Chapter 6
Interaction Aesthetics and Ubiquitous Music

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6.1 Introduction

Two recent approaches to interaction design have good potential to address creative practice in everyday settings: interaction aesthetics and ubiquitous music. We discuss the theoretical and methodological issues raised by both perspectives and highlight the similarities and differences among the two approaches. Through the analysis of a series of experiments, a common theme emerges: relational properties may provide a useful target for creativity-oriented experimental work.

The first section presents the conceptual and methodological issues raised by interaction aesthetics research. Engagement, temporal patterns of behavior, alternative forms of design with innovative material combinations, and user identities inserted in cultural contexts are approached through methods based on situated experience, consensual rationale, and reflective practice. A recent definition of ubiquitous music encompasses the issues dealt within interaction aesthetics and highlights the need to account for everyday creative phenomena. Creative potentials, everyday creativity, and distributed creativity emerge as targets for the

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experimental research carried out in ubiquitous music. The implications of adopting material relational properties and social relational properties as targets for experimental work are discussed within the context of a series of ubimus design studies. The last section of the chapter points to the methodological challenges faced by creativity-aware interaction aesthetics, including factors related to the profile of the participants, the profile of the by-products, and the observation of situated behaviors.

6.1.1   Interaction Aesthetics

A promising approach for supporting the design of everyday creative activities.

Advances in interaction design have highlighted the need for a wider view on technological developments and their applicability in everyday activities (Löwgren 2009). The utilitarian focus of previous human-computer interaction research is being questioned by researchers interested in the creative enhancement of technology usage (Mitchell et al. 2003; Shneiderman 2007) and by investigators dealing with the aesthetics of interaction design (Redström 2007; Wright et al. 2008). In 2005, Udsen and Jørgensen stated: "at present, the aesthetic turn is not a full-fledged shift in paradigm. However, it is undoubtedly an indication of a new awareness of the wide-ranging dimensions of interaction between humans and computers." We have reasons to believe this situation has changed, particularly within the practices of interaction design.

Interaction aesthetics is surfacing as a strong alternative to mainstream human-computer interaction theories and methods (Hallnäs and Redström 2002; Löwgren 2009; Redström 2007; Stolterman 2008; Udsen and Jørgensen 2005). Löwgren (2009) and Stolterman (2008) propose a shift in focus from task-oriented, utilitarian approaches to human-centered and experience-centered methods, described as a "rational, disciplined, designerly way" (Stolterman 2008). Redström (2007) suggests that a central idea is the need to create a richer relation to computational things, through the exploration of:

- Engagement rather than efficiency
- Temporal patterns of behavior
- Alternative forms of design that challenge expectations
- User identities, cultural contexts, and traditions, within specific design domains
- Innovative material combinations

Despite the significant theoretical advances in interaction aesthetics, how to approach the variety of methodological issues raised by this perspective on technology is still an open question. In one of the initial studies in this area, Redström (2007) endorsed a radical change of focus, i.e., how to design for living with, rather than just using, computational technology. To design for everyday life involves more than supporting people to accomplish certain tasks effectively. Designs for usability and functionality are not sufficient. This broader view of interaction

explores aspects for which the traditional usability assessment methods are incapable of providing useful information. New techniques are necessary.

As a general trend, situated experience, consensual rationale, and reflective practice are surfacing as key aspects of interaction aesthetics. From an aesthetically aware perspective, Stolterman (2008) proposes the following methods: "(i) precise and simple tools or techniques, (ii) frameworks that do not prescribe but that support reflection and decision-making, (iii) individual concepts that are intriguing and open for interpretation and reflection on how they can be used, (iv) high-level theoretical and/or philosophical ideas and approaches that expand design thinking but do not prescribe design action." Sketching and prototyping (Buxton 2007) are examples of item (i). Instead of prescribing solutions for well-defined problems, interaction aesthetics techniques employ design patterns, design actions, and interaction metaphors to handle open-ended research problems. Given that these techniques reduce the development cycle ensuing multiple iterations through the design process, they may eventually serve to fill the gap indicated in item (ii). Specific examples are personas, scenarios, probes, and affordance-based methods. These tools provide inspiration to deal with situated issues, fostering reflection and understanding of the implications of each design decision (iii). Despite their misleading name, design actions (De Bruijn and Spence 2008) are high-level applications of cognitive theories that can be used to guide aesthetically informed design decisions. When similar technological solutions are observed in various contexts, interaction patterns may provide a useful generalization. Interaction patterns can be applied to the task of finding suitable techniques to deal with recurring implementation issues. We can think of interaction metaphors and patterns as results of opposite design trends. While metaphors provide instantiations of general interaction mechanisms, patterns are generalizations of specific solutions. This means that solutions encountered by inductive or bottom-up processes (patterns) could eventually match solutions reached top-down – through deduction of general principles (metaphors). These specific cases are the strongest candidates for useful applications in multiple design contexts. Design actions, design patterns, and interaction metaphors provide non-prescriptive frameworks for design thinking (iv).

6.2 Goals of Ubimus Design

Ubiquitous music (ubimus) research (Keller et al. 2011a) has also targeted aspects of interaction design that have not been dealt with within the mainstream human-computer interaction perspectives. *Ubiquitous music deals with systems of human agents and material resources that afford musical activities through sustainable creativity support tools*. Viewing Redström's (2007) interaction aesthetics proposal from a ubiquitous music perspective, we see a convergence of interests and methods, including engagement, temporal patterns of behavior, alternative forms of design with innovative material combinations, and user identities inserted in

cultural contexts. Despite these common themes, there are three ubimus design concepts that have not been considered within aesthetically informed trends: creative potentials, distributed creativity, and everyday creativity. Let us review the convergent approaches first and we will tackle the differences afterwards.

Engagement has surfaced as one of the constructs that impact creativity outcomes (Bryan-Kinns 2011; Brown and Dillon 2007; Keller et al. 2011b). This factor is particularly relevant when the activities involve intense social interaction (Pimenta et al. 2012). Engagement may encompass multiple mechanisms related to personal (Keller and Capasso 2000) and social aspects of the creative activity (Lima et al. 2012).

The study of *temporal patterns of behavior* has gained increased relevance in the context of creative activity. Eaglestone et al. (2008) and Shneiderman (2007) have proposed longitudinal studies as the method of choice to capture design requirements that are not addressed in short, task-focused experimental studies. Activity-based computing (Bardram 2005; Bødker and Klokmose 2011) may provide conceptual tools to tackle aspects of the interaction support involved in creative activity. Characterizing creative activities has become one of the major goals of the experimental ubimus research program (Keller et al. 2010).

Alternative forms of design and innovative material combinations were already present in ecocompositional practices (Keller 2000) but have gained new strength with the introduction of the technique of repurposing within ubiquitous music systems design (Flores et al. 2010, 2014). Multimodality (Keller 2004) also seems to be an emerging common theme that may be further developed by the exploration of aesthetically informed design qualities. A quality that shows promise for creative musical applications is ambiguity (Gaver et al. 2003). The semantic content of musical products is usually open to multiple interpretations. These interpretations depend on the personal history of interactions with everyday sounds (Keller 2004; Keller and Capasso 2000). Therefore, the function and emergent properties of ubiquitous musical experiences open opportunities to explore ambiguous design. This goal may separate the ubimus research agenda from the utilitarian objectives laid out by sonic interaction design (Serafin et al. 2011). An aesthetic ubimus experience involves not only new materials or combinations of materials; it also provides new forms of engagement.

User identities, cultural contexts, and traditions have been partially explored within the domain of ubiquitous music design. Brazilian creativity traits were introduced in interaction design by Pimenta et al. (2012). This line of research may be expanded through cross-cultural and ethnographic studies, although the current emphasis seems to be on the impact of user identities on aspects of everyday creativity. In other words, rather than applying large-scale comparative studies indicating general cultural traits, everyday creativity may demand detailed micro-observations of creative activities in ecologically valid contexts.

Ubiquitous music research may provide a contribution to interaction aesthetics by expanding the design goals to account for creative potentials (DiLiello and Houghton 2008). While existing approaches – synthesized in Redström (2007) – propose alternative forms of design and innovative material combinations to obtain new artifacts, ubiquitous music techniques target the increase of creative potentials.

Thus, one objective is the empowerment of participants in creative actions rather than just the implementation of creative products. For example, sonic sketching involves various exploratory activities that increase the knowledge of potential sonic results (Lima et al. 2014). This experiential knowledge may materialize as creative products but it may also induce new paths for exploration. Methodologically, having alternative goals indicates the need for multiple forms of assessment, including products, processes, and potential resources.

Ubiquitous music design decisions are materialized as technological prototypes that afford but do not enforce creative behavior. This proposal is rooted in the Brazilian dialogical education movement (Freire 1999; Lima et al. 2012). As we will see in the next section, relational properties result both from agent-object interactions and agent-agent (or social) interactions. When the social dynamic is nonhierarchical, creative products and processes may not necessarily fit within the division of labor traditionally applied in the industry: users may become cocreators. In this sense, the dialogical approach has strongly influenced the participatory design movement (Ehn 1988).[1] A focus that is missing from current research efforts in interaction aesthetics is the socially distributed nature of creative activity. This aspect is featured in the application of communities of practice within ubiquitous music research (Pimenta et al. 2012). Musical prototyping (Miletto et al. 2011) – encompassing a process of negotiations among participants, working on a shared creative product – provides another example of non-prescriptive support for aesthetically grounded decision-making.

A new focus on activities carried in everyday settings has opened the door to the study of everyday musical creativity (Pinheiro da Silva et al. 2013). Because creative ubiquitous musical experiences occur in everyday contexts featuring ordinary people, experiments are done outside of the institutionalized spaces for music making. Hence, another objective of the ubiquitous music design process is the support of manifestations of everyday creativity (Richards et al. 1988), defined as the processes and products that are both innovative and socially relevant but that do not attain status of artworks. Site-specific creative experiences – rather than digital musical instruments, instrumental virtuosity, or isolated sound objects (Schaeffer 1977) – are the material for study of aesthetically informed ubimus design. Hummels and Overbeeke (2010) stated that "design is about being-in-the-world." Paraphrasing, we can say that ubiquitous music design is about being creative in the everyday world.

Summing up, although there are several parallels between the interaction aesthetics and the ubimus research agendas, targeting creativity implies dealing with phenomena that have not been considered within the aesthetics-oriented human-computer interaction perspectives. Engagement, temporal patterns of behavior, alternative forms of design with innovative material combinations, and user identities inserted in cultural contexts are common themes. Creative potentials, everyday

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[1] Pele Ehn (1988: 9) stated: "The research approach I advocated was action research together with trade unions, and here I was strongly influenced by Paulo Freire and his 'pedagogy of the oppressed' as well as by Kristen Nygaard and the work he was doing together with the Norwegian Metal Workers' Union."

creativity, and distributed creativity are emerging phenomena highlighted through the experimental research carried out in ubiquitous music. The next two sections will discuss the implications of adopting material relational properties and social relational properties as targets for experimental work. This discussion will provide the necessary context to define a common ground for interaction aesthetics and ubimus research methods. The last section will point to the methodological challenges faced by creativity-aware interaction aesthetics.

6.3 Material Relational Properties and Creativity Support Metaphors: Implementation of the Metaphors and Testing the Solutions Through User Studies

Keller et al. (2010) have proposed anchoring as an affordance-formation process for supporting creative practice. Affordances are not properties of the environment or properties of the human agents. They are relational properties that arise while activities are been carried out. Activities involve cognitive and proprioceptive processes that engage both material resources and conceptual operations. By understanding affordances as dynamic properties emergent from agent-object (natural or material affordances) and agent-agent interactions (social affordances), a key aspect of the design process emerges: how affordances are shaped. Anchoring is one of the key mechanisms for cognition and proprioception integration (Hutchins 2005). It may also play an important role in affordance formation. Two examples of the application of anchoring within the context of design are the creativity support metaphors: time tagging (Keller et al. 2010) and spatial tagging (Keller et al. 2011a, b).

1. The *time-tagging metaphor* provides direct couplings between sonic cues and conceptual operations making it possible to define how a set of unordered virtual elements or processes is layered onto a tagged timeline.
2. The *spatial-tagging metaphor* makes use of virtual or material visual cues – anchors – to support creative musical activity.

Creativity support metaphors embody methodological solutions that are not bound to technical specificities. Time tagging defines a process by which a set of unordered virtual elements or processes is layered onto an abstract one-dimensional structure – a tagged timeline. The time-tagging interaction metaphor is applicable to mixing on stationary or on portable devices. It can be applied on sonic data or on control sequences. It could also be extended to video applications. As a creativity support metaphor, time tagging materializes relational properties that fulfill part of the human and the technological demands of the mixing activity.

This metaphor was used to implement a series of prototypes grouped under the label mixDroid first generation (mixDroid1G). MixDroid1G is a compositional tool that allows the user to record sonic performances which can be merged into complete artworks. Usage consists of selecting and triggering multiple sound resources,

doing the mix while sounds are being played. Several experiments encompassing domestic and public settings have shown that time tagging provides effective support for creative musical activities in everyday settings (Keller et al. 2010, 2013; Pinheiro da Silva et al. 2013, 2014; Radanovitsck et al. 2011).

As previously stated, spatial tagging is defined as an interaction metaphor that makes use of virtual or material visual cues – anchors – to support creative activity. The spatial-tagging metaphor was encapsulated in the Harpix prototypes. In Harpix 1.0, the visual elements of the interface can be manipulated directly, establishing a straightforward relationship between user actions and sound events. Keller et al. (2011b) tested the application of spatial tagging in musical epistemic activities. Three subjects realized 37 interaction essays, comprising exploratory, imitative, and product-oriented activities. Six creativity support factors were assessed: productivity, expressiveness, explorability, concentration, enjoyment, and collaboration. Enjoyment and expressiveness were highly rated during product-oriented activities, while exploratory activities yielded high enjoyment scores. Contrastingly, collaboration was poorly judged in all conditions.

The results of this experiment – encompassing three types of musical activities by three subjects – indicated good support for creative and exploratory activities, with particular emphasis on two factors: enjoyment and expressiveness. However, the collaboration and explorability factors were not evaluated positively, and imitative activities did not yield high scores.

Recapitulating, anchoring serves as a mechanism for linking constraints of the external structure of the environment to constraints on cognitive operations. This view implies that both memory and processing loads can be reduced if the constraints of the activity can be built into the physical structure of the material resources. The problem faced by system designers is thus reduced to finding consistent relationships between the abstract concepts and the local resources available during the activity. In other words, appropriate metaphors for creative activity may handle material relational properties through direct couplings between material and conceptual operations. This hypothesis was tested through the implementation of two interaction metaphors: time tagging and spatial tagging. Time tagging used local sound cues to support creative decisions. Spatial tagging employed visual cues to enable exploratory creative actions. Both metaphors showed good support for creative musical activities but did not fare well when collaboration was involved.

6.4 Social Relational Properties: Distributed Creativity

Converging trends in creative practice research (Keller and Capasso 2006; Truax 2002), educational research (Loi and Dillon 2006), and music education (Burnard 2007) point to the local context as a key factor in shaping creative experiences. These approaches propose creativity as a research focus within socially informed paradigms, gathering support from ecological methodologies (Keller 2000; Loi and Dillon 2006) and activity theory research (Burnard 2007; Keller et al. 2010; Leont'ev

1978). Loi and Dillon (2006) propose adaptive educational environments that can be designed as creative spaces to foster interaction through situational and social dynamics. Technological infrastructure is a key resource in this type of educational environments. Burnard (2007) places creativity and technology as the two central forces enabling innovative educational practices. She cites the use of online and collaborative technology, proposing practice, participation, and collaborative networking as objectives of music education research. These situated, socially informed approaches provide a stark contrast to the standard educational views on musical creativity (see Keller et al. 2011b for a review). While standard models are concerned with activities that (in theory) can be carried out without the need for social interaction or place-specific experience, such as "problem solving" and abstract "thinking," situated approaches bring socially acquired musical experience to the forefront of the research agenda. Thus, they highlight two aspects that need to be considered in aesthetically informed approaches to design: the local resources for creative action and the mutual processes of adaptation that emerge through social interactions.

The dialogical conception challenges the view of creativity as a purely mental, individual process (Freire 1999; Lima et al. 2012). Through hands-on activity and social interaction among peers, students are stimulated to evaluate their work. Given the relevance of the local referents, participants are encouraged to reflect about their own processes and products during musical activities. While keeping tabs on the local reality, they develop a critical view on their products and creative processes. Through iterative cycles of exchanges, dialogical methods foster individual and collective reflections. In line with other socially oriented perspectives, the dialogical view is based on the premise that knowledge is constructed. This knowledge is considered the basis for reflective actions. Freire's educational philosophy encourages pupils to assume an active role in the educational process, reflecting and justifying their creative choices and independently seeking resources within a context of open proposals. This consensus-building process opens a space for coexistence of diverse and sometimes opposing views. Thus, Freire's proposal emphasizes exchanges without confrontations, providing a foundation for the emergence of communities.

Liikkanen et al. (2011) argue for the adoption of practice-based design methods focused on creativity. Their proposal is situated within the participatory design initiative, integrating users as co-designers (Ehn 1988). On a similar vein, Botero et al. (2010) propose the exploration of a continuum from use to creation involving strategies such as repurposing of existing technology for rapid prototyping. A central aspect of this emerging trend is the focus on creativity and sustainability allied to the adoption of participatory techniques. Two recent studies carried out by our group applied this design approach within the context of ubiquitous music practice (Lima et al. 2012).

Lima et al. (2012) developed and applied a set of design techniques – the ubimus planning and the ubimus design protocols – to assess relevant aspects of social and

procedural creativity dimensions that have been usually excluded from musical creativity field studies. Two workshops were conducted to assess both technological and domain-specific requirements for support of creative musical activities. The first workshop was conducted with music teachers and schoolteachers that had no formal musical training. The objective of this workshop was to assess domain-specific requirements for musical activities by educational staff. The second workshop focused on technological support for tool development by nonmusicians. This workshop yielded two software projects which involved user evaluations of creative musical processes. Participants in the user studies included both musicians and nonmusicians.

The ubimus planning protocol served to raise important questions regarding technological usage by musicians and naive subjects in educational contexts. Nontechnical approaches, such as those proposed by traditional soundscape activities (Schafer 1977), may not be suited for introducing nonmusicians to sonic composition. Naive subjects may respond better to technologically based approaches which emphasize aspects of the relationship between the personal experience and the environment. The ubimus design approach was effective to assess the usability of musical tools at early stages of development. Prototypes were implemented and usability studies were carried out by undergraduate information technology students within a 3-week time-slot. Sharp differences were observed in the type of requirements expressed by musicians and nonmusicians regarding creativity support tools. Despite these differences, both groups of subjects regarded the use of software prototypes within exploratory musical activities as being fun and expressive.

The ubimus planning and ubimus design protocols highlighted the existing limitations in the evaluation of creative activities in real-world settings. Although the protocols included careful consideration of the role of the participants within the design cycle, the data obtained did not provide enough information on the dynamics of the creative processes. Place and product creativity factors were considered both as individual and group manifestations of creative behavior. But the assessment of procedures was limited to the analysis of the participants' self reports. The study helped to identify a methodological gap in the development of procedural support for creativity, namely, the lack of time-based methods to study long-term creative musical practice.

This section explored the implications of adopting social relational properties within the context of aesthetically oriented ubiquitous music design. Experimental results indicated that nonmusicians responded better to technologically based support for creative activities when compared to musically trained subjects. A procedural limitation of the studies was the lack of time-based methods to deal with the assessment of local resource usage in creative activities. Support for distributed creativity poses at least two challenges: (1) the availability of local resources for creative action and (2) the emergence of consensus through shared social resources.

6.5   Relational Properties in Ubimus Design: Methodological Implications

Given the radical shift set forth by the interaction aesthetics and the ubiquitous music research programs, existing approaches to interaction design are being reformulated bringing new issues to the foreground. Relational properties – such as pliability (Löwgren 2009) and anchoring (Keller et al. 2010) – capture the tight agent-object interaction dynamic that has been at the center of the embedded-embodied approaches to cognition (Gibson 1979). In line with the enactive perspective (Di Paolo et al. 2010), these design qualities emerge as a result of mutual adaptations between agents and objects. Because they demand the active engagement of an agent, relational properties cannot be "attached" to objects. They can only be experienced "in the act." There are several methodological implications of adopting relational properties as theoretical constructs.

Firstly, design experiments must take into account both subjective and material constraints and opportunities. Experiments that adopt closed epistemic fields – where subjects are given a task to complete in laboratory settings and the results measure their efficiency in completing the task – do not provide information on the ecosystem's support for the emergence of relational properties. In this case, the material resources are chosen by the experimenter and may not fulfill the creative needs of the subject. This is an example of the problem that ubiquitous music research has labeled as the "auto-referentiality of the theoretical-experimental construct" (Keller et al. 2011b): the experimental situation does not take into account the conditions of real-world settings. Relational properties may be absent from a laboratory task but may be accessible when participants are interacting on site.

Second, the adoption of a tool at the initial stages of the design process may forgo the emergence of relational properties. Sometimes, the agent-object ecosystem's potentials to support relational properties are not enough to ensure creative outcomes. These potentials have to be materialized in products and behaviors. Given that behaviors are constrained by personal factors (including both cognitive and social resources), understanding the creative profiles of the subjects is an integral part of the design process. From a ubiquitous music perspective, this procedural limitation is defined as "early domain restriction" (Keller et al. 2011b).

Third, assessments purely based on products may not provide a complete picture of the creative factors at play. There is a rich literature of product evaluation methods in creativity studies (Baer and McKool 2009; Mumford et al. 2011). Creative products give reliable information on creative outcomes. This information can be enhanced by the analysis of domain-specific products. Nevertheless, despite its untapped potential, this retrospective approach has an epistemological limitation: products and procedures are usually not equivalent. Whether considering synchronous or asynchronous creative activities, if a relational property emerges as a by-product, it may not be discernible through the analysis of the finished product but it may be observable while the product is being made or used. Asynchronous creative activities furnish procedural data that needs to be collected during the creative

activity (Coughlan and Johnson 2006). This data is not easily recoverable from the finished products. Contrastingly, synchronous creative proposals (such as improvisatory musical practices) fuse products and processes into a unified entity. In this case, the assessment of the product imposes the same requirements as the assessment of the creative performance: time-based methods.

Furthermore, while creative products are not enough to enhance the knowledge of aesthetically aware designs, creative processes may be insufficient to assess the level of support for creative behavior. Creative potentials are externalized as creative actions, which may yield creative by-products (Runco 2007). The creative magnitude of these by-products can only be assessed in relation to a specific social context (or social niche – Keller 2012). This context is shaped by the life histories of the participants of the creative experiences. Therefore, evaluations of technological support for creative behavior demand: (1) assessments of by-products, (2) observations of situated behaviors, and (3) analysis of the profiles of the participants. As Mumford et al. (2011) suggest, creativity evaluation methods are necessarily multidimensional. Ubiquitous music research is no exception.

This section discussed the adoption of relational properties in ubiquitous music experimental research, highlighting the methodological implications of creativity-aware interaction aesthetics. The requirements for multidimensional assessment encompass the evaluation of by-products, the observation of situated behaviors and the analysis of the personal factors.

6.6   Conclusions and Future Work

Generally speaking, since the late 1990s, musical practices have incorporated resources that were absent from purely instrumental music performance and from studio-centered creative practice. Ubiquitous music making has expanded this trend by embracing personal experiences that lead to creative musical phenomena that were excluded from professional musical practices. Creative music making has incorporated the creative experience as a target of compositional practice. Furthermore, music making through technological means has become the rule, rather than the exception.

We believe that considering the conceptual framing provided by relational properties is useful to help researchers and practitioners find common ground concerning the understanding of everyday creative activities and foster the emergence of design solutions for supportive digital artifacts. The time- and spatial-tagging metaphors can, in fact, be applied to other domains than the creation of sonic products. For example, tools to support digital storytelling are, in some cases, already using time- and spatial-tagging metaphors to facilitate the organization of collected content and enable the emergence of contextualized narratives based on people in situ experiences (see, e.g., Nordmark and Milrad 2012).

To overcome the limitations of previous methodological approaches, three strategies were identified: (1) usage of real-world resources and conditions, (2) furnishing

potential material resources that match the profiles of the participants, and (3) adopting time-based multidimensional evaluation methods targeting by-products' profiles, situated behaviors, and subjective evaluations. Given the complementary goals of interaction aesthetics and ubiquitous music research and the methodological implications of adopting relational properties as experimental variables, what are the consequences of the application of the ubimus agenda in interaction aesthetics? Would ubimus concepts provide a sharper focus to aesthetically aware design? We believe that the methodologies presented in this chapter point to an affirmative response to these questions.

In the previous section, we mentioned three important aspects connected to the third strategy just mentioned above: (1) acknowledging the significance of by-products of the overall creative process instead of just focusing on end products, (2) considering strategies that enable the observation of situated creative behaviors, and (3) taking into serious consideration an analysis of participants' profiles. Let us try to reflect further on these and foresee possible implications for the creative technologies community and society in general.

In relation to the first aspect, the immediate question is: what are by-products good for? Recent developments of digital tools are widening the ability of people to create their own digital art forms, disseminate them, and store them. We believe that by-products cannot only be a useful learning resource allowing creators to go back, check, and reflect upon past learning trajectories and creative processes, but they can also provide a repository of past collaborative experiences, probably strengthening the group members' feelings of shared and common ground. Furthermore, such repositories of by-products can become invaluable resources for music historians in their quest to understand the creative product and process.

The second aspect emphasizes the need to understand people's in situ dealings with creative tools. The observation of situated behaviors, from a research point of view, seems crucial if we want to design better tools to support people's opportunistic adoptions and use of digital tools. Furthermore, we also envision the possibility of providing appropriate scaffolding to the creative processes themselves, and such scaffolding needs to be grounded in authentic and meaningful situations; otherwise, people might miss the relevance of the scaffolding cues and suggestions.

The third aspect emphasizes the potential of facilitating people's choices of digital tools based on their own strengths, weaknesses, likes, and dislikes. This is a major issue for at least two reasons. Firstly, it provides opportunities for creative action to a potential community of users that has been excluded by the expert-oriented approaches. Second, it empowers nonspecialists to shape design decisions by tinkering with digital tools, yielding precious information on the relationships among design choices, local resources, and personal profiles.

Concluding, we also hope that these aspects can function as triggers to the widening of informed discussions about the nature of the creative act, its function in society, and its associated costs.

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