D2.1 User-Centred Design Methodology

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# D2.1 USER-CENTRED DESIGN METHODOLOGY

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1 Executive Summary

The purpose of this document is to provide all project partners with a summary of the User-Centred Design (UCD) methodology for work package (WP2). This methodology will directly engage industry users (represented by SMEs and Industry Panel members) and consumer end-users through focus groups, workshops and participatory design activities. This will allow us to gauge industry needs and catalogue the SMEs’ production roadmaps to interpret their design methods and identify gaps in their workflow, while the cyclic testing of prototypes will keep informing the development and integration cycles.

A set of design guidelines for a next generation of Multimodal, Interactive and Expressive (MIX) technologies will be generated and continuously updated to inform product design and the project’s knowledge transfer. WP2 lays the foundations for tasks in the product development cycle (WP3-WP5). It will assure the alignment of project ICT solutions with user and market needs and maximise take up by the creative industries.

The Goldsmiths University of London partner produced this document. It is the second issue reflecting all procedures designed to maximise the quality of project execution and outcomes. In order to fulfill its function as a quick reference to frequently asked questions and problems, if necessary this document will be updated and changed according to the evolution of procedures and progress during the lifetime of the project. The feedback of all partners to improve this report is appreciated.
1 BACKGROUND

This deliverable introduces the methodological structure of RAPID-MIX, and one of its fundamental aspects of innovation. This is a working document part of the work package 2 efforts in User-Centred Design describes the methodological framework for assessing industrial and end-user design requirements.
2 INTRODUCTION

This document describes deliverable D2.1, the User-Centred Design methodology adopted in the project RAPID-MIX.

2.1 User-centred design in RAPID-MIX

RAPID-MIX will apply a highly user-centred methodology to product development as a key strategy for incorporating market pull and industry need, and for producing robust tools (the RAPID-API) and systems (MIX-Products) that can be later integrated into the design roadmap of industry partners. This iterative process, which will continually and mutually inform the work between work packages, will bring the shared set of new technologies from academic and industrial research to general industrial standards, and to the user groups and businesses that will ultimately use these tools. These will be delivered to both B2C and B2B markets, as well as shared with the creative community through open access channels.

2.2 Scope of Document

This document provides the User-Centred Design guidelines to support the direct engagement with industry users (represented by SMEs and Industry Panel members) and consumer end users through focus groups, workshops and participatory design activities. This will allow us to gauge industry needs and catalogue the SMEs' production roadmaps to interpret their design methods and identify gaps in their workflow, while the cyclic testing of prototypes will keep informing the development and integration cycles. A set of design guidelines for a next generation of Multimodal, Interactive and Expressive (MIX) technologies will be generated and continuously updated to inform product design and the project's knowledge transfer. WP2 lays the foundations for tasks in the product development cycle (WP3-WP5). It will assure the alignment of project ICT solutions with user and market needs and maximise take up by the creative industries. WP2 will gauge industry needs, assess and interpret product design methods, and identify gaps in the workflow. The Industry Panel experts will provide advice on the outcome of design activities (e.g. workshops) and design document, benchmarking technological development against the general creative market.
3 STATE OF THE ART

Please add as many chapters as needed, following the presentation of chapters made in the introduction. For the structure of sub-chapters, we recommend to use only following levels 2, 3 and 4. Additional sub-level may be includes as:

3.1 Literature overview

3.1.1 Understanding User Experience

With the evolution of HCI domain, a trend emerged that focused on Human as actors, participants or users, and encompassing of Human elements such as Culture, Emotion and Experience. User experience (UX) has been adopted by the HCI community for several years now but its definition is an on-going effort that is not yet settled.

Several definitions of UX have been put forward. Law et al. (2009) define UX as a dynamic, context-dependent and subjective concept that belongs to the HCI domain. For the authors, UX stems from the “potential benefits that users derive from a product” and that designing for UX must be grounded in user-centred design practices.

This is a broad and abstract definition but more recent definitions, which consider the need for quantification and measurement, attempted to model and identify hierarchical dimensions of UX. Park et al. (2013) did an extensive literature survey to construct the concept and model UX, considering both academic and industrial perspectives. The authors have identified usability, affect and user value as the main UX elements, where “usability, affect and user value can be defined as the degree to which a product/service is easy to use, the degree to which a product/service’s appearance or image appeals to the users, and user’s subjective values attached to a product/service, respectively”.

A parallel on-going effort is being taken by International Organization for Standardization (ISO) with the development of models that attempt to standardize UX and usability, and prescribe design and evaluation procedures for industrial use. The definition of proposed by ISO 9241-110:2010 is UX as “a person’s perceptions and responses that result from the use and/or anticipated use of a product, system or service”.

3.1.2 User Centred-Design

UCD is a process based upon the understanding of users, their tasks and environments. Typically, users in UCD processes are involved in early stages of system design, and throughout the whole development and product lifecycle. The design is driven and refined throughout an iterative cycle of development and user-centred evaluation. The adoption of UCD methods has been discussed over the years, and its value has been promoted not only for usability issues but for making the business case.

Abras, Maloney and Preece (2004) define UCD as “a philosophy and methods, which focus on designing for and involving users in the design of computerized systems”. UCD was originally coined in “User-Centred System Design: New Perspectives on Human-Computer Interaction” (Norman & Draper, 1986). Several rule sets and heuristics for UCD have been produced since then e.g., see Nielsen (1993).

Norman (1988) articulated a set of principles of design for facilitating the designer’s task:
- Building intuitive conceptual models
- Explaining in reading manuals before implementation
- Making tasks consistent
- Providing mental aids
- Giving control of the tasks to the user
- Making things visible
- Designing for natural mappings between intentions, actions and outcome,
- Applying constraints
- Designing for error
- Standardizing

Figure 1 shows a generic UCD cycle with the main operational stages.

![UCD Cycle Diagram](image)

**Figure 1. UCD cycle**

### 3.1.2.1 Other design research approaches

There are conflicting definitions on the relationship between UCD and “human-centred design” (HCD). The W3C Notes on User-Centred Design Processes indicate "UCD is also called human-centred design process." Others consider UCD to be a subset of HCD. HCD is considered the starting point to account for usability and “user experience” (UX) (ISO/IEC 9241-210 2010), and it is prescriptive regarding the focus on users, users’ tasks and operating context or environment, and iterative design and evaluation of prototypes with users.

Participatory Design (PD) was borne out of the trade union movement in Scandinavia in the 1960s and 1970s, with the aim of improving workers’ conditions in an increasingly technologized and mechanised workplace through giving them a role in the design and implementation of these technologies. Participatory design now may have lost many of its political connotations, and refers broadly to a group of practices including user-centred design and co-design which attempt to bring end users into the design of products or services. (See Simonsen, Jesper & Robinson, 2012).

Other design centric approaches of relevance are Contextual Design (Beyer, 1997, Holtzblatt, 2004) and Adoption-centred design (Chilana, Ko & Wobbrock 2015). The former approach is more oriented to practitioners. The latter paper analyses a case study within the borders of technology transfer in software engineering, innovation in the marketplace, and generalizability of HCI research evaluation. It explains the “the motivations for adopting different HCI methods at different stages during the evolution of the research,
product, and start-up business and the trade-offs made between user-centred design” and what they have termed “adoption-centred design”. The authors highlight the importance of considering a diversity of stakeholders beyond end users, and that are critical for product adoption.

Whilst UCD, HCD, PD and others are contingent with specific historical circumstances and much is to be debated over their nomenclatures, they nonetheless give us a broader set of techniques and tools for getting what we broadly refer to as “users” to be involved in the creation of the products and services they will ultimately use. These techniques and tools remain useful outside of the socio-political circumstances under which they first arose.

3.1.3 Action Research

Action Research (AR) emerged from the work of Kurt Lewin (1946) and has been used most notoriously used by Tavistock Institute of Human Relations, London (Reason & Bradbury, 2000). AR is methodological framework with a dual goal, in which a research organization provides a service to a research "client" (individual, group or organisation) by solving his practical problems, and adding to the body of knowledge in a particular domain.

AR is considered complementary and augmentative of UCD and PD practices (Hayes, 2011) given the action based and iterative nature of this methodology. However, the outcome of AR is learning and scholarly knowledge rather than a technological artefact, which is typically pursued in both UCD and PD. It aims to ensure collaboration with community partners and to achieve a level of scientific rigor that ultimately permits the transferability of the research findings. In fact, AR has been more and more valued for the enhanced credibility of the research findings. External funding agencies, such as National Science Foundation in the U.S.A. and the European Commission, and large tech conglomerates, such as Google and Microsoft, have been focusing in practical research approaches such as AR (Kock, 2014).

AR provides a framework based on an multistep iterative cycle that involves the identification of a general problem to be solved or an improvement opportunity at the client organisation; the identification of practical problems, the solution of those problems, and reflection on the part of the research body, which is then followed again by the identification and solution of problems, new reflection, and so on. The framework ultimately leads to the identification of clear patterns (Kock, 2014), through repeated observations in various iterations of the following stages:

- **Diagnosing:** identification of an improvement opportunity or a general problem to be solved at the client organisation.
- **Action planning:** involves the consideration of alternative courses of action to attain the improvement or solve the problem identified.
- **Action taking:** involves the selection and implementation of one of the courses of action considered in the previous stage
- **Evaluation:** involves the study of the outcomes of the selected course of action.
- **Specifying learning:** involves reviewing the outcomes of the evaluating stage and, based on this, knowledge building in the form of a model describing the situation under study
• Diagnosing - second iteration: can take place in the same organizational context or in a different one (e.g., a different department or company).

Figure 2 presents diagram with a generic AR cycle and the main operational stages.

![Action Research cycle](image)

**Figure 2. Action Research cycle**

In a technology-related inquiry, this could entail the introduction of new technologies in an organisation and at the same time studying the effects of the technology in that organisation (Kock, 2014). The leading research questions must be formalised beforehand based on theory and answered in the study, and for RAPID-MIX we propose an initial set of research leading questions:

- How can we operationalize HCI tech transfer to creative industries, achieving a positive impact?
- How do we create tools that enable development for rapid prototyping and what should they afford?
  How can we build a modern creative programming environment that affords both a low entry barrier and a high ceiling?
- What is the most suitable configuration of UCD guidelines for creative SMEs?

The main data collection approaches are based on participant observation and interviews, where an understanding is sought on how the technology was used, and how its use affected the desired outcomes. This is typically achieved through data collection techniques (both quantitative and qualitative) using the same instrument (e.g., a questionnaire, workshops, etc.) at two different points in time, before and after the technology introduction.

Within this frame, RAPID-MIX project provides a favourable context and a unique case for the application of AR, with financial support for a reasonable period of time to collect data and present results in a consortium of organizations.
3.2 Methods for user involvement

User-centred design processes are used as tools to answer (and refine) key questions throughout the whole development cycle. For example,

- What are the opportunities--recognized or unrecognized-- for a new technology to positively impact a given set of users in a given context? What is the design space of possible technologies?
- How is a particular design approach, if instantiated, likely to impact these users in a given context?
- How does a particular design instantiation impact these users in this context, in reality? What are the consequences for users' efficiency, effectiveness, satisfaction, ways of thinking and acting, relationships with each other, etc.? How do these change with time and experience, with context, or with the type of user?
- How do multiple design alternatives compare against these criteria of interest?
- Where are possible usability problems in a given design, and how might they be mitigated or corrected?

The research partners and SMEs have at their disposal a range of techniques for exploring user interaction with products and prototypes, and generating new ideas. Different stages in the design process, types of user, contexts of use and desired outcomes require different methods, but here we outline some standard techniques we have collective experience with and will be drawing upon at different stages in the iterative design process. Not all such techniques are appropriate for all circumstances, nor can they all be used together, but they remain within our broader arsenal.

3.2.1 Ethnographic interviews and observation

Questioning and recording participants “in the wild” to find how they use technologies is invaluable. Often, what a participant says in interview may in conflict with how they behave in observation, and care must be taken to evaluate data gathered. This technique also helps accumulate a good background of evidence describing why a particular design path was chosen. See, for instance, Preece et al. (1994).

3.2.2 Surveys

Surveys — including online surveys — are useful in providing qualitative and quantitative data about, for instance, how geographically remote users use existing tools. See e.g., Vehovar & Lozar Manfreda (2008).

3.2.3 Logging

Logging user actions with an instrumented piece of software can be an unobtrusive method for understanding users’ actions with a system. Log data allows us to see what users really did with software and (often) what problems they encountered without relying on users’ memory or taking up their time and focus. Applying visualisation and data mining techniques to log data can also reveal latent subgroups of users or styles of interaction. See e.g. Dumais et al. (2014).

3.2.4 Focus groups

The value of focus groups in HCI is debated, as they are seen as rooted in market research rather than as a serious evaluation or design tool. They nevertheless have their role, and their relative merits are discussed in Rosenbaum et al. (2002).
3.2.5 Brainstorming techniques
Techniques such as Mackay’s Video brainstorming are described in Mackay and Fayard (1999).

3.2.6 Sketching/Storyboarding
Storyboarding provides a technique for envisaging actual uses of hypothetical objects, as well as for honing in on the actual steps surrounding people’s actions that can get overlooked. Discussed, for instance, in Truong, Hayes, and Abowd (2006).

3.2.7 Lo-fi and higher fidelity prototyping
Low-fidelity (“lo-fi”) prototyping allows for quick production of placeholders that can be used to explore interactions with more ‘final’ products. Lo-fi prototypes can take a variety of forms, from paper sketches showing the basic functions of a GUI or workflow with a system, to physical mock-ups that demonstrate size and form, to digital “vapourware” that uses PowerPoint, Photoshop, or other tools to mimic the front end of software without any backend implementation. Any of these prototypes can be made “interactive” using “Wizard-of-Oz” techniques in which a human designer stands in for unimplemented computer functionality (e.g., changing a paper GUI in response to a user “click” on a paper button).

Lo-fi prototypes can be useful to obtain early feedback on a design idea, before many resources have been devoted to its realisation. Lo-fi prototypes can also be very useful to focus user feedback on core functionality of a system without distracting the user with irrelevant details. (e.g., user evaluation of a paper GUI mock-up will lead to feedback on GUI content and user flow, without users being drawn to comment on surface details such as colour or font choice).

High fidelity prototypes are more functional and robust than their lo-fi counterparts giving a closer idea about user interaction with the final product. See for example, Egger (2000); also Houde and Hill (1997).

3.2.8 Cultural probes/Technology probes
Cultural probes provide exploratory, ethnographically orientated and often open-ended ways of looking at how people use technologies in their day-to-day lives, discussed in Gaver et al. (2004). Technology probes provide a similar role, though they may be seen as being geared more towards the production of a product alongside ethnological investigation, described in Hutchinson, Hilary et al. (2003).

3.2.9 Longitudinal studies
Understanding the usability of a complex technology often requires studying users engaging with it over longer periods of time. This is especially true when developing familiarity or expertise with a technology takes time, or when a technology or a user’s interactions with it are impacted by user state or context, or when it is important to discover how users might appropriate a technology beyond its intended use. Each of these criteria is relevant to technologies emerging from the RAPID MIX project. For example, the nature of a new musical instrument employing RAPID MIX technologies may emerge over time as opposed to through short term testing. A half-day user study on the saxophone (were it a novel instrument) would yield less useful results than a study-taking place over several years. Longitudinal research is discussed in, e.g., Karapanos, Jain and Hassenzahl (2012).
3.2.10 Workshopping

Workshops are defined as “collaborative design events providing a participatory and equal arena for sharing perspectives, forming visions and creating new solutions” (Soini & Pirinen 2005). Workshops cover a diverse range of situations, and some of the creative uses of workshopping for encouraging participation in DIY music technologies are discussed by members of the Goldsmiths team in Jo, Parkinson and Tanaka (2013).

3.2.11 Hacking, Do-It-Yourself and Appropriation

The idea of “hacking” has gained considerable popular currency, often at the expense of any meaningful definition. We see hacking as an area where commercially available goods are used in ways beyond their initial intent, which is a common practice within interactive music. Workshops drawing on hacking enable users to find new affordances in existing technologies and can become a way of exploring unexpected uses of prototypes. Hacking is of interest to the human-computer interaction research community, as we can see in Buechley et al. (2009).

3.2.12 Design workbooks

Design workbooks act as scrapbooks that gather together different perspectives from different participants over time, allowing ideas to develop over time with input from different participants (Gaver, 2011).

3.3 UCD in Goldsmiths EAVI research group

Beyond this broad range of techniques, Goldsmiths leverages on its EAVI group experience from ACM SIGCHI in participatory techniques that are 1) deployed “in the wild”, 2) accommodate diverse stakeholder groups, and 3) involve end-users from the beginning of the design process. This involves proven methods including ethnographic scoping interviews; structured brainstorming sessions; lo-fi prototyping; and video sketching. Below we describe some Goldsmiths specific projects and the unique combinations of methods they deployed.

3.3.1 A20

The A20 (Tanaka, Bau & Mackay, 2013) describes a series of studies comprised of ethnographic interviews to establish existing use patterns, and participatory design workshops to imagine and generate hypothetical future usage scenarios. The main goal was to see through an iterative process that linked UCD and new interfaces for musical expression (NIME), whether it was possible to identify emergent themes from users descriptions of interacting with musical content in everyday life, and then propose advance forms of sonic interaction as ways to address these themes. By focusing on modes of sonic interaction emerging from the UCD studies this study led to the production of a prototype of a kind that would not otherwise arise out of classical product development or task-based interaction design.

A mix of several techniques has been used to target different research aspects, such as Scenario Building, Brainstorming, and Video Prototyping. Scenario building was based on individual scenario notation in storyboard form followed by group discussion. This permitted identifying aspects of the scenario that could be enhanced by new technologies. The critical incident technique (Flanagan, 1954) was used to elicit specific recent, memories of personal music player use in context, and examples of interruptions, or specific moments at which music listening use was interrupted.

Brainstorming sessions with idea cards took place, in order to help inspiring participants and allow them to imagine how the music listening activity in those settings could be improved, augmented, or expanded.
possibly by new technologies. Participants acted out their scenario and filmed it with a simple camcorder to create a video prototype. This process invited participants to project their storyboard into the physical world, imagining form factors, and actual use dynamic. Through this process of enaction, participants were able to test their scenario as an embodied experience (Dourish, 2004).

After the ethnographic studies, the A20 was introduced as a design probe (Gaver et al., 1999) having succeeded on several levels. The initial scenarios people presented were consistent from the interviews at the beginning of the project through to the final workshop.

The coupling of UCD and NIME disciplines enabled the use of advanced interactive music techniques within a participatory context, allowing novel forms of interaction to be studied that otherwise would not have arisen from a pure UCD approach. This provided the answer to the question of how rich expressive interfaces coming from a top-down development process such as NIME could be used alongside ideas and uses emerging from bottom-up processes like UCD to define an expansive design space that would facilitate sonic interaction and be an inspiring generator of ideas.

### 3.3.2 Form Follows Sound

Form Follows Sound (Caramiaux et al., 2015) is a sonic interaction design research project being undertaken within EAVI. Sonic interaction is the continuous relationship between user actions and sound, mediated by some technology. Because interaction with sound may be task oriented or experience-based it is important to understand the nature of action-sound relationships in order to design rich sonic interactions. Form Follows Sound uses a participatory approach to sonic interaction design that first considers the affordances of sounds in order to imagine embodied interaction, and based on this, generates interaction models for interaction designers wishing to work with sound. The project has carried out a series of workshops, called Form Follows Sound, where participants ideate imagined sonic interactions, and then realize working interactive sound prototypes. These deploy the “Sonic Incident technique”, as a way to recall memorable sound experiences.

### 3.3.3 Audiovisual User Interfaces

AVUI research project (Correia & Tanaka, 2014) adopted a mixed methodology of workshops, chosen as a key element of for their collaborative and participatory, and bootlegging. A one-day, 6-hour workshop was conducted, aiming to produce sketches of novel tools for audiovisual performance.

Bootlegging is a “structured brainstorming technique particularly suited to multidisciplinary settings” (Holmquist 2008, p.158). Bootlegging applies the notion of cut-up – a form of literary collage popularized by William Burroughs – to brainstorming sessions, mixing familiar concepts in a way that stimulates creativity. A bootlegging session requires a theme. It also requires the definition of four categories for idea generation, two relative to the user side and two related to the theme and technology. A presentation format should also be chosen. The participants, divided into groups, should then generate several ideas (as post-its) for each category, mix those ideas and create 4-5 random combinations of each category per group. Those combinations then become the trigger of a brainstorming session, attempting to imagine different potential applications for each combination. Afterwards, the groups are asked to pick one of the ideas and prepare a presentation in the chosen format (Holmquist, 2008, p.159).

The study also proposes an extension to the bootlegging methodology, entitled reboot. Reboot extends open-ended brainstorming to bring additional focus to brainstorm sessions through focused iteration. In this case, the focus was defined based on key themes identified during the earlier interviews stage. The interviews set themes. Bootlegging facilitates serendipity and out of the box thinking. Reboot brings themes
from interviews into an iteration of bootlegging to provide focus and structure to the brainstorming process without constraining it to a task-based exercise.

3.3.4 HapticWave

The EAVI group worked on the HapticWave, a haptic audio waveform display device, (Parkinson, Cameron & Tanaka, 2015) in through a series of participatory design workshops and smaller one on one workshop sessions, collaborating both with a diverse group of audio engineers with visual impairments, and a group of designers, hackers and makers. The UCD methods used here bring two things to the table: diverse groups of “EAVI researchers”, “users” and “makers” are conceptualised as three “actors” engaged in iterative interactions. Furthermore, dialogues can take place through objects: physical prototypes, such as early versions of the HapticWave, formed part of the dialogues and interactions between. This was published in Parkinson, Cameron and Tanaka (2015, forthcoming).

3.3.5 Make Your Soundlab

Make Your Sound Lab (Katan, Grierson & Fiebrink 2015) applied interactive machine learning (IML) to the creation and customisation of gesturally controlled musical interfaces in six workshops with people with learning and physical disabilities. Drawing on observations and discussions with participants demonstrate that the IML developed at Goldsmiths is a powerful tool for participatory design of accessible interfaces. In particular, IML was an effective way for workshop leaders to quickly translate participant observations from workshops (i.e., what input devices and human actions seemed like good candidates for controlling digital music) into new musical instrument prototypes for the next workshop.

The participant observations and informal interviews used in Make Your Soundlab have also led to better understanding of challenges in end-user training of learning models, of how people develop personalised interaction strategies with different types of pre-built gestural controllers, and of how properties of control spaces and input devices influence people’s customisation strategies and engagement with instruments. This work has also uncovered similarities between the musical goals and practices of disabled people and those of expert musicians.

3.3.6 Synthesis - “Our” approach, an ethos

The above projects illustrate the Goldsmiths team’s core approach to research and innovation, which is the tight combination of user-centred design and cutting-edge technology development. Our work is driven by value systems and methodological approaches from UCD, as well as by our expert understanding of signal processing, software engineering, machine learning, and related fields. Our goal is not merely to understand users, nor to merely produce realisations of technically sophisticated ideas, but to create usable, useful tools.

The above projects illustrate a variety of approaches to engaging diverse user groups in the creation of new music technologies. Our experiences in such projects informs our understanding of the necessity to draw on different methods for different users, different contexts of use, and different stages in the design process of a new technology.

Through RAPID MIX, we will bring our tried and tested methodologies into new terrain. The iterative design processes allow for us to hone and adapt these methods to account for different and changing user groups and the specifics of the technologies that will emerge. We can then share with the community the effectiveness or shortcomings of different methods in newer contexts.
4 Users

4.1 User groups

In HCI textbooks and research literature, the word “user” can usually be assumed to mean the end user of a piece of technology. In RAPID-MIX, however, we have two main types of technologies under development - the RAPID API tools, and the SME products that are built using those tools - and therefore two distinct sets of users differentiated by the technology they are using. The usability of the RAPID API tools is tightly linked to the usability of the end products: the quality, learnability, flexibility, etc. of these tools will impact the quality and type of products SMEs can build with them, and the efficiency with which those products can be built. However, it is critical to differentiate between API users and end product users when we design and report on activities in our user-centred design process, as these two types users have very different contexts of use and end goals when engaging with the respective technologies. Table 1 summarizes the user categories in RAPID-MIX UCD processes.

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<tr>
<th>Inside the consortium</th>
<th>API users</th>
<th>End product users</th>
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<td>RAPID-MIX SME developers (and stakeholders)</td>
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</tr>
<tr>
<td>Hackers, makers, other industry developers beyond RAPID-MIX SMEs</td>
<td>End users of other products built on our API</td>
<td></td>
</tr>
<tr>
<td>Outside the consortium</td>
<td></td>
<td>Some users - especially hackers/makers and students - will be making technologies primarily for themselves</td>
</tr>
</tbody>
</table>

Table 1. User categories in RAPID-MIX

By engaging developers (and, to an extent, other SME stakeholders) as users in the RAPID MIX UCD processes, we will drive development of an API toolkit that meets the most high priority SME business needs, while also supporting efficient, accurate, flexible development work on top of the platform. Some research literature explicitly describes user-centred approaches to developing middleware on which future end user-facing products will be built, e.g., Edwards, Keith et al. (2002).

Working with SMEs to engage end users of SME products (or potential products) in the UCD process will be crucial to inform prioritisation of API capabilities, in order to focus API development in areas that are most likely to support usable, engaging, timely end products. Furthermore, it will be useful at times to make a distinction between users who are consortium partners (or directly linked to those partners) and users who are part of the broader community.

Within the consortium we have RAPID-MIX SME developers, product designers, and other general stakeholders (e.g. management); the experiences of their products’ end users are of obvious priority to our project, and we have easy access to these product end users through the SMEs. For example, there is already an active community around ROLI’s JUCE toolset. Beyond the consortium are API users who include professional developers as well as “DIY” hackers and makers, as well as students. We will reach out to these users through events such hack days, where we can provide instruction on the latest version of our platform,
observe people using our tools in practice, and learn about the larger space of products and experiences 
people envision making with our tools.

Finally, also beyond the consortium are end users of products developed by entities who are not part of the 
consortium. These users will be harder to reach, but they also do not need to play as significant a role in 
shaping the RAPID MIX tools. Our industry advisory board is comprised of people with knowledge of the 
current media technology landscape, including market segmentation, and we will periodically elicit their input 
regarding how our toolset matches this landscape of current and potential products and market needs.

**Designing expressive wearable technology for music performance**

Cutting edge technologies have opened up new ways to use our bodies to expressively control music, 
and this workshop will allow you to explore and use them. This is a hands-on workshop during the 
Hackdays that will combine innovative multimodal sensing technology (BiTalino) real-time machine 
learning interfaces (Wekinator, GVF) and audio synthesis/processing libraries (Maximilian) for 
prototyping wearable, mobile music interfaces and instruments involving physiological computing and 
motion sensing. BiTalino is a low-cost toolkit to learn and prototype applications using physiological 
signals, like an Arduino you can connect direct to your body. Wekinator and GVF are tools for 
interfacing with complex machine learning techniques to explore how different gestures we make can 
be used to control sounds. Maximilian is an open source, cross platform, C++ audio synthesis library 
that is simple to use, lightweight yet extremely powerful. RAPIDMIX researchers will introduce these 
technologies and pose a hack challenge. Group work will allow you to tinker and play with them on 
your devices, generating ideas for new and unusual uses, applications, and artworks. Participants from 
all backgrounds - technical or artistic, are welcome. We will work together, sharing knowledge and 
ideas for exploring the creative potential of these new technologies. Please send along links, 
examples of work, or just a note saying what you want to get out of the workshop. Please bring 
tablets, smartphones, laptops, etc.

Recruiting text for RAPID-MIX technology workshop at Music Hack Day Barcelona, June 2015 (Music Hack 

5 UCD in RAPID-MIX

The theoretical background previously described in section 3 informs the methodological framework defined 
for User Centred-Design in the RAPID-MIX project. This methodological framework derives from both AR 
and UCD, by building on their iterative nature, and aiming to complement the product oriented traits of UCD 
with the rigour, reliability and transferability that characterises AR, as its adequacy to study in social and 
organizational scenarios. Therefore, this framework is the strategic backbone of the project and shall be 
executed in a practical and smart manner. This chapter outlines the practical aspects of the framework 
concerning its operational implementation, and describes a first instance of iteration cycle, enumerates some 
of the possible events and provides guidelines for user consent forms, documentation, naming conventions, 
ethics considerations and reporting guidelines.
5.1 The OPPP framework

On a high level analysis, RAPID-MIX will apply a highly user-centred methodology to product development as a key strategy for incorporating market pull and industry need, and for producing robust tools (the RAPID-API) and systems (MIX-Products) that can be later integrated into the design roadmap of industry partners. These will be delivered to both B2C and B2B markets, as well as shared with the creative community through open access channels.

The following diagram (Figure 3) illustrates how the WP2 fulfils the project’s objectives in an overarching structure. In most cases, multiple consortium partners are assigned to the same work package tasks. Such choices were made so that partners with related expertise can closely work together and support each other’s efforts. In all cases, special care is taken so that individual partners will still have clearly defined roles within each task to assure accountability. At the same time, the collaborative dynamic ensures that no task is entirely dependent on a single partner.

The User-Centred Design package provides an informed entry point to a 3-step product design cycle involving Agile Prototyping, API Development, and Integration (red in figure).

Meanwhile the outer loop of Evaluation (blue in figure) including user studies, will feed back to subsequent rounds of UCD. This permits learning from the early assessment of prototypes and uses the outputs as examples in the next round of user-centred design activities to inform subsequent product design cycles.

The efforts in User-Centred Design of WP2 will feed these two loops. The methodological framework for assessing industrial and end-user design requirements, provides shared methodologies for user involvement, encompassing techniques from section 3, and data collection techniques (both quantitative and qualitative). These instruments will be applied at different points in time, according to the development, readiness levels and technology introduction.
Focusing on WP2 per se, each iteration will include all the steps of the OPPP methodological framework, which unites both UCD and AR:

- Observation - observe participants using existing tools or performing task
- Probes\(^1\) - introduce speculative technologies into the participants activities
- Prototypes - based on the documentation and responses to these speculative technologies, produce more solidified prototypes that can be used in participants activities
- Products - after further testing of the prototypes, which may be qualitative and less open ended than our earlier investigations, develop the prototypes into products suitable for wider use.

The diagram in figure 4 depicts the application of the methodological framework in the lifetime of the project.

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\(^1\)Probes are considered different from prototypes. “We usually distinguish between ‘technology probes’ and ‘prototypes’: the former are designed to help us (and the users) understand the design problem and the design opportunities; the latter are based on the former and can be evaluated more directly.” (Mackay, personal communication, 2015)
By the end of the first iteration there will be ideas seeding products or possibly early advances. This iterative process will continually and mutually inform the work between work packages, and will bring the shared set of new technologies from academic and industrial research to general industrial standards, and to the user groups and businesses that will ultimately use these tools.

### 5.2 Deployment in project

It is important to highlight here that a linear path from idea - even worked-up idea - to a finished product is an illusion. The reality involves messy tangles and exchanged, feedback loops between designers, users, hackers, performers. Affordances of products are only revealed through the circumstances they are placed in. Robust and long lasting products emerge from iterative cycles, where each iteration is used to improve a prototype.

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**Figure 5. Schedule for deployment of OPPP**

Figure 5 highlights the time periods and project outcomes that WP2 will affect through the RAPID-MIX agenda. In the cycle we shall have:

1) **Year 1**: 1\textsuperscript{st} Iteration (Prototyping)
   
   a) BCN Co-Design workshop
   
   b) Music Hackday Pre-workshop
   
   c) Music Hackday hack challenge

2) **Year 2**: 2\textsuperscript{nd} Iteration (API)

3) **Year 3**: 3\textsuperscript{rd} Iteration (Products)
For 2nd and 3rd iterations, activities should continuously cover both industrial and end-users, and new events may be considered and targeted.

5.2.1 Examples of events/venues

Deployment can take multiple forms, from trade fares to conferences, concerts to workshops. The current list of proposed venues and events at which there will be a RAPID MIX presence is condensed, but includes

5.2.1.1 DIY and Hackdays

Hackdays at DIY events are an opportunity to put our API tools right into the hands of people who will be using them, observe their use.

- Barcelona Hackday, June 2015
- Maker Faire Rome, October 16-17-18

5.2.1.2 Electronic Music Festivals

These festivals provide an opportunity for performers and audiences to experience interactive musical instruments drawing on RAPID MIX technologies:

- Sonar Festival, June 2015
- CTM Club Transmediale Berlin, February 2016
- Mutek Montréal, Spring 2016
- IRCAM Forum, November
- IRCAM Festival, June

5.2.1.3 Music industry events and showcases:

These events provide an opportunity for potential industry partners to see technologies that could be used in future products:

- NAMM, January
- MIDEM, June
- SXSW, March
- MusikMesse, March
- Berlin music week, May
- Canada music week, September
- New Music Seminar, June
- Popcorn Koln, Aug
- Waves Music Big Research Vienna

5.2.1.4 Concert activities within consortium parties:

These events cement the connections between research centres and the local and national communities within which they operate, showcasing our work to other academic research centres whilst allows members of the public to see the outcome of research that often happens behind closed doors in their local area.

- 3 EAVI concerts per year at Goldsmiths (part of a regular series).
- A RAPID MIX concert as part of IRCAM's Manifest, potential chance to plan a RAPID-MIX concert.
There are also consumer shows (such as CES), health events (such as IEEE EMBC and Biostec), gaming evenings (such as GDC and E3) and events such as a Cannes Lions at which we intend to maintain a presence at later stages in the project.

6 Ethics
RAPID-MIX will adapt Goldsmiths Code of Practice on Research Ethics (See Appendix).

6.1 Workshop Participation Consent Form
Prior to participation in workshops, participants will be given a “Participation Consent” to fill in. This form will list the project name (with some details), names of key individuals involved in the workshop, along with the date and location of the workshop. In addition, the content of the Participation Consent form will include:

- I understand and agree to take part in this workshop.
- I understand that I have a right to withdraw from this workshop at any time, should I wish.
- I understand that recordings including audio, video and photographs may be made during the workshop.
- I understand that all data gathered during the workshop will be securely stored, accessible only by staff.
- I understand that the results of the research of this workshop forms a part may be published and presented in academic conferences, journals, exhibitions, public presentations and other online and offline media outlets.
- I understand that information will be recorded during the workshop, and understand this information may be used in published research, but my personal details will be confidential. Furthermore, I will not be identified by name without giving my explicit consent.

The participant will sign and date this sheet, and receive a further sheet giving them information about the project, entitled the “Project Information Sheet”.

6.2 Project Information Sheet
This document will inform the participant about the project goals and outcomes, describing the partners involved, possible outputs and benefits, and online options to find more information.

7 Data formats
Throughout the multidisciplinary activities carried out in RAPID-MIX, multiple types of data will be generated and acquired, both for sharing/dissemination activities as well as for internal use. The following subsection outlines what the data types will be, what standards/formats will be used and how they will be shared and curated. It should be noted that RAPID-MIX has applied to participate in the Horizon2020 Open Research Data Pilot, and as a result we are working with the comprehensive Data Management Plan as a task in Work Package 7. The currently plan for research data management will be subject to further refinements.

7.1 Types of data
Data collected from the User-Centred Design sessions:
- Video recordings
- Audio recordings
• Data from the involved sensors (motion, biosignals)
• User activity tracking data
• Questionnaire data

Data to be generated:
• Numerical features extracted from raw audio/motion/physiological data
• Documents (deliverables, reports)

7.2 Standards and formats

One-dimensional data streams (such as audio recordings, physiological sensor raw data, position/orientation/acceleration XYZ-axis data, extracted features, etc.) will be stored using the Broadcast Wave format (BWF). BWF is an extension of the popular Microsoft WAVE audio format with the addition of an XML header chunk, used for storing metadata associated with each file (such as recording device, sampling rate, minimum and maximum value, etc.). The advantage of using a binary format like BWF is that it easily opened by many audio editors as well as numerical computing software like PyLab, Octave or Matlab.

Video data will be stored using the Motion JPEG format that uses intraframe-only compression. This method produces larger files than other video formats (like H.264 or MPEG-4) but allows cutting video files at any starting and ending frame, avoiding the process of decoding and encoding again without losing quality, as it happens with other interframe compression formats. This allows for easily accessing a specific chunk of a video recording rather than having to download the entire file.

Questionnaire data will be stored using interchangeable spreadsheet formats such as the Comma-Separated Values (.csv).

7.3 Data sharing

The online platform for multimodal data storage and sharing developed by UPF (Repovizz) will be used to share the data originating from the User-Centred Design activities under a Creative Commons (CC) license (specific CC license details will individually depend on the contents of the dataset). All data will be anonymised before uploading.

Each uploaded dataset will have a unique identifier assigned by the Repovizz framework, which can be used to provide access to the datapack using one the following:
• a RESTful API, which is currently under development, and
• a unique URL which redirects to the Repovizz HTML5 web client

Documents generated for the needs of the project such as deliverables and reports will be stored on the RAPID-MIX website with username/password protection as necessary for access control. It is in the interests of our consortium to have an open data policy to the maximum degree that is afforded, both in the service of contributing to standardisation and good practices in interface design, as well as fostering research in the field. However, if select data and their derived findings are deemed core, strategic and/or specific to the services of our SMEs by the Project Steering Committee (it requires decision at board level), we reserve the right to keep them internal.
7.4 Data preservation and curation

Initially, the uploaded datasets will be stored locally on the Repovizz servers. Current development efforts are being concentrated on restructuring Repovizz as a data access framework rather than a localised repository, which will act as a streaming client between the user and the stored data. In this way, data that is formatted and organised according to Repovizz's standards will be able to be stored on other servers as well. In all cases where SME data or user data are sensitive or required to be anonymised, they will be treated as research data in line with the outlined ethics policy.

8 Results and reporting

Team members leading UCD sessions or events will first document events using technology appropriate for the venue and event type (e.g., video and/or written notes for interviews and interaction with prototypes, paper or electronic questionnaire results, photos of paper prototypes or user sketches, electronic files of logging data from user interactions with software prototypes, etc.).

Within a reasonable timeframe after any UCD event, in addition to making this data formatted and archivable according to the previous session, the team members involved in a session will create an internal document that concisely summarises the event and outcomes for the rest of the consortium. This document will include:

- The Work Package and Task(s) with which the session is associated
- The names of people leading the session
- A description of the main activities of the session
- A description of the users (how many were there? Where did they come from? How were they recruited?)
- A description of how this session fits into future and past sessions, if appropriate (e.g., is this the second in a set of four observations with a particular group of users? When will the next session in this set happen?)
- A description of how the session outcomes inform recommendations for development of the RAPID MIX project, with recommendations linked to specific data and reasoning explained
- A list of work packages and tasks whose future work should be informed by the session outcomes

The outcomes of the sessions will also be reported via updates on the project website (to include information that is relevant to funders, to the community of API users, and to the broader public), via written summary reports (possibly summarizing multiple UCD activities over a period of time) to the industry advisory panel, and as part of the annual work package activity reports.
9 Conclusion

This document describes the methodological framework for assessing industrial and end-user design requirements. It is an intended working document and manual that codifies UCD and harmonises UCD activity across the project. In this task we have defined a set of methodological tools for the assessment of design and production needs with strong focus on industrial and end-user requirements. To achieve this, both SME and academic partners will participate in the definition of user-centred design activities, validation and assessment actions.

Whilst we collectively have a powerful toolkit and range of techniques for studies and workshops that put users at centre stage for designing and testing products, the unique circumstances of RAPID MIX - the range of users that incorporates both individual artist/researchers and companies in the marketplace - means that we will be testing some of these methods in unknown terrains, and so they must adaptable and the methodology sketched in this document will evolve according to circumstances.

This document therefore outlines the user-centred design techniques at our disposal and proposes how we can adapt them to the specifics of this unique project. One of the outcomes of RAPID MIX, aside from the technologies, will be to share guidelines developed along the way, to help research centres and SMEs work together to quickly produce novel products, and this document is the stepping stone to that vision.
10 REFERENCES

10.1 Written references


Egger, Florian N. 2000. "Lo-Fi vs. Hi-Fi Prototyping: how real does the real thing have to be." Teaching HCI workshop, OzCHI.


### 10.2 Web references

11 Appendix

Goldsmiths Code of Practice on Research Ethics (http://www.gold.ac.uk/media/research-ethics.pdf)