Breaking the workflow: Design Heuristics to Support the Development of Usable Digital Audio Production Tools

Framing usability heuristics for contemporary purposes

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ABSTRACT

The investigation that follows presents the results of a series of workshops with professional musicians and music producers. The work here elicits requirements for musicians in terms of software systems. The scope here explores how to design systems to support creativity and collaboration while maintaining a usable system – one which is effective, efficient and satisfies the user. The format models that of similar workshops, where a three-pronged approach is taken to focus on three different types of creativity: exploratory, combinatorial and transformational approaches. Participants describe a story that defines different user roles and expectations. Focus groups help to refine and combine the existing experiences and begin identify ways in which systems can be made more usable, and support more creative ways of working. We consider the broader consideration of usability, including defining and describing different user types and how their views of usability may differ or even be at odds. Our findings show that while existing systems are very good at supporting traditional usability metrics they may not consider the broader implications of a considered and holistic user experience.

CCS CONCEPTS

• Human-centered computing~Empirical studies in HCI • Human-centered computing~Interaction design theory, concepts and paradigms • Applied computing~Sound and music computing

KEYWORDS

Music, Production, Design, Interface, Professional, Heuristic; Collaboration

1 Introduction

The importance of music, in any society cannot be overstated. Music is a necessary component of modern life. It can be used for communication, as an approach to eliciting emotions, as a measurement of time or for entertainment purposes[34]. Music, in some forms, is older than language[48]. There is value in tools that aid in the creation and composition of music[7]. Technology provides a vessel for efficient creation through processes such as automation. We can think of technology-oriented audio production as a channel by which composition happens. If we are to consider how well these systems work, then there are metrics such as heuristic guidelines which can be used to evaluate how usable a system is. We can consider usability as three core constructs under these metrics: effectiveness, efficiency and satisfaction[35,36].

Heuristic evaluation guidelines are useful as a quick and easy way to evaluate systems. However, we must be cautious in the application of these metrics. By enabling efficiency and effectiveness in production, there is a risk that the user is forced down a particular path and that the inherent creativity is lost[16]. We may consider a more usable system as a net positive, but must also contemplate the challenges and risks associated with the system appropriating these tasks. The work here aims to identify problems and solutions in enabling creativity in music systems without reducing usability. We also consider multiple systems and people interacting at different levels of abstraction. One way in which creativity can be encouraged is through the creation of constraints[49]. While this may seem counterintuitive we can point to examples. Instruments are constrained by key and tonality. Without retuning a guitar for instance, there is a limited range of notes that can be played. Mixing equipment is constrained by the number of available inputs and so forth. KOMPLETE 9, a package of digital instruments and effects - for instance, contains 33 products and over 120GB of sounds. This is double the number provided by KOMPLETE 6, a package released only a

few years earlier. The trend here is that capacity and functionality is ever increasing through feature creep. These systems are constrained by things such as screen real estate and processing power. We must also consider the value of flow. This challenge becomes more complex given the growing functionality of systems. We might think of goal-oriented systems as being advantageous in the sense of being efficient. From the perspective of a sound engineer this may be a valuable consideration. Creativity and innovation suffer in such an environment[22]. When the goal of the system is for instance to be creative but also be efficient then we must consider how to mitigate these concerns against things like flow and engagement[47]. There is a trade-off here between the complexity of applications and the time it takes to learn and memorise how to use these tools. For sound engineers this may be a worthwhile expense depending on context[26]. We might consider this challenge as a representation problem. Nielsen and Gentner discuss alternatives to the traditional interface and how rich representation of objects can produce value[37]. We might consider for instance the difference between playing an instrument and how it differs from producing music using digital tools. The technology should augment the process but learning to use said technology may in itself be difficult. We might in this context aim for the technology to disappear when used as the digital instrument then becomes a vessel for expression over an entity or object[23].

Addressing issues of functionality against the concept of engagement and flow becomes problematic in this setting. Forcing the user down a prescribed path may improve efficiency and reduce clutter in the user interface through presentation of a single view. This however may disrupt flow and engagement where the core number of interactional possibilities are limited. Approaches in similar systems can be used to model a strategy in which subtlety and performance are key. A study into piano techniques and expressive gestural interaction highlights some methods that could be transferable[33]. Here, the findings show that expression is important and can provide utility. Metaphors drawn from the real world can also be useful in helping to facilitate ease of use within this context. Image schema theory research[13,14] considers metaphors in user interface design to ease use in a similar context. The focus here is on reducing cognitive load and enabling users to draw from previous experience. The process of music making may not necessary facilitate an end product, for instance in the context of practice or collaborative play[17]. Ease of use from these perspectives may not be clearly defined[5,11]. Commercial settings may require both creativity and an end product, for instance when rehearsing or songwriting[12]. In some cases technology is not a necessary component[15]. This then poses the dichotomy of design between physical instruments and digital audio production systems.

Early work in the support of innovation[44] sets the basis of what would later became more refined work in musical creativity-focused systems, exploring expressivity[9]. More domain specific approaches might consider context[18] or feasibility[45]. These user led design approaches have developed theories and valuable insights in understanding how to design better systems. The work here aims to draw from these areas and combine approaches to better understand resonant constraints and concerns around practice in music production.

This work explores both the importance of music and the relevance of music in varying settings. Field based studies provide a platform for understanding rich contextual settings[1,26,28]. The findings of these studies show that music is a social activity and that such activities are not reducible or easy to relate to[29]. Music making happens in a semi-structured way[28,32]. There is a clear need for freedom of expression[29,43]. We might consider musical notation as a vessel for this expression. A guitarist for instance may choose to write using a formal structure through scores and notations. Equally they may use tabulator or even chord structures with more loose representations of a piece. Complexity in this case presents a design challenge. Instruments such as the harp are complex by design. A piano with only three keys for instance would be sufficiently constrained, but possibly not well designed from a utility perspective. The history of musical development and non-intuitive, complex nature of notion present as problems which existed before the computer interface and as such, cannot be addressed as computing problems[4]. We must therefore consider how to manage complexity as an inherent challenge.

These workshops have been designed to encourage participants to think in novel ways about how systems are used. By bringing together participants from multiple disciplines and with varying goals, contributions can be made using domain specific knowledge. The work here builds on existing knowledge to support the development of design strategies for future software applications.

2 Approach

The following section details the methods used to encourage the generation of creative ideas and assess how existing tools could be made more usable. A workshop format has been chosen as it allows stakeholders with varying backgrounds to communicate thoughts and ideas in a formative way[25][24] with a music oriented focus[31]. The focus of the exercise is on composition but participants are free to explore the creative process. The workshops are conducted in a creative environment, a rehearsal studio where instruments, digital audio workstations and SoundCloud are open and available to be used. Sessions are split into twenty minutes of activities and then ten minutes of reflection. Participants are recruited from fields of audio production, with different specialized areas of interest. The

workshops each have twenty participants. Focus groups are also used to consolidate the workshop findings. Each focus group comprises of ten participants who discuss findings. Results are analysed and coded using thematic analysis.

2.1 Storyboarding

Storyboarding exercises enable the representation of time, dependencies and objects in a finite space[25]. They can be created from multiple perspectives and identify flow, navigation, structure and interactional components. They are also able to describe a system in non-functional ways[39]. Storyboards are then evaluated through active scenarios. This helps to identify user contexts. Through clearly defined roles and understanding the interactions that take place between roles we can begin to consider how usage scenarios might play out. Storyboarding happens as a group activity. Participants work within a rehearsal space amongst various instruments and with access to digital audio workstations. Participants are also provided with sheets of paper, sticky notes, pens, pencils, whiteboards and markers. The sessions are split into three, twenty-minute sessions, with ten minutes reflection time.

2.2 Focus group and creative triggers

The second workshop focuses on mapping ideas and expectations against current systems to identify flaws in their design. The focus groups are directed by the active roleplay exercises. The storyboards are played out in real time in order to elicit the complex requirements and interdependencies that exist within these types of systems. Users are presented with SoundCloud and asked to discuss their findings in relation to the web-based music sharing and commenting tool. Here, iterative evaluations take place using SoundCloud as a creative trigger[6,41]. There should be a clear definition of requirements in relation to roles. This technique also enables the discovery of functional requirements by task.

2.3 Scenario oriented design

The workshop focuses around designing a solution and aims to generate a transformation of existing models into new methods and contributions. The aim here is to propose solutions to existing usability problems, highlighted in the initial storyboards. While the novelty here is similar to that of the combinatorial process it extends beyond a familiar space, in this case SoundCloud, to generate new workspaces and approaches to solving problems. Here, the system is no longer the focus but the process. People are the centrepiece for such a system and the process revolves around their relationships with both the technology and each other, describing the sociotechnical relationship therein[21]. The workshops and supporting focus groups aim to identify the major challenges and suggest feasible solutions for overcoming such challenges. The aim is to generate solutions that are clear and generalisable, with software and hardware agnostic guidelines.

2.4 Results

The findings from the series of workshops are as follows.

2.4.1 Storyboarding (exploratory)

Participants explored three major roles in the composition and collaboration process. These roles were defined as the performer, the producer and the agent.

Performer	The performer is defined as a musical individual. The performer is described as someone who has an intimate understanding of the music they write and perform. The performer has goals in either live performance, composition or to communicate with other members. In some instances, the performer and producer can be the same individual or group.
Producer	The producer is defined as someone who works with technology, in some instances exclusively. Musical knowledge is not imperative for this role, but the producer must have a thorough working knowledge of how digital audio workstations can be used. Here the focus is on taking input from performers and agents and working on a compromised version of a solution that matches the requirements of both users.
Agent	The agent is described as any user which does not directly contribute to the production or performance element of music but has a supporting role in the process. The agent may be defined as a representative from a record label, management or an external stakeholder such as a financer. The agent relies on technology for more general tasks such as communication, time management, planning and project scheduling.

Table 1 - Participants identified three core 'roles' within music production scenarios

2.4.2 Focus groups and creative triggers (Combinatorial)

The workshop focuses on using the predefined roles generated when storyboarding to work through roleplays in real time. Participants make notes to define status, progress and to manage memory. Participants focus on what the software does well and consider what could be done to improve the process.

Current Feature	Future Implications
Inbox and playlist feature make it easy to deal with multiple tracks and multiple people. Easy to manage and maintain.	Could become difficult working with lots of content. Not everything presented on the screen is relevant.
Integration with social networks or sending all options. Relative ease in uploading/ downloading tracks and performing basic tasks. Some crashes and errors.	Integration could be seamless. Amazon's one-click-to-buy feature identified as a valuable technique in time critical situations.
Pleasant interface. Comments presented in time. This makes it easy to point to particular parts and adds context to the comments. Interface becomes cluttered as networks grow.	Further richness of information. Working on the track and making live changes enables links between agents and producers/performers.
Internal messaging and external embedding of tracks allows information to be passed out. Sharing through social media or APIs and desire to define aesthetics.	Lack of control confusing. Options limited. Opportunities for stakeholders to refine listening experience. Provides control but expensive/ad-hoc.

Table 2 - Participants described their own work and considered possible improvements to their workflow

Participants used sticky notes as an extension of the system. These were attached to the screen to create a new series of systems. Users created hybrid systems, adding and integrating notes by sticking them to the edges of the screen. Features include further control: changing tempo, transposition, allocating ownership or tracking progress. Single click functions were added, including tools such as 'sort by user' and 'sort by genre.' Users described these features as being able to, work "seamlessly together".

2.4.3 Exploring the unknown (Transformative)

The workshop format here enables the representation of new ideas or concepts in a novel way. Participants are no longer constrained by the system. Here, participants explore a flow-based system and define this by the usage scenario rather than the system.

Owner	Performer	Producer	Producer
Sub-owner	**Agent**	**Performer**	**Performer/Agent**
Tasks	Define rules	Digitisation	Processing
	Define tempo	Track-by-track	Effects
	Allocate people	Key matching	Levelling (volume)
	Manage time	Refining tempo	Signal processing (flow)
	Choose instruments	Layering	Preparation for release
	Define melody		Distribution (fuzzy)

Table 3 - User types described in relation to their changing roles during a dynamic workflow of production

Participants here describe the pre-production phase as a "balancing process", finding the right fit and testing how well content works cohesively. Production is described as the, "least creative process", in that there are expectations and digital/music theories than can be used to automate the process. Much of the production process can be defined in metrics, where creativity and innovation are at their lowest. Post production is also described as, "a creative process, where a user imparts a personal touch on a song." Here, participants describe the process as a, "merging of a series of tracks into a single track, thus changing the definition of the work in progress." The final stages are described as a "signature process," where a producer can "mimic their signature sound" and apply it. The processes here are interchangeable, with each step imperative to the process but order changing as a matter of personal preference.

The workshop also highlights the process of music production here as both distinct and personal. While some producers, "share certain general processes," their working patterns, behaviours and expectations of what the system can and should be able to do differs broadly. Beyond production the process then becomes individual, with each producer adding their own "touch" to a song. Many of the users here are happy to hand off control to the system provided that it is a system that they trust, ie one that they work with on a regular basis.

Example	Factor 1	Factor 2	Factor 3	Solution
Too much control, too many things on each page	Efficiency	Learnability	Visibility	Simplification
Illogical order, no flow, poor visibility	Visibility	Memory		Clearer expression
Metaphors poorly used, unclear symbols, doesn't match instrument	Learnability	Memory	Visibility	Standardisation
Accelerators differ across packages, same controls perform different functions depending on context	Learnability			Standardisation

Table 4 – Summary results of third focus group. Associated cost of usability issues in a production workflow

Where less familiar tools are suggested then users take more ownership of their production process and choose a more distributed set of tools to achieve a task rather than utilising a single tool. Intuitively this seems less efficient, however it reduces learning and memory as users do not have to learn a new set of rules in a system. Each distinct stage is defined by producers, though links between each vary on a user by user basis. Each user also defines their own work. Levels are set dependent on a pre-defined notion of how each instrument or sound is important in the overall context of the recording and this can differ from one producer to the next. Instruments do have pre-defined frequency ranges that participants agree on, whereas elements such as compression and equalisation focus on the holistic sound. Each of these steps is imperative to the mixing process, though the approach varies differently in how and where these features are applied. Participants agree that this process is defined as a cyclic one. At this stage the process can be generalised in that users utilise one or more of these processes in their work, while some users choose to spend more time on particular aspects depending on the resources that they are working with.

Some broad features are generalisable, but approaches may vary between individuals. The mixing process is described as integral steps in the development of a track. The workshops have enabled definitions of roles and inherent problems therein. The problems identified thus far have been focused on a particular tool or piece of technology, however previous work has already identified that multiple tools are used in production[30,46]. Often times these tools are described as not fit for purpose but used as they are familiar or comfortable.

The usage of multiple tools to perform a task has also been described as problematic in that there are learning/memory gaps when moving between systems or adapting to an entirely new system. We must then explore these problems further to determine why these problems exist, how detrimental they are to the process and approaches to solving such issues. The following section highlights the results of a series of focus groups aiming to define problems in terms of existing frameworks and examples and to explore strategies that may help to overcome such problems.

3 Focus Groups

Focus groups support workshops by enabling the discussion of ideas and concepts[8]. Focus groups enable the representation of ideas in the form of categories which can then be related to existing structures - in this case heuristics. Three focus groups form to discuss ideas about existing systems, considerations and implications of music systems. The three groups match those in the workshops focusing on exploring, combining and transforming. The aim here is generate a unique set of recommendations in designing and evaluating systems for musicians.

3.1 Group 1

The first group describe the following categories of usability issues with examples where appropriate. Participants agree that such problems are inherent of all music systems and are not related to a particular software tool. These problems are

described as “common,” occurring on a regular or semi-regular basis.

issue	example
features	too much control, too many things on each page
flow	illogical order, no flow, no visibility of status
disconnect	metaphors poorly used, unclear symbols, doesn't match instrument
controls	accelerators not uniform, behaviour of controls varies in different contexts

Table 5 – Results of first focus group. Problems experienced with user interface designs of digital audio workstations

3.2 Group 2

The focus of the second workshop is on contextualising issues. Participants chose a traffic light system to categorise issues with a corresponding number between one, green (low) and three, red (high) to rate severity. Issues coded as green are considered a nuisance but do not cause the system to slow down or stop working.

Amber coloured issues (2) are described as issues which cause a system to slow down but not stop. This loss of efficiency can exist in both the system or in cognition where users become confused and flow is lost. Red issues are described as severe in that they either result in a large drop in efficiency or cause the process to come to a halt. Red issues cause users to revert to earlier versions of composition as current state is unmanageable. Red issues are: functionality, visibility and accelerators. Amber issues are: Control, flow, metaphors and symbols. Green issues relate to order and digital instruments.

3.3 Group 3

The final focus group further refine these categories by relating them to appropriate heuristics and coding them according to each with the support of the researcher in describing each heuristic. The severity rating (1-3) is also unanimously agreed upon by the group.

Issue	Heuristic
Control (2)	Learnability
Functionality or lack thereof (3)	Efficiency
Order (1)	Learnability
Flow (2)	Memory
Visibility (3)	Efficiency
Metaphors (2)	Memory
Symbols (2)	Memory
Digital Instruments (1)	Effectiveness
Accelerators (3)	Efficiency

Table 6 – Results of second focus group. General heuristics to define usability issues in music production settings

Results show that efficiency is the integral factor in determining the severity of usability issues. The more complex problems present as difficulties in learning, memory and through poor expression. Examples here include issues such as buttons not corresponding to the heading directly above, tools not appearing in logical areas (workspace or menus) and difficulty in accessing regularly used tools (multiple clicks, hidden several submenus deep.) The difference in behaviour of identical tools (buttons, sliders) also presents as a visibility issue that affects speed.

4 Discussion

The workshops highlight major issues in solid integration and cross platform support. Music making is both diverse and rich in contextual information, with unlimited customisation and personalisation options. When we consider this context in a digital system, the constraints are far greater. One of the reasons for this may be the difficulty in accessing data stored in different forms. The systems here rely on the knowledge entity (user) rather than aiming to encapsulate such information within the system. The importance of knowledge sharing has been explored in a general context[19] as has the importance of knowledge in music systems[4] and collaborative contexts[42]. Tools such as SoundCloud aim to improve collaboration and visualisation. Digital audio workstations however support these processes as a supplement of core practice. The focus is on the production

element. A failure to encapsulate the requirements of a user in a context-driven way leaves a disconnect between what the system and what supporting tools provide. This further emphasises the need for both content management and knowledge sharing, preferably in an integrated way. Through representation of knowledge engineers can spend more time on core tasks.

Convergence towards a more efficient solution is not the only issue present here. Visualisation of status, presentation of information and context are ever present issues in music production. The inherent complexities of such systems[2,16,38] suggests that there is an even greater need for deference of cognitive load and easier recognition of elements. Visualisation of information becomes even more problematic when appreciating the different types of users and contexts that exist. The solutions presented here are from a contextual perspective and would not necessarily be usable solutions in any context. These contextual views enable the representation of different interfaces depending on a predefined context contributing to a cohesive whole through providing different types of input. The three roles defined here could provide three different interfaces focused around the views. The 'agent view' for instance, could provide information about ownership, progress tracking and sharing and time constrained tasks, without presenting the unnecessary elements of composition such as equalisation, compression and panning. Equally, those involved in these states of production could subdivide tasks, offer ownership and tracking capabilities and improve collective understanding.

The final issue presented in the workshops is one of collaboration. While SoundCloud provides a fairly robust collaborative interface, this is not the norm. Users overcame this problem by adding sticky notes to increase functionality. Buttons for sharing, tracking and such enable moving between current interfaces and suggested ones. This represents a need for additional functionality in a contextually driven way, in this case focused on the work in progress composition. Sharing is fairly important in the context of music[3] and this is an area which has yet to be explored by digital audio workstations on a broader scale. Other complex systems such as software development environments provide content and knowledge management systems to overcome many of the problems explored here. This approach could potentially translate and improve the usability of digital music environments. The focus groups highlight some of the critical success factors in designing usable systems for music production and a growing body of knowledge about how to build usable systems. The examples highlight a need for standardisation, solid integration and more user control. Many of the problems highlighted relate to memory or learning and could be overcome by simplifying the interface in terms of context, perhaps orientating by task. Users highlighted that they would simply choose to use an alternative tool rather than deal with complications of adapting to an unfamiliar tool. This is the case even where the process is much more time consuming and therefore less efficient in the tool of their choice. In terms of working patterns, by allowing users control of their own interface they can work in a more efficient and effective manner. The physical world is not defined by such criteria. If we take the example of the guitarist, using multiple signal manipulation tools and post processing tools is indeed a reality (digital effects pedals, noise cancelling, amplifiers, PA and such.) The space in which a musician works is defined by their working patterns and they are free to express themselves in a manner of ways. The issue of flow in this context has already been discussed at some length, though the use of hardware-based tools over software is defined as preferential in most cases. Allowing users control in a similar context could potentially reduce a fear of using the technology, reduce barriers to learning and create a more usable system as a result. The issue of complexity and learning exists even before any software is used. Instruments themselves are complex technology, though digital systems provide an additional layer of complexity and learning hurdles[16]. The suggestion here is that more usable solutions could be built through encapsulating the requirements of the user. Allowing the user control over their system would enable better awareness and would allow users to remove some of the unused features of the system to drill down to a more contextually relevant version of the software. Tighter integration is also likely to provide more usable solutions, for instance by using a universal language of communication between software packages[10] rather than relying on the currently distributed architecture.

5 Conclusion

The work here supports findings about the usability of tools[26] and understanding about the core roles in music production[27] that need to be encapsulated in design. Participants express a need for content management and knowledge supported engagements in a system where metadata is emergent and growing. Users present unique solutions to the problem of collaboration in a distributed environment by supporting multiple user-centred perspectives. The work suggests that current solutions could be improved through the use of ownership, tracking progress and knowledge sharing. There is also an inherent need for freedom of expression. By adding functionality there is the potential to complicate an already inherently complex tool. The results here highlight the key changes that need to be made in order to build more usable systems. Many of the solutions proposed here for the improvement in quality of the software interfaces involves subtle changes, but involve a process of risk mitigation when varying context of use. A change to improve usability for one case may drastically impact how others use the system. Users identify challenges in standardisation between existing commercial software. There is also a distributed nature of work with such systems that are potentially flow-breaking. Some of the more complex issues present in memory and visibility, suggesting that these issues have wider implications. A loss of efficiency is detrimental because it then breaks flow and creates a disconnect between the user and the creative process. Lack of control reduces opportunity for users to tackle these issues effectively

and the issues themselves can create wide ripples. There is a desire for better control and better integration between software tools designed to edit and manipulate sound. This is a problem that is unlikely to be solved easily due to the various legislative restrictions and proprietary nature of music formats. To focus on metadata in the first instance and processing of sounds in the second might be one way in which systems could be redesigned. This would also enable distributed systems to encapsulate different types of users, rather than assuming that every product is tangible. The necessity for an agent to familiarise themselves with equalisation and compression for instance may seem like a waste of time, where their time might be better spent focusing on the tasks that they wish to perform. Visibility of status in this case might lend itself to a production and agency perspective, through consolidating and presenting metadata in a timely manner. This presents a good argument for a context-driven system with different levels of information and abstraction present depending on user-context.

A system with better control[40], knowledge management[19], visualisation[20] and flow[47] would solve many of the inherent usability problems here. There is perhaps a challenge in taking control from the system and putting it into the hands of the user. The general consensus here is that systems are designed to be functional under any context, but for such functionality to be useful the user needs to adjust to using the new system and learn and adapt to a new set of rules or constraints that may exist. There is a severe lack of control in such systems. This control however needs to be carefully mitigated to not infringe on other contexts of use. Control here is a double-edged sword in that it allows users freedom of expression but too much control could cause further problems. Requirements are ever changing, as is context, meaning that these problems are difficult to solve without first considering context of use. Digital interfaces are as prone to clutter as any physical workspace, in that they use the same set of distinct processes and working patterns but rely on metaphors that may no longer be relevant or useful[30]. We have found that current solutions are fairly robust and reasonably fit for purpose, though we have made some suggestions here in how to improve solutions in the future in the design and evaluation stages of developing such systems. The growth in technology and development of such systems means that functionality of these tools continues to increase rapidly. Though it is important to recognise that these tools are not the core of such a system and should not be described as such. A stronger focus on the user and user-centred design processes would enable the development of tools where functionality is driven by the user and workflows are improved[27]. In summary, software developers need to focus less on building complex functionality and consider the context of adaptive, flexible, collaborative working patterns and usage scenarios in order to design and build more usable systems.

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