comments and it is compatible with all Excel versions, opening the possibilities for feedback exchange.

Some of the options that designers use to share the artefacts are Dropbox, Wetransfer, and occasionally Google Drive. Other tools, like Axure, let designers send the link for the interactive prototype directly to the client. Email is only used in the case where the client cannot access the files via the Dropbox or Wetransfer. There is also a need for the client to send back the files with their comments. Some design teams have created a specific Dropbox folder for the client to upload their input files. In this case, the client used it to upload files and share them with the rest of the design team. One of the interviewees detailed that in one occasion: the design team shared the complete folder structure of the project with the client. Since the design team was continuously working on the project adding new files to the folders, the clients received multiple notifications every time a new file was modified or created. The clients were annoyed by these notifications that they deleted the folders and files that were not interesting for them. This caused the team to lose important information but the problem was solved by creating a specific folder for the clients and only sharing that folder with them. One designer commented that in a previous project she used Basecamp. She positively commented that Basecamp was very convenient for sharing the results and files with the client, and the client could leave comments on the document, enabling a direct conversation between external stakeholders and the designers.

4.2.4 KEEPING THE TEAM ON TRACK

All the designers stressed that communication within the team happens through the whole design process. However the team communicates in different ways, depending on the specific situation. This category covers the communication processes, whose main purpose is to keep the team in tune and engaged, updating them about the course of the project or team, and addressing the problems that might arise amongst its members.

The designers continuously update their colleagues about important events in the project. They need to keep in touch with the team without requiring active discussions but rather notify them to keep them informed and engaged. The team traditionally updates their members through face-to-face meetings. However, face-to-face meetings with other team members do not always occur on a daily or weekly basis, sometimes they happen on a monthly basis. Therefore Facebook

Groups and other group communication platforms are used to keep the team updated more frequently. Several designers consistently refer to it as the company's intranet where weekly announcements are published and general information is shared. The fact that "everybody uses Facebook" makes it a great tool for collaboration: "With Facebook, it is easy to keep in touch, and because everybody is always on Facebook, you are already sure that if you post something on it, it will be read." Facebook groups are also used to update the team about meetings and events. Since Facebook can be accessed from the mobile phone, it is very useful for informing the team on updates, like someone being late or if a meeting has been cancelled. As mentioned before, Facebook Groups are also used regularly for sharing links or videos as source of inspiration to the team, and for storing files such as images and documents. Finally, Facebook Groups are used to keep in touch with other designers through projects that are not regularly active but that have existed for long periods of time.

Similarly to Facebook Groups, Whatsapp Groups are commonly used within the team for direct communication with the whole team. The team uses the Whatsapp group to communicate urgent matters or to update last minute information. It is also practical to have two Whatsapp groups in a team, one for work related issues and the second for sharing "fun stuff". Whatsapp is faster for communicating specially when the individual is on their mobile, because it takes less effort to leave a message to the complete team. Whatsapp is also widely used to arrange meetings and to agree upon time and place. One participant stressed that it is faster to arrange a meeting through Whatsapp than using any other tool, like Outlook and shared agendas: "So I asked in Whatsapp, and it was faster because everybody reacted in Whatsapp." Doodle was also mentioned as a tool for arranging meetings. Doodle provides a poll where participants can indicate their preference between several options about time and date facilitating the arrangement among all the attendees.

Communicating with the team is not an easy task. One of our interviewees commented that collaborating is hard: "We are working together trying not to kill each other, trying to get the best results." Another participant said that it is common to encounter obstacles in the way of communicating with the team members when there is a problem: "There were moments where I was hoping there was more communication with my team that I worked with." Some of the interviewees indicated that they lack options to support conflict resolution within the team. They commented that they would like to have ways to provide negative feedback or to directly discuss and address a problem: "Rather have people talk straight to me and have a discussion about it." However, they emphasize that most of the times the problem is not related to the specific medium of communication but more of an issue related to the way the individuals cooperate and solve conflict: "The problem was not the means of communication, Facebook, or Whatsapp. It was more a problem of the personality, some people sometimes don't care that much."

One of the designers explained that these issues are common when working with a group of freelance designers, compared to working with a well-established design team inside a company since there is no formal way of providing negative feedback. Another participant described the use of feedback assessments at individual and team level as a way to indirectly solve conflicts between team members. Each designer in the team will usually write a personal feedback assessment in which they will rate the commitment and support of the other team members: "when you are working in a group, you have to present a reflection at the end of the project. Even if you have a group reflection, you have a personal reflection. And in the personal reflection, you can always say that someone in the group didn't collaborate and that would be a negative thing for that person. And everybody tries to avoid this negative feedback because you are assessed based on that reflection." In this sense the personal reflection works as a tool that supports conflict resolution and team development. Designers comment that usually problems have their roots in individual expectations within the team. The person is focused on achieving his or her personal goal, rather than trying to help the team achieve the goal. However, the person can mostly only see the consequences until the end of the project.

4.2.5 MANAGING THE DEVELOPMENT OF THE PROJECT

As part of the design process, designers spend part of their time on documenting how the project evolved, organizing the collection the artefacts and documents, breaking down and dividing the work and tracking the execution of the tasks. This section covers the activities that support designers in keeping the development of project under control.

Many of the designers that we interviewed commented that it was important to have every project well documented. A document is usually created containing the requirements and specifications of the design project. This document is usually created on Google Docs or using a web blogging platform in which everyone can contribute and modify it. During this process, the goal of the project and the functionality of the design are clearly stated, as well as the approach and all the decisions that have been made until that moment. References to the user stories and discussions are included if existing. All the important steps are recorded from the start, including the conceptual ideas and the document is updated regularly during the process. The document helps “to keep everyone on the same page”. One of the designers points out the role of the document: “It gets updated, and it is not very strict but decisive. So what is on that document, it will be on the end product.” All the team members are involved in the creation and verification of the document. It contains a detailed description of the assignment and the activities that will be executed by the team. The document is often used as a formal agreement with the client. In case that there are disagreements with the client, the team can always consult the document and clarify the problem.

Tasks are typically divided at the group meetings: the team sits together to discuss the approach on how to implement the ideas that came out of the brainstorm or requirement definition session. The discussion is focused on what kind of steps and requirements should be followed. After that, the tasks are divided among the team. One person (project manager / team leader) is usually responsible for the final decision in this process. Finally, a procedure of action is defined in the case that some tasks are dependent among each other facilitating the combination of the outcomes of the different tasks. One best practice is to make short and well defined tasks so that it is easier to track when something goes wrong. In some occasions the task definition includes a collection of artefacts that the designer might use during the implementation, such as results from user tests, storyboards, or artwork.

Organizing time is done often individually, and is closely related to the task organization. For example, a plan is made at the beginning of the day, containing the lists of tasks that the designer will complete and the team is updated about it. At the end of the day, the plan is updated with the tasks that were finished and the tasks that were not completed. The designer includes details about the issues encountered during the completion of the tasks and the ones that were missing. In other cases a similar plan is defined at the beginning of the week and a review of the plan is done at the end of the week. Some of the designers use Gantt charts —via the online tool Redmine—, or shared calendars to keep track of the project, the availability and the progress of the others.

Some of the most successfully used tools for distributed project management are Outlook, Teambox, Trello and Excel. Outlook is used to write down what the designer is doing at the moment, and to map it into the calendar, while Excel is used to simply define a list of the tasks to be done. Designers argued to be more satisfied with management tools that gave them more flexibility when defining and organizing the tasks. Emphasis is given on tools that allow for easy modification of the status of the task in case it changes during its realization. Trello is the tool that was most mentioned by several of the participants because of the possibility to define their own functionality, their priorities or their own approach to the management of tasks. For example, a designer explains how he has successfully used Trello implementing its own management method: “In Trello, you define your functions, like I wanted to do the MoSCoW for example. I can use it that way”. Trello also allows the all team members to view the list of tasks and see who is working on what and comment on each of them. Another advantage is that everyone receives an email when there is a change in the planning.

Teambox is another tool in which the designer can define their own projects and sub projects and attach a list of tasks and deadlines. Apparently, the main advantage of Teambox was the possibility to create a Gantt chart out of the defined projects. Several interviewees mentioned that it would be ideal if other collaboration platforms such as Dropbox could be connected to management tools and support project planning and work breakdown functionality. Redmine, Mavelink, Wonderwall were other tools that were negatively reviewed. The main negative issues of these tools were: high complexity, lack of flexibility, difficult to learn and very time consuming for setting up a project. Interviewees expressed their need to have project management tools that do not require a big effort to learn in order to achieve “a relatively simple goal”.

Tools like Dropbox, Google Drive, Facebook Groups, and internal network storage are used for storing files. In this way, all files and documents can be accessed everywhere and by anyone in the team. The main goal of these tools in this specific context is to host a centralized repository of the files of the project where anyone can consult at anytime. The files that are stored can be of any type — PDFs, images, videos, documents, Photoshop files, project reports, etc. The type of file and the length of the project affect the adoption of different online services. For example, Google Drive is referred for its support for navigation through the files, and Dropbox is mainly preferred because it can handle large files and images. Internal repositories are traditionally adopted for Government related confidential projects. Based on the duration of the project, Dropbox is used for longer projects, while Facebook Groups are used in projects that last for a shorter period of time, for example less than a month. The main reason for this choice is that during a longer period of time, there is a larger amount of files that are created and stored. While Facebook could store a large amount of files, it does not permit the grouping and organization of the files into categories such as folders and subfolders. Grouping files into folders facilitates the searchability and management of those files.

The structure of the organization of the files changes over time of usage and there is a clear difference in the way recently created files are stored and the way older files are stored. Files will usually be grouped together in folders according to the actual context of use, and they will be regularly regrouped into different categories depending on how these files evolve, and depending on the new files that will be created during the different phases of the project. For example, at the beginning of the project, a category called “images” will be created to group all the visual artefacts, like photographs, and sketches. In the next phase, new sketches of design explorations might be created and a new folder called “sketches” will be created, and all the sketches will be moved into this new folder. Later on, a specific design will be selected and all the images will be regrouped based on the chosen design. This structure becomes more stable at the end of the project when all phases have been completed. Every time a new project starts, a new folder is created and the process is repeated. However, the internal folder structure of a specific project is not exactly the same as the one of another project. Two of the participants have noted that sometimes the folder structure becomes too messy and full of files. In that case the team does a reorganization and clean-up of the folders.

The majority of the interviewees use the free version service of Dropbox and Google Drive, which provide with a limited storage of gigabytes and automatic backup features. One of the designers interviewed explained that in his company, they have premium accounts of Dropbox since they needed several terabytes of storage for keeping the videos and animations that they produced. In some settings, interviewees use a combination of Dropbox and an internal repository. In such cases, Dropbox is used to store the files that were recently created and the internal repository to backup the files that are not used anymore. Another advantage of Dropbox is that it synchronizes files faster than Google Drive or than a internal repository. According to some interviewees, network transfer speed is a common problem for synchronizing files, even in Dropbox.

4.3 DISCUSSION

The current study explores how online collaboration tools support designers during the early stages of the design process. As part of this study the CONCEPT team was also interested in what were the most frequently used and most popular tools. First, we identified the following clusters of tools based on their functionality: file sharing, online edition of documents, instant communication tool (Chat, Video chat, Group Chat), group discussion platform, online blogging sites, social networking, specialized video collaboration tool, email, scheduling tool, lists and project management (tasks and tracker), version control, community (mass) collaboration, and integrated collaboration platforms. Table 2 provides an overview of all tools mentioned, clustered by functionality.

TABLE 2: ONLINE COLLABORATION TOOLS CLUSTERED BY FUNCTIONALITY

Functionality	Tools referred
File sharing	Dropbox, Google Drive, Fileshare, Intranet file-sharing, SkyDrive, Yousendit, iCloud, Wettransfer
Online edition of documents	Word, Google Docs, iCloud, SkyDrive
Instant Communication tool (Chat, Video chat, Group Chat)	Skype, Office Communicator, Google Hangout, wechat, facebook chat, Whatsapp
Online blogging sites	Blogspot, Wordpress, Tumblr, Twitter
Group discussion	Online Forums
Social networking	Facebook, Linkedin, Whatsapp, Twitter, Yammer, Tumblr, Google, other.
Specialized video collaboration tool	Collaborate.io, Webex, Teamviewer
Email	Outlook, Gmail, own email service
Scheduling tool	Doodle
Lists and Tasks tracker, Project management	Trello, Evernote, Shotgun, JIRA, tgant, Wunderlist, Teambox
Version control	Tortoise SVN, Github, Bitbucket
Community (mass) collaboration	desing2gather, visual.ly
Integrated collaboration platform (includes all or almost all of the above functionalities)	Services provided by Google, IBM, Samepage.io, Slack, Sharepoint, Sametime, Basecamp, Confluence, Bitrix
Other	Mural (virtual whiteboard), Excel, Axure

Other services like Google, SharePoint, Basecamp were categorized as integrated platforms since they include a considered number of different features. When organizing the tools based on the functionality they support, we found that

many of the technologies that were listed provide different core functionality (e.g. instant communication vs. social media), while offering extra features that are similar or overlapping. For example, Google Docs and Facebook provide chat functionality but the intended goal of Google Docs is to support the online editing of documents.

Designers generally opted for tools that are generally available and free of charge. For example, several interviewees used a spreadsheet application because every computer usually has it installed by default and it is a commonly used application in office environments. On the other hand, the majority of the online platforms listed in our study provide access to basic functionalities without any cost and, simultaneously, they offer the option to pay for additional services and extended functionalities. The design process is bound to the possibilities, advantages and limitations of these free of charge services. As a result, designers are forced to adopt extra measures to bear a successful collaboration. For instance, the individual must collect a large amount of generic applications and might struggle while approaching them in different ways as the originally intended ones. In extraordinary cases, a tool might be used to support a different task than the one intended in its default setting. Spreadsheet applications, such as Excel, illustrated a clear example of this situation. Spreadsheet applications are used for prototyping and brainstorming instead of being used as accounting and calculation tools. Furthermore, Excel was preferred over other tools because of its compatibility between older software release versions and the fact that it supports annotations.

The results from the web survey, shown in Figure 4, describe that social media applications were the tools most often mentioned for supporting collaboration. The most frequently named tools were instant communication applications, followed by file sharing platforms. The survey showed that online editing of documents and integrated collaboration platforms are commonly used. Other mentioned tools included email and task tracking (project management) services.

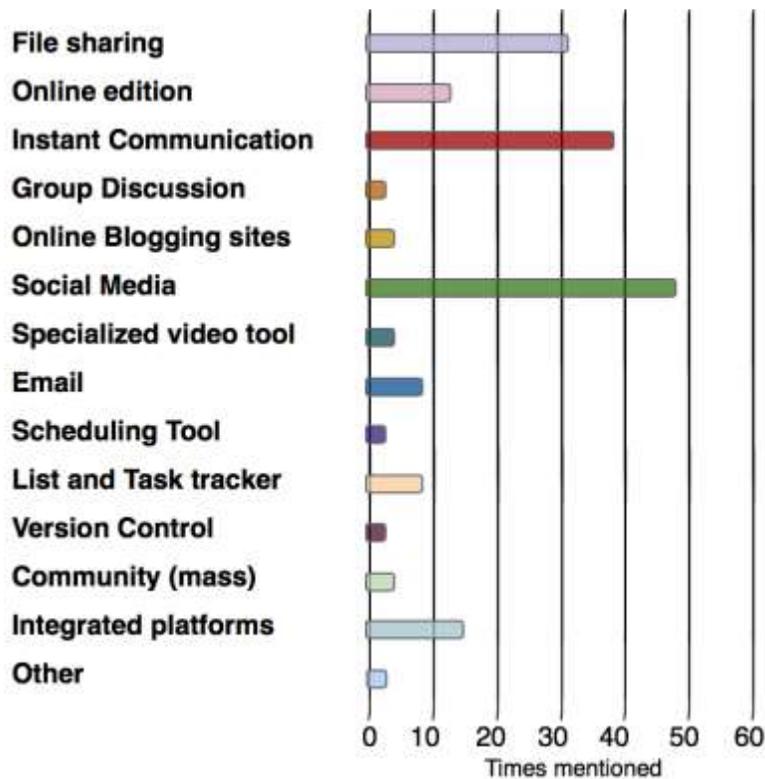


FIGURE 4: TOOLS CLUSTERED BY FUNCTIONALITY AND TIMES MENTIONED

Similar to the results from the web survey, the interview analysis surprisingly showed that Facebook was the most popular tool for collaboration purposes. We found that one of the main reasons for a tool to be used is the designer’s previous

experience with the tool. Additionally, the whole team should be familiarized with the tool in order to use it. Opting for Facebook for collaboration purposes might seem a natural choice since it is widely used to interact with other people on a daily basis. In this sense, the user does not need to learn how to use a new tool. Facebook already provides multiple functionalities and enables multiple types of group interactions that are familiar to the user. Our participants constantly referred to activities that required instant communication, group discussions, online edition of documents and file sharing functionalities. With the exception of online edition of documents, Facebook covers these functionalities to a certain extent. Di Maggio et al. (2001) explained that the specific functionality provided by technology is what makes it relevant to people. Users will approach an application if they find its use relevant and interesting. The adoption of a new online application will depend on how the user understands it. Another reason for choosing Facebook was that users are almost 24 hours connected to the application, whether via their computers or their smartphones. They receive notifications every time someone shares a new file or someone comments on something.

Another finding was that Facebook was often preferred over other applications in several of the conceptual categories depending on the situation. A clear example of this finding is the case of Dropbox and Facebook Groups. Dropbox is widely adopted for its main feature of online storage of documents with the intention of making them accessible at any moment and place. Although Facebook and Dropbox are not specifically developed to completely cover all the different needs, the designer uses both platforms to store and share inspirational material, to share assets with other designers, to backup files and to support the evaluation of artefacts. For short projects the Facebook Group is used as a file management and storing platform. For longer projects Facebook is used for communication purposes, and Dropbox for file storage and management.

The COncEPT team was interested in discovering what were the specific behaviours and activities that designers conduct in the context of online collaboration tools. The general results acknowledge that tools can only be understood based on the specific context of use and the activity supported. The analysis of the interviews revealed certain patterns of behaviour that resulted in five major categories: (1) creating ideas and concepts, (2) developing ideas and concepts, (3) making sense of the material, resources, and experiential knowledge, (4) keeping the team on track, and (5) managing the development of the project. The findings suggest that all categories are interrelated to different degrees and that, together, they articulate the design process. First, three categories can be differentiated that represent the core or primary activities of the designer: creating ideas and concepts, developing ideas and concepts, making sense of the material, resources, and experiential knowledge. The two remaining categories — keeping the team on track, and managing the development of the project — cover secondary or enabling activities, which facilitate the collaboration process in the team. The core activities have a strong interdependence among each other and are directly related through an iterative cycle. The enabling activities are present during the full cycle, closely interacting with and influencing the core activities. Figure 5 illustrates how the enabling categories, located in the external circle, are continuously supporting the iterative process of the core categories.

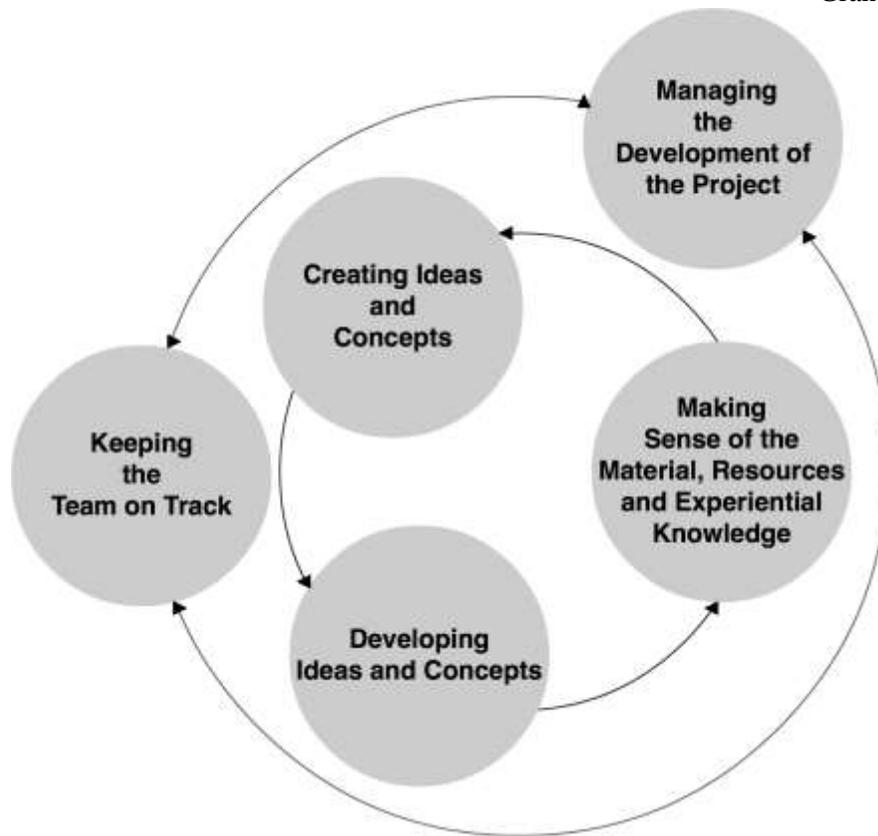


FIGURE 5: FLOW OF THE CONCEPTUAL CATEGORIES

As the interviews revealed, designers switch from one tool to another depending on the moment, the specific needs and how the tool covers those needs. The common scenario is a combination of physical tools and online services. Devices such as smartphones and tablets are used differently depending on the specific context and goals that the designer is trying to achieve.

5 REFLECTION ON ACTION: CURRENT COLLABORATIVE DESIGN PRACTICE - DLAB

The current report empirically investigates the challenges of collaborative design practices, as it qualitatively analyses traces of creative group behaviour in a localised, yet distributed setting. The study took place at Designlab, a design SME in South Europe for a period of 18 days. The aim of this study was to discover how collaboration was and was not supported by current technology, understand main challenges of distributed collaboration and identify priorities that need to be addressed by COnCEPT. Distributed collaboration within Designlab did not involve long distance collaboration but different rooms and floors within the same building. The study also resulted in the “Intelligent Breathing Trainer” use case, presented in D1.6.

In order to create the intelligent breathing trainer use case presented in D1.6, a log was created based on Designlab’s design process. The daily log kept track of all the relevant tasks carried out by the design team as well as all the interactions among the team members, over a period of 18 working days. By studying the results of this field research, one can acquire a good understanding of collaborative design practices as they are currently being carried out within the design industry. The process of analysing the log and current tools aims at contributing to the overall design, functionality and user experience of the integrated tools, as they are driven by the needs of the end users. Finally, it is one of the ways of revealing opportunity areas within current design practices where COnCEPT can improve and innovate.

5.1 DATA COLLECTION

The involved team members were four: Fred, Jane, Patrick and Laura. The following tables depict all the tasks executed per user throughout the two first creative phases (discovery & vision) of the design process. The team members themselves collected the data for the empirical study. A spreadsheet was created in Google docs and shared among the participating collaborators. Each day constituted a different sheet within the document and contained four identical matrices -one for each participant. Each row of the matrix was representing a task whereas each column a quarter of an hour. Every time the participants were involved in a task for the specific project they had to colour in the cells of the matrix, thus specifying the task and duration. They were also asked to include the tool utilised for the task and to add any notes / comments regarding the task (i.e. when filling in a communication task they had to specify whether it was computer mediated or face-to-face communication). One of the participating team members was responsible for the research and overlooked the process.

DURING THIS PROCESS, THE PARTICIPANTS WERE ALSO ASKED TO WRITE DOWN ANY THOUGHTS REGARDING THE DESIGN PROCESS AND THEIR TASKS SUCH AS TASKS SUCH AS SUGGEST THINGS THAT THEY MIGHT CHANGE, MENTION ISSUES / GLITCHES IN EVERYDAY TASKS OF THE PROCESS, IDEAS ON WHAT WOULD HAVE WHAT WOULD HAVE BEEN THE OPTIMUM WAY OF EXECUTING A TASK, OR ANYTHING THAT COULD ENHANCE THE PROCESS. THE IDEAS AND THOUGHTS WERE THOUGHTS WERE CAPTURED AND ARE PRESENTED FURTHER ON IN THE DOCUMENT. AT THE END OF THE STUDY, ALL THE SEPARATE DAYS WERE COPIED IN ONE COPIED IN ONE SPREADSHEET (SEE

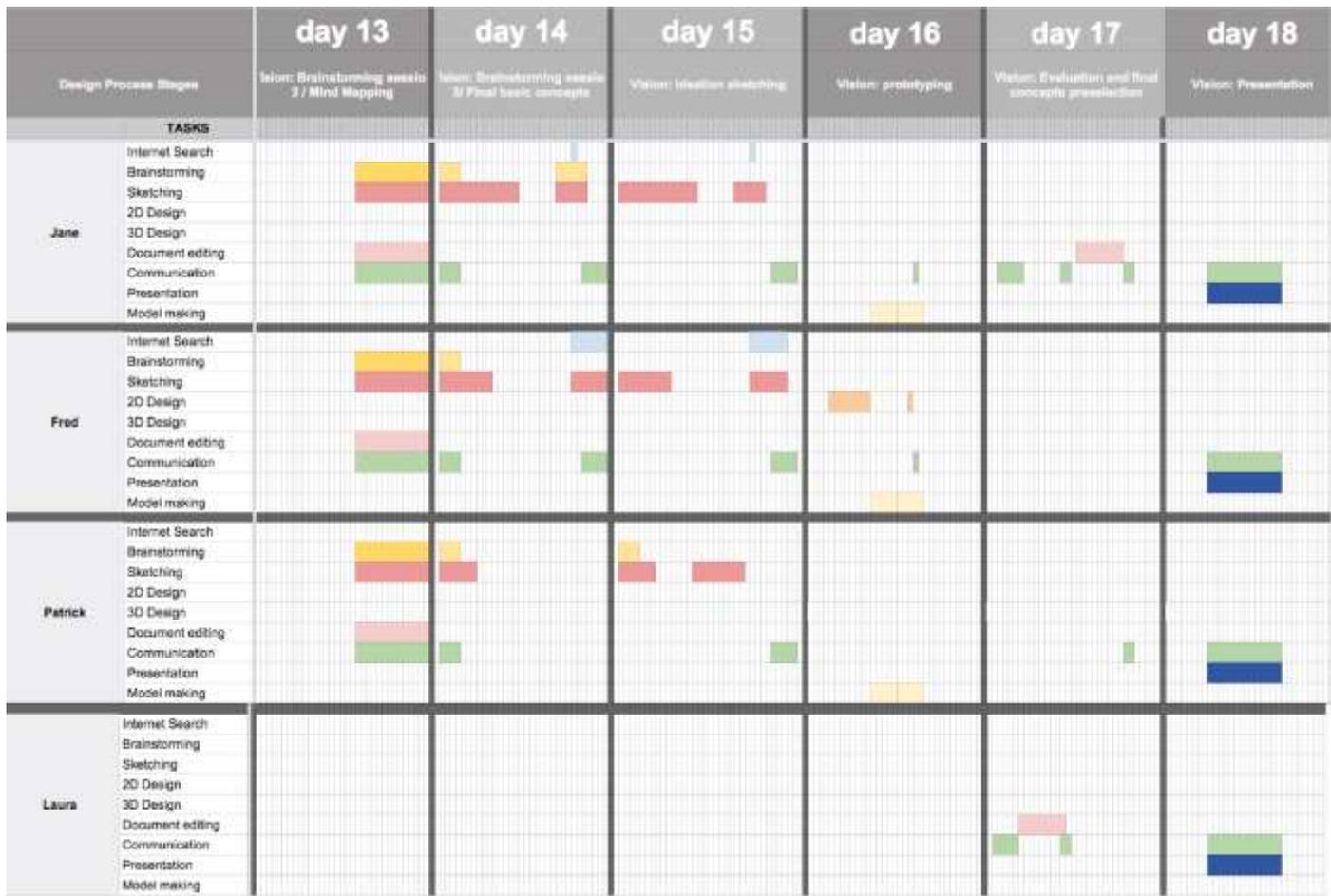
Table 3, Table 4, and Table 5) in order to get an overview of the process and compare the data. The following tables visualise all the tasks, the instant they were executed as well as their duration and frequency.

TABLE 3: WORKFLOW OF ALL TEAM MEMBERS FOR DAYS 1-6

		day 1	day 2	day 3	day 4	day 5	day 6
Design Process Stages		Discovery: Mapping of main groups and components	Discovery: Creation of a common vocabulary among team members	Discovery: First approach to specifications and requirements for breathing trainer	Discovery: Understanding and analysis of set up & use	Discovery: Personas and Use Scenarios	Discovery: Device handling analysis
TASKS							
Jane	Internet Search						
	Brainstorming						
	Sketching						
	2D Design						
	3D Design						
	Document editing						
	Communication						
	Presentation						
	Model making						
	Fred	Internet Search					
Brainstorming							
Sketching							
2D Design							
3D Design							
Document editing							
Communication							
Presentation							
Model making							
Patrick		Internet Search					
	Brainstorming						
	Sketching						
	2D Design						
	3D Design						
	Document editing						
	Communication						
	Presentation						
	Model making						
	Laura	Internet Search					
Brainstorming							
Sketching							
2D Design							
3D Design							
Document editing							
Communication							
Presentation							
Model making							

TABLE 4: WORKFLOW OF ALL TEAM MEMBERS FOR DAYS 7-12

		day 7	day 8	day 9	day 10	day 11	day 12
Design Process Stages		Discovery: Research and analysis of competitive products	Discovery: Design Benchmarking	Discovery: Define positioning and placement of the product	Discovery: definition of design requirements	Discovery: Final design brief definition	Design: Brainstorming session / Basic concept comparative analysis
TASKS							
Jane	Internet Search						
	Brainstorming						
	Sketching						
	2D Design						
	3D Design						
	Document editing						
	Communication						
	Presentation						
	Model making						
Fred	Internet Search						
	Brainstorming						
	Sketching						
	2D Design						
	3D Design						
	Document editing						
	Communication						
	Presentation						
	Model making						
Patrik	Internet Search						
	Brainstorming						
	Sketching						
	2D Design						
	3D Design						
	Document editing						
	Communication						
	Presentation						
	Model making						
Laura	Internet Search						
	Brainstorming						
	Sketching						
	2D Design						
	3D Design						
	Document editing						
	Communication						
	Presentation						
	Model making						

TABLE 5: WORKFLOW OF ALL TEAM MEMBERS FOR DAYS 13-18


In the tables above one can see the four team members involved in the project and the tasks they executed over the period of the 18 days. These tasks and their sub-tasks are also listed here in the same order as in the tables:

- Internet Search
 - Online research
 - Annotation / bookmarking
- Brainstorming
 - Ideation
 - Mind mapping
 - Evaluation
- Sketching
- 2D Design / 2D design collaboration
- 3D Design / 3D design collaboration
- Document editing
 - Moodboards
 - Document compilation
- Communication
 - Information exchange (links, data, files)
 - Verbal communication

- File sharing
- Presentation
- Model making

These tasks and the tools used to implement them are described in the following section.

5.2 TOOLS FOR COLLABORATION IN CURRENT DESIGN PRACTICES

In this paragraph there is a list of the interactions and tasks occurring during the recorded design process, accompanied by the tools that support each action. All the tools mentioned are existing tools currently used in collaborative design practices and derive from the log.

- Communication
 - Face-to-face
 - Computer mediated interaction: Instant / synchronous communication (Skype)
- Information exchange (links, images, files)
 - Synchronous: Instant message tool (Skype)
 - Asynchronous (email)
 - Pinterest
 - Evernote
- Moodboards
 - Pinterest
- Online Research & annotation tools
 - Web browser (Google Chrome, Safari)
 - Bookmarks
 - Pocket
 - File downloads
 - Evernote
 - Pinterest
- Document compilation (word, spreadsheet, presentation)
 - Google docs
 - i-work
 - MS office
- File sharing
 - Cloud
 - Copy
 - Dropbox
 - Google Drive
- File storing / backup
 - External backup LAN hard drive
- 2D design collaboration (Illustrator files / InDesign file exchange) via synchronous or asynchronous communication tool
 - Adobe Illustrator (with embedded images, outline fonts, in pdf format)
 - InDesign (packaged folder)
 - Photoshop files
 - VoIP
 - Screen sharing on Skype or Google hangouts

- Video call on Skype or Google hangouts
- 3D design collaboration via synchronous or asynchronous communication tool
 - e-drawings files exchange via instant messaging
 - e-drawings offers the ability to make annotations and comments directly on the 3D model
 - Rhino files exchange
 - 3D pdf with annotations
- Brainstorming session
 - Basic tools / stationary (pen, paper, post-it notes, scissors, tape, stickers)
 - Brainstorming cards
 - Brainstorming methods
 - Mind mapping tools
 - If in different locations tool used is VoIP with screen sharing / video
- Ideation sessions
 - Tablet (Wacom)
 - iPad
 - Pen / pencil, paper, tracing paper
- Evaluation process
- Presentation / Meeting client
- Project management
 - Shared calendar (iCal)
 - Reminders
 - Wunderlist (to do list)
 - OmniPlan

5.3 TASKS WITHIN COLLABORATIVE DESIGN PRACTICES THAT CAN BE ENHANCED

As previously mentioned, the participants were also asked to write down any thoughts regarding the design process and their tasks such as suggest things that they might change, mention issues / glitches in everyday tasks of the process, ideas on what would have been the optimum way of executing a task, things they miss from the process. The ideas and thoughts were captured, organised per task and are listed here:

- Communication
 - Seamless communication, non intrusive but with increased awareness level
 - Integrated instant messaging system in COnCEPT with the ability to search all previous discussions via date or keyword
 - Scan-ability of information
 - Sorting / tagging
- Information exchange (links, images, chat)
 - Integrated instant messaging system in COnCEPT with the ability to search all previous discussions via date or keyword
 - Scan-ability of information
 - Tagging
 - Sorting of exchanged information
 - History / timeline
 - Visual representation of information, gathered all in one page regardless information format (pdf, text, image, link, video etc.)

- Moodboards
 - Space for creating moodboards in CONCEPT in a Pinterest layout providing the ability to share, categorise, keywords, extract colour palettes, identify similar shapes / forms
 - Automated moodboards
- Online Research
 - Ability to save all research findings regarding a project in the same place visually organised (Pinterest style). This would contain imagery, videos, notes, websites, file downloads (or online pdf) etc. organised in folders, one per project. A timeline visualisation would also be useful.
- Document compilation (word, spreadsheet, presentation)
 - Collaborative editing of documents, spreadsheets and presentations with ability to track changes, make comments, revision history per collaborator, annotation
- File sharing
- File storing / backup
- 2D design collaboration
- 3D design collaboration
- Brainstorming session
 - Ability to capture session conducted in physical space
 - Create brainstorming session online / make it possible to recreate a war room without having actual physical space
 - Generate and capture ideas
 - Comment on ideas
 - Prioritize ideas
 - Mapping of ideas
 - Grouping of ideas
 - Show results of clicks/ favourites / time spent on idea per user. This tracking of usage can provide the collaborators information regarding which ideas seem to attract most interest
 - Equal artboards per idea / Same dimensions among different ideas / same scale for all leads to better visualisation
 - Ability to magnify artboards that attract more interest
 - Timeline visualisation of ideas evolution
 - Reporting (innovation reports where ideas are automatically captured on spreadsheets)
 - Reorganising brainstorming results
 - Automatic capturing the team's interest on specific ideas (eye tracking?)
 - Evaluation of ideas
- Ideation sessions
 - Ability to capture and upload hand drawn sketches
 - Ability to sketch digitally
 - Ability to keep track of the evolution of an idea
- Evaluation process
 - Auto colouring of better ideas
- Presentation / Meeting client
- Project management

As one can see, most of the priorities that need to be addressed are related mainly to information sharing / gathering and brainstorming. The participants clearly suggest that they need all the relative information regarding a project to be visually organised in one place and not in separate files and folders, browser bookmarks and external applications. Ideally, they want everything nicely visualised in one shared space that provides different search options (date, name, user, keyword, kind etc.).

Regarding brainstorming, most comments involved tasks happening during face-to-face brainstorming that can be enhanced in a computer mediated environment, as well as concerns in the conversion of a face-to-face brainstorming to a virtual environment. For the participants, face-to-face communication during brainstorming in a war room is crucial. Therefore, the transition has to be as smooth as possible, providing incentives with extra features such as the ones mentioned above that augment the brainstorming process. Most of the features mentioned deal with grouping and mapping the ideas, timeline visualisation of the evolution of the ideas and capturing the ideas. COnCEPT can address these at various levels; from performing complex tasks down to designing simple details of the user interface. For instance, it can assist by performing complex algorithms that provide intelligence when connecting and clustering ideas or even create “innovation reports” and timelines that capture all the ideas mentioned. On a simpler level, making information and concepts clear, searchable and traceable as well as designing a simple and intuitive GUI can upgrade the overall user experience. Virtual brainstorming sessions cannot precisely replicate the feel of face-to-face communication, however, the virtual environment can provide important features that simplify the process and delight the user.

6 COLLABORATIVE SURFACE TABLE ENVIRONMENT AND INFINITE WHITEBOARD CONCEPTS

The use case concerning collaborative architectural design within an educational context (details of the case and method are described in deliverable 1.6) raises a number of important issues with regards to process, interface and information.

A central part of the use case concerns the manner in which design process can be assisted, guided and tracked by the interface itself. Therefore, an ability for the concept tool to allow users to somehow record the process followed in the generation of ideas (through a tracked system, or portfolio development, perhaps) would be most likely to prove useful to the design team.

With regards to the interface, and bearing in mind that the use case concerns ICT enabled synchronous collaboration in a single location, the central issues which can be brought forward as user requirements are an ability to have multi-user participation, an ability to draw or sketch within the system, and an ability to switch between programs and applications.

Finally, users in previous iterations of the case have expressed and demonstrated a need to search for information in real time, and as a seamless part of the design process. Within the tangible interface, this meant an ability to search without having to exit the design process itself, and should be embedded within the Concept tool.

7 CURRENT PRACTICES IN DESIGN CONSULTANCY

RGU's COncEPT team interviewed the owners of two London-based design consultancies, Studio Levien (SL) and Doshi Levien (DL), on the ways in which they collaborate with stakeholders, on the methods and tools with allows this collaboration, and gaps in requirements. In this section, we consider the issues and possible solutions regarding: 1) project management, 2) current collaboration tools, 3) design research tools, and 4) the track and review process.

7.1 PROJECT MANAGEMENT

The owners/founders of the studios we visited assume the majority of project management duties for the running of the studio, its projects and its clients. For example, Robin Levien (RL), owner of SL, keeps one folder of printed documentation per project. The printing and archiving process requires significant organisation and time commitments, and detracts from the actual creative work of designing. This is central to how the COncEPT platform will be developed. We recommend COncEPT is designed to enable the following features to facilitate project management:

- I. Creation of a project space per project.
- II. Contract is automatically generated on the creation of the project to protect all stakeholders.
- III. Integration of this 'central bureau', all documentation (e.g. emails, contracts, contact details, and all paperwork relating to a specific project) will be housed, collected and archived.
- IV. Ability to add staff to join the project space. The project/design manager (PM / DM) decides who to add (dependent on skills, availability etc.). PM designates roles to fulfill.
- V. Enablement of shared access to the project central bureau with varying degrees of access (e.g. read only, can edit, full access) for project team members to be decided and set by the PM / DM.
- VI. PM / DM sets a milestones and deadlines on a timeline in the project space. The collection of documentation is time lined in visually.
- VII. When the timeline is edited, an email is automatically generated to inform all stakeholders of the change.
- VIII. Milestones automatically require approval from stakeholders before progression to the next stage.

Such a project space assists project/design managers in maintaining currency of documents, as well as removing the need for, and time spent upon, paperwork. This is expected to be desirable for designers for commercial and management reasons. Moreover, these steps have the benefit of protecting all parties against doing work extra to the agreed contract.

7.2 COLLABORATION AND SHARING TOOLS

It is evident that design collaboration happens in a variety of situations: internally and externally; at the same time or at a different time; in the same place or a different place. It is crucial that CONCEPT has tools to enable each of these types of situations. The requirements of the platform differ in each of these situations.

7.2.1 INTERNAL STUDIO COLLABORATION

Design teams are assembled at the beginning of a project by the PM/DM. At the studios visited, collaboration between the internal team happens both face-to-face and using technology.

At the early stages of the project, collaboration is usually face-to-face. At the beginning of the project, team meetings are convened to brainstorm, exchange ideas and discuss the factors influencing the project. Designers show each other images and objects, and often make quick sketches to explain ideas. Conversations are informal. Therefore, the face-to-face context is crucial to this type of early collaboration.

By contrast, at the later stages of the project, collaboration normally happens using technology and software. For example, the team builds client presentations together. These are housed on the studio's central server and each team member can access, work on, save and edit these documents. Having a central server works well at the studios we visited. These consultancies comprise small numbers of staff. Archives of past work are held on the server.

To allow the internal team to collaborate effectively, CONCEPT must be able to replicate the environment of face-to-face meetings – for example, by:

- I. Having the capacity to allow designers to sketch virtually
- II. The ability to upload images of real sketches
- III. Enable voice and video conferencing
- IV. Share files in the cloud

7.2.2 EXTERNAL STUDIO COLLABORATION

When collaboration with stakeholders outside of the internal team, technology is crucial. RL reports that meetings are being conducted face-to-face far less frequently with clients as the result of tight budgets, and therefore there is a reliance on technology to facilitate meetings. Since there is little direct personal contact, RL takes care to ensure the project is being managed by way of frequent email contact with clients on current projects. However, where file sizes are particular large, the file sharing services Webex (www.webex.com/), Wettransfer (<https://www.wettransfer.com/>) and FTP are also used.

RL uses email to set timelines with the client at the beginning of the project. These are then amended via email during the course of development. By using email, there is the added advantage that sent messages are automatically saved for future reference. During the project, RL schedules online conference meetings on Webex. In the Webex interface, files can be shared on screen with other parties. Each party is then able to edit the file in real time, with editing 'control' being passed back and forth.

CONCEPT should improve the disparate types of technology currently being used in the design studio by offering an integrated platform. Therefore, the current requirements for sharing files, editing files in real-time and maintaining

contracts and deadlines must be included together inside of the same interface. There should also be interoperability with other software (e.g. emails in another package (e.g. Outlook) should be able to 'speak to' the COnCEPT platform).

7.3 DESIGN RESEARCH PROCESS

The type of research engaged in by designers towards the beginning of the project is often immense and time-consuming, comprising both textual and visual sources. First, visual stimulus materials are addressed, and next textual insight.

7.3.1 RESEARCH FOR VISUAL STIMULUS MATERIAL

Previously, design studios had multiple subscriptions to design magazines, and would await their arrival each month. Catalogues of manufacturing firms were also collected and kept inside design studios. The Internet has, however, overtaken a previous reliance on magazines and catalogues as the primary research method for stimulus material at the early stages of a new project. Designers, however, lament the loss of this method, as researching online is described as "too easy" and encouraging a blasé approach. Magnetic pin boards in studios are popular and allow the printing, selection and sharing of interesting images with colleagues.

The current trend is for the majority of research to take place online, particularly in online repositories of images, such as Google Images, Getty and Pinterest. The designers we interviewed report that Google is typically the first website visited when starting research for a new project. The process of finding appropriate stimulus images snowballs as one area of interest quickly leads to another. Designers have the tendency to save images into a personal repository, or project related folder, stored inside their PC or the studio server. However, designers report that the process of saving images to their own personal repositories or to the central server of the consultancy is laborious. There are many shortcomings to this mode of online research, for example:

1. Naming files is difficult, and usually images are stored under strings of meaningless letters and numbers
2. The process of right clicking and saving is unwieldy
3. Images take up substantial amounts of space
4. Finding the images again after having saved them is difficult
5. There is no means to view stored images all together (besides using the Windows thumbnail view)
6. Some websites (e.g. Getty) place a large watermark across the centre of images

Designers report that Pinterest is incredibly useful for: 1) finding, and 2) storing; 3) viewing of relevant stimulus images. The images on Pinterest are desirable because they are ordered in popularity making it easy to find up-to-date, unique, and on trend material. Pinterest enables uploaders ('Pinner's') to add a description about the image, and each image is followed by a list of related images called 'others you may find interesting'. The attractive display of images inside Pinterest's boards allows the designer to select images to save and create client presentations at the end of a project. However, there are also grave security concerns – naming clients and/or projects prior to launch breaches client confidentiality contracts, even if the boards are 'secret' or private.

A tool that allows designers to find, store and view stimulus material privately was considered a very attractive prospect by the designers interviewed. It is recommended that COnCEPT delivers such a function, while at the same time easing the process of organising visual information in a cloud repository.

7.3.2 'SMART' SEARCH

Other than visual information, there is also the need for insight on materials, technology and market news. There is no methodology used by designers to accumulate this type of information. Often, the process is serendipitous, and resting on chance.

There is the capacity to make this research process more efficient. It is recommended that COnCEPT is tied in with sources of interest to design, such as: trend forecasting websites; market research consultancies; government patent offices; current affairs websites; technology news websites. This would work with key words or phrases entered by the designer being used to execute a search of these websites and repositories. This tool could be turned on or off. Moreover, tolerances (e.g. rated on similarity / dissimilarity) could be exploited to uncover associated products and related technology on the market.

7.4 TRACK AND REVIEW PROCESS

While there is no need to keep every iteration of a project as it develops, it is important to keep a record of progress at various milestones. This has an application for practice, since it reveals the extent of work undertaken by designers, and therefore has the potential to demystify the processes and enhance design's standing with clients.

At the end of a project, it is normal practice to present an outline of the project's progress (a 'story') to clients. The designers we interviewed described the challenges involved in saving all development work for each project as it progresses, and therefore the difficulty in telling the story. For this presentation, designers select inspirational material and early sketches that were significant for the progression of the project. These are then integrated into the project's story. It is often difficult to find early iterations of a project because several drawings and sketches are usually done on the one file, updated or discarded.

A feature that automatically takes a 'snapshot' of the project at pre-defined milestones would assist the process of creating this story and the final client presentation. Such a tool also has an application in an education context. It would allow students and their supervisors to assess progress over a period of time. This can be used in universities to assist supervisors in assessing individuals' contribution to group projects. In practice, it could allow apprentices and junior designers to reflect on projects and enhance contribution. It could moreover be used in timesheets and for billing purposes.

7.5 IMPLICATIONS FOR CONCEPT

This research has highlighted issues faced by designers when using tools currently available to them in the design studio throughout the collaborative aspects of designing. Here we highlight why these are worthy of development in COnCEPT:

7.5.1 PROJECT MANAGEMENT (PROJECT-WIDE, ORGANISATIONAL FEATURES)

This feature requires the sharing of all project documents in the cloud, and interoperability between other packages and COnCEPT. Project management tools enables transparency between each of the stakeholders, and reduces risk in collaboration.

7.5.2 COLLABORATION (GENERAL, PROJECT-WIDE COLLABORATIVE FEATURES)

In tools of collaboration, we recommend COnCEPT as integrated environment inside which all stakeholders may communicate freely and by multiple means (e.g. voice, file sharing, synchronously, asynchronously).

7.5.3 DESIGN RESEARCH (INTERNAL, STUDIO COLLABORATION)

This is an internal type of collaboration facility. We recommend there is interoperability between COnCEPT and other systems and repositories. All internal design team members should be able to easily find and view a catalogue of background material.

7.5.4 TRACK AND REVIEW (INTERNAL, DESIGN-TEAM SHARING)

The purpose of this is for internal design *learning* amongst the studio team, as well as in an education context.

8 DISCUSSION AND CONCLUSION

In this deliverable we have discussed research related to CONCEPT and we have presented several studies to find requirements for the CONCEPT platform. Based on this work we present in this section a meta-review of requirements elicited from the literature and the studies presented earlier.

8.1 BRINGING TOGETHER PHYSICAL AND DIGITAL ARTEFACTS IN EARLY STAGE DESIGN

Looking at the activities that designers undertake in early stages of design, we can conclude that work in early stages of design is highly material in character, either in the form of sketches, physical prototypes, mockups, moodboards etc. Though some of these artefacts could be replaced by digital counterparts, the effect on creativity of physically and spatially interacting with these actual artefacts should not be underestimated (Vyas et al., 2009). Also, some physical artefacts are hard to replace by digital instances; for example, the look and feel of mock-ups built from different types of materials is hard to transfer to the digital domain. Still, designers working in different locations have the need to share these artefacts to progress creatively, and as Vyas et al (2013) state: ‘there is a need for an infrastructure that allows designers to capture, integrate and arrange these artefacts’. The CONCEPT platform could play a role in fulfilling this need by making the transition from physical to digital as smooth as possible, for example by supporting easy capturing of paper sketches. Also, the CONCEPT platform could enhance face-to-face brainstorming by providing extra features that augment the brainstorming process such as: grouping and mapping the ideas, timeline visualisation of the evolution of the ideas and capturing the ideas.

8.2 INTEGRATING INFORMATION

Designers tend to make use of a wide variety of tools in their work practices. Roughly, these tools can be subdivided in tools that support project management, communication and creativity. Often these tools have some overlap in functionality (see Figure 6). However, none of the tools offer an integrated approach that supports designers in early stages of design best.

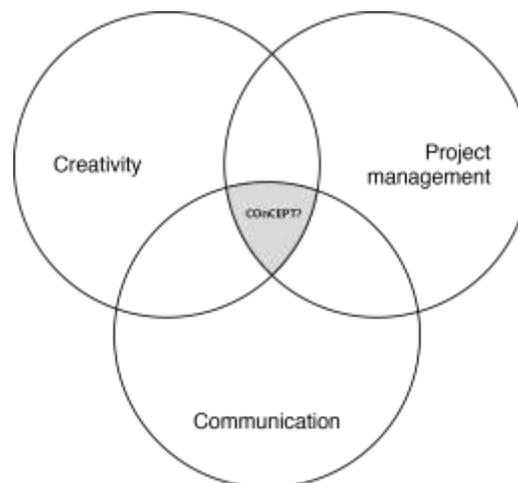


FIGURE 6: OVERLAP IN FUNCTIONALITY IN TOOLS

Furthermore, we also learned from designers that they, in fact, do not wish to learn yet another tool and that they appreciate the flexibility they have in selecting the most appropriate tools and services per project. It seems that designers opportunistically choose which tools to use, in a trade-off between ease-of-use, accessibility (for themselves, but also when sharing with others), availability (cross-platform, cross-device), functionality and project context. For example,

designers might choose Facebook as their go-to tool, for communicating and sharing ideas, when it concerns a small project, and the overhead for setting up a folder on a shared service is too large. A web-based tool is deemed the best, as it is viewed as easier accessible and requires no additional installation.

Because of the wide variety of tools concurrently used, issues arise that affect a continuous, easy, workflow. These are discussed in the next subsections.

8.2.1 SHARING

Currently there are many ways for sharing digital artefacts of design projects, typically in the form of files. Files are shared via email, and shared folders by services such as Dropbox. However, as a multitude of tools is used to create design artefacts, sharing is made more difficult as not all stakeholders in a project may have access to the same tools, and thus making it difficult to share files in certain file formats. A current strategy to deal with this is to use tools not specifically designed for a task, but are available to most people – such as using Excel to draw wireframes of designs, or to create Gantt charts. Alternatively, dedicated tools are used (e.g. Microsoft Project for project management) at the risk of not being able to share file formats.

As digital artefacts are created with a variety of tools, the files may exist in many locations (e.g. Dropbox, internal servers, proprietary cloud services). With regard to files several challenges can be identified that a platform could support:

- Supplying a consistent naming strategy for files
- Automatically keeping versions of files to avoid overwriting important documents
- Management and organization of files
- Searching for files across locations
- Management of accessibility and sharing rights (e.g. read only/read and write).

8.2.2 SYNCHRONOUS COLLABORATION, REVIEWING AND TRACKING VERSIONS

File sharing is a common way of collaborating on a project, and though synchronous collaboration is a feature of some tools (e.g. Word), most designers indicated that in reality they seldom use such functionality as they find it error prone. Instead, ‘turn-based’ collaboration is achieved by agreeing on workflow processes to ensure no overlap in work and editing of files. Dropbox offers a crude form of automatically creating versions of each file, though it does not warn a designer when he/she is editing a file that a colleague might be working on as well. Though changes are not bluntly overwritten, conflicting copies are created that later take effort to be merged. Designers do see the value of systems that offer versioning management (such as SVN and GitHub), but typically find these systems too difficult to use.

For commenting on each other’s work several strategies are adopted. Tools such as Word and Excel offer integrated review and commenting tools, but not all tools offer such functionality. To comment and review each other’s work often comments are emailed, discussed in face-to-face meetings or documented otherwise. The COncEPT platform could support the review and comment process consistently across tools and services.

8.2.3 COMMUNICATION AND AWARENESS

Designers communicate in many ways, both synchronously as well as asynchronously: face-to-face, using chat, phone, or tele-conferencing, email etc. One of the challenges that we identify is to log and keep track of communications across all these channels. For example, a discussion might have been started over email, to be later continued using Whatsapp. To retrieve details of what has been discussed is currently cumbersome, as it requires searching both email and Whatsapp logs. Therefore, a tool that integrates different communication channels and makes it easily searchable is an asset.

Another challenge is to keep project members aware of each other's activities and work progress. Also, for creativity reasons, designers need to be aware of each other's work to comment, learn, reflect and build upon it. Currently, systems that provide awareness cues are too intrusive, not adaptable and/or too scattered over several sources, making it difficult to form a coherent view on team activities. Similar to tracking communications, a tool that offers a system for aggregating and managing personal preferences for awareness cues would be an asset.

8.2.4 INTEGRATION

Though each of the tools or services currently used in early stages of design could be individually improved to more easily facilitate the process of sharing, collaboration, communication, tracking and reviewing the real challenge is to create a platform that can offer either integrate services or support this across multiple tools. For example, a project milestone might include documents, design artefacts in different formats, and related communications. Currently, this is scattered across multiple tools and services. A tool that offers an integrated view of a whole project, from a communication, creative and management perspective would provide a step forward compared to existing tools.

8.3 SUMMARY

Taking into account the above, in summary the following challenges and requirements can be formulated for a platform to support a team of distributed designers in early stages of design:

- Designers do not want to learn yet another tool
- Designers want the flexibility to pick from a wide variety the tools and services that they deem most appropriate for the project at hand
- The platform must offer a solution for easy sharing, collaborating, reviewing and versioning of project assets (that might be created in a variety of tools and services)
- The platform must offer a way to search and filter content and communications across tools and services
- The platform that supports all this, is preferably web-based and usable from a range of devices (computers, tablets, smartphones)
- The platform must provide design practitioners with a straightforward, integrated, way of visually organising and sharing all images, documents, browser bookmarks, sketches, inspiration material etc. in one place. The stored data should be easily searchable, enhancing the creative process. A timeline visualization would also be useful.

9 REFERENCES

- Dix, A., Finlay, J.E., Abowd, G.D., and Beale, R. (2004). *Human-Computer Interaction* (Harlow, England ; New York: Prentice Hall).
- Georgakopoulos, D. (2004). Teamware: An Evaluation of Key Technologies and Open Problems. *Distributed and Parallel Databases 15*, 9–44.
- Hummels, C., Overbeeke, K.C.J., and Klooster, S. (2007). Move to get moved: a search for methods, tools and knowledge to design for expressive and rich movement-based interaction. *Pers Ubiquit Comput 11*, 677–690.
- Leon, M., Laing, R., Malins, J.P., and Salman, H. (2014a). Developing a Design Protocol for Computer Mediated Collaboration During the Concept Stages with Application to the Built Environment: A Study in Multidisciplinary Collaborative Design Through Tangible User Interfaces. In *Proceedings of 12th International Conference on Design and Decision Support Systems In Architecture And Urban Planning*, (Eindhoven, the Netherlands),.
- Leon, M., Doolan, D.C., Laing, R., Malins, J.P., and Salman, H. (2014b). Application of interactive surfaces to support computer mediated collaborative design environment. In *Proceedings of 18th International Conference Information Visualisation*, (Paris),.
- Van Rosmalen, P., Boon, J., Bitter-Rijkema, M., Sie, R., and Sloep, P. (2014). Supporting co-creation with software, the idSpace platform. *Computers in Human Behavior*.
- Schön, D.A. (1983). *The reflective practitioner: How professionals think in action* (Basic books).
- Voigt, M., and Bergener, K. (2013). Enhancing Creativity in Groups – Proposition of an Integrated Framework for Designing Group Creativity Support Systems. In *2013 46th Hawaii International Conference on System Sciences (HICSS)*, pp. 225–234.
- Vyas, D., Heylen, D., Nijholt, A., and Veer, G. van der (2009). Collaborative Practices that Support Creativity in Design. In *ECSCW 2009*, I. Wagner, H. Tellioglu, E. Balka, C. Simone, and L. Ciolfi, eds. (Springer London), pp. 151–170.
- Vyas, D., Veer, G. van der, and Nijholt, A. (2013). Creative practices in the design studio culture: collaboration and communication. *Cogn Tech Work 15*, 415–443.
- Yuill, N., and Rogers, Y. (2012). Mechanisms for Collaboration: A Design and Evaluation Framework for Multi-user Interfaces. *ACM Trans. Comput.-Hum. Interact. 19*, 1:1–1:25.