

Activity Theory for Design

From Checklist to Interview

Matthew Duignan, James Noble¹, and Robert Biddle²

1 School of Mathematics and Computing Sciences
Victoria University of Wellington, New Zealand
Matthew.Duignan@mcs.vuw.ac.nz

2 Human Oriented Technology Laboratory
Carleton University, Ottawa, Canada
Robert_Biddle@carleton.ca

Abstract. Cultural historical activity theory has shown much promise as a framework for Human Computer Interaction, particularly for analysing complex activity and its context. However, it provides little practical methodological support for user interface designers. This paper presents an activity interview resource which can be used by interface designers when developing new tools to support creative activity. The new activity interview is based on the excellent foundation of the activity checklist, but resolves a number of its deficiencies. In particular it provides concrete questions to fuel an activity theory analysis, rather than the more abstract and less accessible checklist. We describe how we have dealt with these problems, and reflect on our experience applying the activity interview in the domain of computer mediated music production.

2 Introduction

Supporting creative computer-based activity presents many challenges to interface designers. Its open-ended nature requires non-prescriptive and flexible designs that still meet the needs of creative professionals. Understanding these needs requires a thorough and holistic analysis of their activities. We have been conducting research of one such activity: computer meditated music production. Our aim is to challenge existing user interface metaphors, and design new and compelling alternatives. In our work we found a need for a framework and methodology for analysing this activity, and turned to cultural historical activity theory [16, 10, 19].

Activity theory has been gathering recognition as a useful analytical framework for understanding human activity. However, it provides little of the crucial methodological support required for practical use in design. One resource that has worked towards meeting this need is the activity checklist [13]. We found that while an invaluable resource, the activity checklist has some significant shortcomings.

In this paper we present a practical research tool we have developed for use in the design process. It provides a series of interview questions designed to lead

Please use the following format when citing this chapter:

Duignan, M., Noble, J., Biddle, R., 2006, in IFIP International Federation for Information Processing, Volume 221, *Human Work Interaction Design: Designing for Human Work*, ed. T. Clemmensen, Campos, P., Omgreen, R., Petjersen, Al., and Wong, W., (Boston: Springer), pp. 1–25.

directly to an activity theory analysis. This tool is based on the activity checklist, but attempts to address some of its limitations. In particular it provides concrete questions to fuel an activity theory analysis, rather than the more abstract and less accessible checklist.

Firstly we show the motivation for such a tool. Next we provide a brief primer on activity theory and its use in Human Computer Interaction (HCI). We introduce the activity checklist and present our critique of its limitations and then present our activity interview resource. Finally we reflect on our use of this new resource in the domain of computer mediated music production.

3 Motivation

Computer mediated music production is just one of a class of open-ended creative activities supported by computer software. Many of these activities can be found in the various forms of multimedia development. Two and three dimensional modelling and animation, graphic design, interactive art, computer game modelling, and some forms of industrial design have many important features in common.

These activities are typified by several characteristics. Subjects' actions in these activities are non-prescriptive and they do not follow a predefined or predictable ordering. Different actions are carried out as and when needed and in response to the emerging requirements of work. Moreover, these activities are highly open-ended. While subjects may have some general idea of what they wish to achieve, the specifics of the result will depend entirely on the unfolding and unpredictable nature of their creative process.

We have been working on a detailed analysis of the activity of computer mediated music production. Here we use the term production to include the entire process of composing, recording, editing, arranging, and mixing of musical content. We also include the process of preparing material for use in a live context. Our analysis is informed both by the activity interview which we present here, cognitive dimensions analysis through interviews [6], and observations. The resulting analysis has provided us with many useful insights into this activity and is informing our design of a novel user interface which breaks some of the music production metaphors that currently dominate music interface design. We will continue by producing prototypes and design sketches. Figure 1 shows the Arranger and Session views of the Ableton Live [1] music production software (above) and one of our very early prototypes (below). Ableton Live (and most other audio and midi sequencers) embodies strong multi-track and mixer metaphors. We are working towards a sequencer which allows for custom abstractions which retain the conceptual clarity of multi-track and mixer models, but allows more flexibility of structural expression.

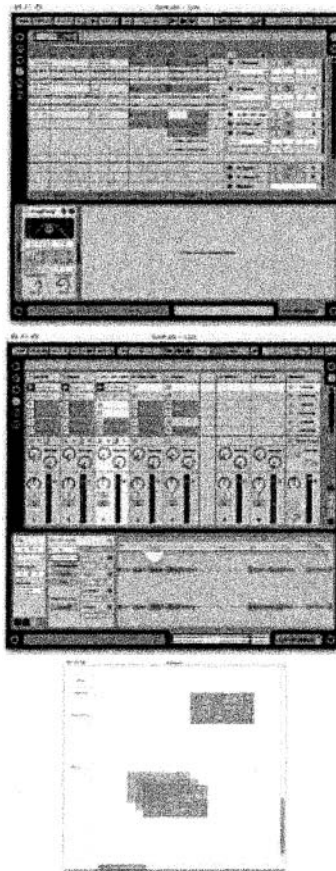


Fig. 1. Ableton Live's Arranger and Session views (above) and one of our early prototypes (below).

In music making and other similar activities contextual concerns can have large consequences for how software is used. There is typically a large degree of collaboration between the various subjects who take part in music production. These subjects include producers, composers, instrumentalists, and engineers. They often need to share the results of their work, both in real-time, and after the fact. Due to the aforementioned open-ended nature of this activity, it is impossible to prescriptively describe the ways in which any given tool will be used in collaboration.

Different subjects will have different skill specialisations, and hence use different tools which may provide obstacles to their integration. Even single subjects often use a complex and heterogeneous tool set. Any difficulties in getting these tools to work well together in a manner that complements the activity can be a major impediment to creativity and efficiency.

The study of HCI has led to the development of methodologies for analysing many types of task. However techniques such as task analysis and decomposition fall short when applied to these more rich and dynamic domains. Traditional methods typically fail to account for “the tacit knowledge that is required in many skilled activities, or the fluent action in the actual work process” [2] which need to be taken into consideration when analysing open-ended and exploratory activities. These methods can also fail to describe the rich context of activities such as music production, which must be taken into account when looking at tool design.

One analytical framework that has been claimed to have strengths in describing context and creative action is cultural historical activity theory [16].

4 Background on Activity Theory

Activity theory stems from the Russian branch of Psychology, based principally on the work of Vygotsky which emerged in the 1920s [19]. The resulting family of theory focuses on the context of human activity, and explains human consciousness in these terms. The theory uses the notion of an “Activity” as its central unit of analysis. Activity is a high level of analysis which includes the meaningful context of individual actions in a group context, rather than just the actions themselves. It can be difficult to clearly define activity theory due to the large quantity of competing and complementary theory that has developed under its banner over the years.

Nardi argues that activity theory has much to offer the process of user-interface design as it:

“... offers substantial tools for a broadly scoped study of ‘computer-mediated activity’... it weaves together, in a single coherent framework, so many interesting theoretical constructs crucial to an understanding of human activity: dynamic levels of activity, mediation, contradiction, intentionality, development, history, collaboration, functional organ, the unity of internal and external.” [16](p.375)

Activity theory encompasses and integrates a number of different areas of analysis for any given activity, including structure, context and development.

The structure of the activity is decomposed into its sub-components, and analysed in terms of human motivations. This decomposition includes the full range from understanding the broad activity and its motives, individual conscious actions and goals, down to people’s sub-conscious operations and the conditions that trigger them [14].

In activity theory, subjects’ consciousness is explained through their internalisation of abilities such as mental addition, mental simulation, touch typing, and language. Humans also extend and share their consciousness through externalisation. This includes note taking and the use of symbolic and abstract tools.

The context of an activity is analysed in terms of various influencing forces in the environment in which the activity takes place. Activity theory places a special emphasis here on how tools mediate action between any number of subjects and an object. The contextual analysis also examines the impact of the surrounding community, explicit and implicit rules, and the division of labour.

These various aspects of the theory provide a broad and flexible framework and terminology for describing human activities and the factors that influence them.

5 Activity Theory in HCI

Much of the comparatively recent research in activity theory has focused on activity systems in complex work environments [10]. This led firstly to a natural growth in its application to computer-supported collaborative work (CSCW), and later to further use in the more general field of HCI. In 1991 Bødker introduced activity theory to HCI explicitly in *Through the Interface* [7].

Activity theory seems to be a natural fit in the HCI domain due to its basis in the central concept of the mediating role of tools in human work. Activity theory provides a comprehensive framework for many of the concerns of HCI practitioners and researchers:

- The understanding of activity structure as a hierarchic set of “activity, actions, and operations” provides additional conceptual insight to conventional HCI techniques such as hierarchical task decomposition.
- Activity theory's model of the social environment provides a framework for the HCI concern of ensuring an interface takes into account contextual issues.
- The study of historical development in activities can provide HCI experts with a model for understanding how computer tools have changed activities in the past, and how changes they make may impact the future activity.
- Activity theory highlights the inherent contradictions in activities, which must be taken into account in interface designs which support these activities.
- User interfaces need to facilitate the natural human processes of internalisation of activity, and externalisation for extension of consciousness. Activity theory provides a theoretical framework to account for these processes.
- Finally, Activity theory exposes the importance of the transition between conscious and subconscious cognition, which is of great importance for learning and mastery of user interfaces.

Most importantly, activity theory provides a body of thought and unified framework for these concerns that might have previously fallen under the term “task analysis”. Activity theory can provide this framework in concert with traditional methods such as user centred design [17]. This allows the HCI specialist to develop a thorough and broad understanding of an activity, and a consistent model to describe it.

However, activity theory's long history, wide-ranging complex and rich approach, and theoretical focus has not lent itself to easy application in the HCI field. Activity theory provides no step-by-step methodology.

Some HCI practitioners have taken a general activity theoretic approach to HCI analysis by firstly immersing themselves in the varied activity theory literature, and then using other techniques to learn about a specific domain where they wish to develop a new user-interface. Activity theory is then used as a framework for explaining and making sense of their findings [16]. This sort of model can then be used as the basis for further, more systematic analysis. For example, Turner and Turner [18] carefully uncovered activity theory “contradictions” in a domain to drive requirements gathering.

While these general activity theoretic approaches have their place, mastering the entire framework is an onerous task which has likely held back its application more universally. With no clear methodological guide it is difficult for HCI practitioners to take advantage of the framework's potential.

Nardi et al. [13], some of the chief theorists behind activity theory's application to HCI, admitted that:

“These general principles [of activity theory] help orient thought and research, but they are somewhat abstract when it comes to the actual business of working on a design or performing an evaluation.”

To this end they developed the “activity checklist” which we describe in the next section.

6 The Activity Checklist

6.1 Background

The activity checklist was presented in 1999 in a paper [13] published in the HCI journal *Interactions*. Its goal was to provide a more accessible formulation of key concepts in activity theory for application to software design and evaluation. The paper was authored by Kaptelinin and Nardi, two of the leading proponents of activity theory's application to HCI, and Macaulay who was acting as a practitioner.

The paper itself contains a testimonial by Macaulay, who explains in general terms why the checklist proved useful. But in the years since its widespread dissemination it has seen only limited use. Moreover, when the checklist has been used, it has been applied in various ways. Turner and Turner [18] used the checklist as the basis for semi-structured interviews, but gave no details of how exactly they derived their questions. Cluts [9] did the same, although used it to inform observation. Fjeld et al. [11] used the “sample questions” provided in the checklist paper to fuel their analysis. In contrast to Turner and Turner, they answered the questions themselves rather than using them in interviews. They did not comment on how limiting their research to the example “sample questions” might have affected their research. Irestig et al. [12] used the checklist as a framework for discussing case studies of prototypes from usage centred and participatory design methodologies. They argued that the

checklist might have biased their discussions away from issues surrounding the management of “signs and symbols”, which they felt to be of great significance and not adequately addressed in the checklist.

6.2 Overview

The checklist consists of a number of points to consider when analysing an activity. There are two versions of the checklist which contain small variations tailored for use in either evaluation or design. The checklists contain a large number of points, 37 and 43 items respectively. Examples of an evaluation and a design checklist item are as follows:

Eval 3.5: Use of target technology for simulating target actions before their actual implementation

Design 3.3: Possibilities for simulating target actions before their actual implementation

The checklist was designed to provide a concrete version of the conceptual system at work in activity theory. This was specifically aimed at making activity theory “more useful” for evaluation and design of interfaces. At the same time they suggest “the Checklist orients without prescribing”, which could reduce its usefulness in research contexts where a more prescriptive resource is desirable.

The checklist is divided into the four categories of *Means/ends*, *Environment*, *Learning/cognition/articulation*, and *development*, each of which are important higher-level concepts in activity theory.

The paper also includes a number of sample questions divided into the same categories, although not specifically tailored to evaluation or design. These questions are presumably derived from the checklist, and provide examples of analysis working above the level of individual checklist items.

The checklist paper contains a testimonial from Macaulay who used the checklist as an integral tool in her research, and the following quote illustrates one of the ways in which it can be used:

“It gave me a quick way of relating experiences in the field to AT concepts. It helped me think about the kinds of data I wanted to gather, and the kinds of questions I wanted to ask.” [13]

7 Checklist Critique

While Kaptelinin and Nardi claim that the checklist makes activity theory accessible, the reality may be quite different. Our colleague Brown [8][p.50] points to the disappointing state of the checklist's adoption, and suggests the following explanation for this:

“For all items, the language used is taken from cultural-historical psychology, hence the checklist is of little use to those without a basic knowledge of the activity theory framework, and this may be a reason for its limited adoption.”

However, the difficulties with the checklist go deeper than this. The following critique is based on our experience of using the checklist in a detailed study of electronic music producers and their tool use. We used the checklist as the basis for carefully developing a series of coherent interview questions. These questions were then used in interviews of five professional music producers. The interviews were semistructured, covering the questions in order, but following conversation threads as they arose naturally. Each interview lasted between one and four hours. In some cases these were then complemented with interviews using the cognitive dimensions framework [5,4], open ended discussion, and observations.

In an effort to examine the learnability of the checklist the lead author sat in on a post-graduate seminar discussing papers on activity theory and the activity checklist. The students experience with activity theory ranged from many years through to no prior exposure. For several students activity theory was a central component of their masters thesis research. Discussing the student's perceptions of the checklist in this context provided a useful touchstone to compare with our experience of understanding and using the checklist in our own research. The comments from this seminar are also reflected in the analysis below.

In the sections below we identify and explain issues which principally apply to HCI practitioners attempting to use the checklist as a gateway into activity theory, and who have limited previous exposure to activity theory concepts. We should emphasise that our aim here in identifying these issues is to work towards remedying specific weaknesses in the otherwise excellent approach and foundation we find in the activity checklist.

7.1 Operationalisation

The first issue with the checklist is that the items are not presented in an operationalised form. The checklist items are worded in a way which does not immediately lead the mind to apply the checklist item. The following item is typical wording from the checklist:

Eval 3.4: Self-monitoring and reflection through externalization

This phrase in itself does not directly pose a question, or impel the researcher to do anything. In order to apply this item, the practitioner must first comprehend the sentence, and convert it into a meaningful question or instruction. While it may not be difficult to do this for any single checklist item, having to interpret a list of more than forty such phrases suggests barriers to the comprehension and accessibility of the checklist. There are two problems this presents. HCI practitioners first encountering the checklist and activity theory may find it hard to understand how the many checklist items would actually be applied. Also, because the checklist is intended to be used as a quick reference guide in the field, for example during a semi-structured interview, obstacles to comprehension could

make fluid discussion difficult. In an interview or other domain setting, HCI practitioners need the content of a checklist to be rapidly accessible so that they can quickly determine the relevance of various items to the current context.

7.2 Different application of points

Many of the checklist items directly address elements of the activity being examined, while others speak to a higher-level of analysis. The following item presumably calls the practitioner to look at issues around how goal conflicts are or could be resolved in the activity in question:

Eval 1.8: Resolution of conflicts between various goals

In contrast, other items seem to call for the practitioner to perform higher-level analysis of their findings, such as the following item:

Eval 1.9: Integration of individual target actions and other actions into higher-level actions

The potential differences in how these items can be applied may also add to difficulties in quickly understanding and applying the checklist.

7.3 Jargon

Another problem with the checklist is that while it attempts to make the ideas of activity theory “concrete”, it uses activity theory jargon which negates this. In particular, the checklist uses specialised meanings of the terms *action* and *operation*, and *internalisation* and *externalisation*. The checklist preamble uses these terms but does not define them clearly.

The concepts and terminology are clearly explained in the accompanying article, but this does not provide an easy or quick reference to a practitioner learning with the checklist in the field. As an example, the following checklist item requires the practitioner to recall activity theory's technical definition of internalisation:

Design 3.1: Components of target actions that are to be internalized

7.4 Number of items

Depending on the version used, the checklist has between 37 and 43 items. In order to make the checklist easier to apply and internalise, it would be desirable to minimise the number of checklist items where any redundancy is present. A number of the items in the checklist closely relate to each other and could be explained as different specialisations of a single activity theory concept. For example, activity theory conceptualises actions and goals as being analysable in terms of sub- and higher-level paired goals and actions. The checklist includes three

items that essentially prompt the practitioner to analyse this dual hierarchy. These items are distributed among other less related checklist items:

Design 1.2: Goals and subgoals of the target actions (target goals)

Design 1.4: Decomposition of target goals into subgoals

Design 1.9: Integration of individual target actions and other actions into higher-level actions

If these types of closely related items could be captured in a single item this might make the checklist smaller, more meaningful and easier to internalise.

7.5 Design vs. evaluation

Kaptelinin and Nardi's approach divides the possible usage of the checklist into two camps, evaluation or design. Providing two versions of the checklist creates a false dichotomy, making it unwieldy for use in the in-between cases. For example, HCI practitioners hoping to use the checklist to understand current tool use with the explicit goal of creating a new and *as yet undefined tool* may find they want to use elements from both checklist versions. However, it is far from obvious at first glance how and where the different checklists vary without detailed examination.

Other methods such as *contextual design* include the evaluation of current systems and work in the design of new systems:

“Use contextual interviews to see *how people use the current system* or prototype, with a focus on how the system gets in their way or interferes with their work.” [3] (Emphasis added)

The information collected from these sorts of *evaluation* interviews feeds directly into the design processes.

7.6 Readiness for application

Another potential concern with the checklist is that even though it is supposed to provide a concrete activity theory resource, there is some conceptual work needed before it can be practically applied. In particular, one suggested way to use the checklist is as a source of issues to cover in an interview. Unfortunately, the difficulties we have already discussed above are an obstacle to this.

As a first step to using the checklist in this way, HCI practitioners need to rework the checklist into a number of coherent questions presented in language that subjects in the domain of study will easily understand. Developing such a resource from the checklist requires an expertise and understanding of activity theory that many HCI practitioners may not have. This creates an unnecessary barrier to the checklist's adoption.

Activity theory argues that learning happens through the process of *internalisation* embedded in a real life activity system. Kaptelinin and Nardi

suggest that ideally this process will be at work in the use of the checklist itself, where the HCI “practitioners should familiarize themselves with the Checklist and even try to internalize it”. Not only will the HCI practitioners be internalising the checklist itself, more importantly they will be internalising the central activity theory concepts. This process is most likely to become “concrete” in the application of the theory to the real world domain that the practitioner is investigating, often through the use of interview and observation.

Instead of having to develop a series of interview questions based on a theory they have not fully internalised, HCI practitioners could make good use of a series of checklist based interview questions using everyday language. In applying these questions in their domain of investigation, a more concrete understanding of activity theory could be more easily internalised. This concrete understanding of the theory embedded in their own domain of interest would complement their readings on activity theory. In this way, HCI practitioners would begin to understand the meaning of the checklist through the nature of their subjects' responses, and their analysis would unfold naturally. In the next section we introduce a series of interview questions which we have designed to fulfil this purpose.

8 The Activity Interview

We have found there to be a clear need for a reference set of activity theory interview questions. This need is shown both by the checklist authors' comments, and by the difficulties raised above. This section introduces a new set of interview questions that we developed in order to meet this need.

Section 6.1 introduced some of the different attempts to apply the checklist in the analysis of activities. One approach seen in some of this prior work is the questioning of subjects directly to obtain their personal activity theory analysis of their activities. The traditional empirical observation model would cast the observer as the impartial and analytical expert, using their theoretical knowledge to dissect the situation. Modern understanding of qualitative methods has since moved the emphasis to the subjective nature of such analysis. This has typically resulted in two approaches. Either researchers emphasise the importance of their own analytical bias in their research, or they attempt to provide minimally mediated accounts of subjects' own understanding.

There are advantages and disadvantages in applying the extreme form of either subjective approach. On the one hand, relying on the external analysis of only the researcher neglects the deep insight that subjects' have about their own activities and behaviour. However, it does allow the researcher to choose an analytical “lens”, or framework, appropriate to their goals. On the other hand, uncovering subjects' understanding of their own activities can expose important facts about how their own conceptions are organised. Unfortunately this can lead to accounts that may be of little pragmatic use given that they can overemphasise the concerns of the subject rather than what the observer may be trying to address.

In using a set of interview questions which implicitly contain the conceptual framework of activity theory we can gain some of the advantages of both approaches. A similar method can be seen in the cognitive dimensions questionnaire [6,4], a technique for evaluating notational systems which depends on the critical insight of a tool's expert users. Presenting subjects directly with the concepts of analysis allows them to express their own deep understanding of their activity, but with the language and focus that will be useful for the practitioner. This technique places a value on the ability and insight of the subject which is in line with the philosophy embedded in activity theory. Activity theory takes the position that humans are highly capable of extending and developing themselves through their use of analytic or physical tools. However, we will also see how the role of the practitioner's external analysis has a place in this, and how it meets the implicit intention in the design of the checklist.

In the sections below we outline how we developed the activity interview and give some examples of the questions derived from the checklist.

8.1 Design goals

A number of requirements for the interview resource can be identified by explicitly addressing the weak points of the checklist that we identified in the critique in section 7.

Of course the principle demand for interview questions is that they do not contain jargon. Interview questions will be of very limited use if they contain unusual terms, or words with special technical meanings. Wherever a word with a special technical definition is used, it is important that the context provided by the question makes such usage clear.

By removing activity theory jargon from the interview the practitioner may lose sight of the relation of specific questions to the theory's concepts. The interview resource should contain non-verbalised references to activity theory concepts and terminology at appropriate points on the interview sheet. This will provide both a means for HCI practitioners to internalise these concepts in the context of their domain, as well as helping them relate the subjects' responses back to activity theory proper.

In order to gain the leverage of the checklist, we need to ensure our questions provide full coverage over all of the checklist items. If the benefit of the checklist is to give HCI practitioners quick access to the important activity theory concepts, these all need to be included in some manner in the interview.

Full coverage of the checklist could lead to excessively long interviews. For this reason it makes sense to attempt to minimise the number of questions through amalgamation where appropriate. Many of the checklist items relate very closely together, and can be seen as different aspects of the same concern. Addressing these in a unified manner in a single question should lead to more coherent, and more informative responses from subjects.

Finally, ideally the interview questions should be able to be used in a wide range of contexts. The evaluation and design dichotomy present in the checklist can

prove to be a barrier where the practitioner is interested in investigating the role of current tools for the design of a new, as yet undefined tool.

8.2 Method

The general method for creating the interview questions consisted of a number of steps. Firstly it was necessary to systematically merge the evaluation and design versions of the checklist. It is non-trivial to identify the differences between the two versions by simply reading them. Often Kaptelinin and Nardi have placed the identical item in both checklists. In some cases the item is reworded specifically for evaluation or design. Some additional items are only included in one of the two versions.

In order to reduce the number of checklist items and increase the coherence of interview questions it was necessary to find items which were near duplicates, overlaps or closely related to each other.

The next step was to reword the resulting items in everyday language that carried with it important activity theory concepts. The resulting set of questions were then checked for coverage over the original checklist items and that they were ready to be used in interviews.

Finally, we used the checklist in our own research of computer music production, and used the experience to refine the interview questions for future use.

8.3 The questions

In this section we introduce a number of the questions we have developed for the activity interview, and explain their origins in the activity checklist. While the full set of activity interview questions are not included here, this discussion serves to demonstrate the way in which they were developed. The complete activity interview resource can be found at the end of this paper.

We applied the method detailed in the sections above to the two versions of the checklist, but excluded the reflexive items that looked at the design activity itself. The “evaluation” version contains 37 items, and the “use” component of the design version contains 34. After carefully amalgamating items which were slight rewordings from the different versions of the checklist we were left with 41 unique items. Our work outlined here resulted in 32 unique interview questions. Below we discuss some of the more interesting cases.

Several groups of original checklist items were combined for the final question list. Activity theory's highly related notions of the Activity, Action, Operation; and Motive, Goal, Condition hierarchies are addressed by several items. The following items all call on the practitioner to determine the elements of this dual hierarchy in their domain:

Design 1.2: Goals and subgoals of the target actions (target goals)

Design 1.4: Decomposition of target goals into subgoals

Design 1.9: Integration of individual target actions and other actions into higher-level actions

The distinction being made between the first and second item is far from clear. Additionally, since goals and actions are so closely related it does not seem ideal for them to be addressed in separate interview questions as seen in the third item. Instead, we can ask subjects to reflect on how they achieve their tasks, and how these actions relate to their goals. This allows the third item to be integrated with the other two into the following compound question:

Interview 1.2: *What are your ultimate goals in your role, and how do you achieve them? What are your goals along the way?*

By presenting several closely related checklist items as a single compound question, we can expect the subject to reflect on the important relationships between their goals and sub-goals, and the actions that they use to achieve them. Addressing these issues as separate questions could lead to a fragmented and incomplete response.

Another example of this type of amalgamation is our approach to several checklist items that deal with externalisation:

Eval 3.8: Coordination of individual and group activities through externalization

Eval 3.9: Use of shared representation to support collaborative work

Eval 3.10: Individual contributions to shared resources of group or organisation

Each of these items overlaps the others, but it not immediately obvious exactly how. The first item deals with both individual and group activity, which means all activity. It emphasises coordination through externalisation. The second item refers to shared representation, which is a form of externalisation, and focuses on just group activity. The first item's issue of coordination through externalisation is simply a special case of the second item – a shared representation to support collaborative work. The third item deals with contribution to shared resources, which are another product of externalisation. As all contributions to groups can be traced back to individuals, it can instead be described as a case of group activity. All of these items can be essentially captured by an umbrella question uncovering what is externalised, and how externalisations are used – including including use for coordination. After removing the jargon, we can express this to subjects in the following question:

Interview 3.4: *How do you use representations of your work – documents, notes, software, and talking etc. – to collaborate and coordinate with others?*

To use the checklist as a unified tool to support evaluation for prospective design, it was necessary to discover the variations in wording between the evaluation and design versions of the checklist. Often the differences in wording do not make a significant change to the item, and simply create potential confusion for HCI practitioners wanting to utilise elements of evaluation and design. For

example, the following two items are based on the same underlying activity theory concept:

Eval 3.3: Time and effort necessary to master new operations

Design 3.2: Time and effort necessary to learn how to use existing technology

Both of these items are attempts to determine how subjects learn to use tools in a specific activity. The same items can both be addressed in an interview context with the following question:

Interview 3.2: *How hard did you find it to master your tools, and what should have been easier?*

There are several checklist items that include activity theory jargon which would not be understood by interview subjects. One such example that was discussed above is the use of the term “externalisation”. Another example is contained in the following item which uses the technical terms “actions” and “operations”:

Eval 1.13: Support of mutual transformations between actions and operations

Again, it is non-trivial to reword this item as an interview question that can be easily understood. HCI practitioners who are learning activity theory may not be ideally placed to try and frame this in the clearest terms for their subjects. We could address this by asking:

Interview 3.6: *How do your tools support the transition between subconscious and conscious use?*

The above interview questions are just a selection of our full set of 32 questions found at the end of this paper. It should be taken into account that these questions are still a work in progress, although they did prove useful to us in our own research. In the next section we will turn our attention to this experience and comment on how well the interview questions worked in action.

9 Activity Interview in Action

In this section we briefly look at how we used the activity interview in our own design process, and then reflect on the success of the interview itself. We used the new activity interview as one of several techniques in our study of computer mediated music production. The other methods included interviews with the cognitive dimensions questionnaire, open discussion, and observations. The activity theory interview component was conducted with five subjects, including professional music producers and a physical music interface designer. Each of these interviews took between one and four hours, depending on the depth of the subject's answers and the time they had available.

In general, this new activity interview tool worked well. Subjects gave meaningful and often insightful answers that related directly to corresponding

activity theory concepts. This helped minimise two forms of researcher bias. Firstly, the questions are based on activity theory without being tailored by the researcher to the specific domain being studied. This means there is more leeway for the participants to draw unforeseen connections between their domain and activity theory concepts. Therefore the researchers expectations do not unduly limit the results. Secondly, basing analysis solely on observation and resulting questions would be inherently limited. Producing a completed piece of music will typically stretch from weeks to years, a time scale that makes detailed observation of the entire process impractical. Obviously, the subjects themselves are the only people with knowledge of their entire activity, and how it unfolds over these macro-timescales. This form of bias stems from the researchers limited exposure to the entirety of the activity, and can only be offset by incorporating the subject's own reflection. With the addition of observation and the researcher's analysis we can hope to get closer to a full picture of the activity.

9.1 Process and results

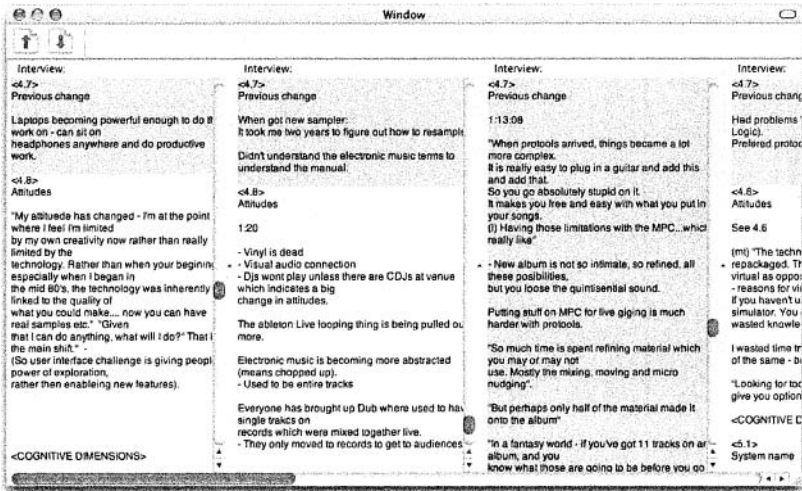


Fig. 2. A software tool we developed to help with analysing activity interview responses.

Practitioners should not expect any trivial one-to-one mapping between an activity theoretic analysis, and their system design. However, such an analysis is a crucial foundation for successful design. In our design process we found that our activity interview helped us ensure that we had covered all of the major issues in understanding the activity system with each interview subject. In order to work through the interview material, we made detailed notes from our audio recordings, and marked them up with simple text tags to organise them by question number.

We then used a software tool we developed to display and highlight all of our interview participants' responses for a given question. When we have a design question addressed by a specific area of activity theory, we can instantly view the responses from the relevant interview question. This tool can be seen in action in figure 2.

The information that we uncovered from these interviews was invaluable and of course is having a direct impact on many aspects of our still unfolding design concepts and prototypes. For example, by highlighting the *activity* as the unit of analysis, rather than just lower-level tasks, the interviews brought out the false dichotomy created in many tools between the studio and live performance. Producers' compositions are typically being crafted for dual use – both for distribution on audio media such as CDs, but also for performance in a live context. Additionally, producers often expressed that their work was never truly completed, and that album, single, and re-mix versions of songs were common. Therefore a design goal of our system has become to allow producers to manage multiple variations of a composition, and allow modifications of one to naturally be reflected in the others where appropriate.

The activity interview also brings out issues of collaboration. For example, we found that often more than one person would want to interact with the computer representation of the composition. This raises interesting design possibilities of having multiple people working on different aspects of a shared composition simultaneously. With collaborators often at times working on developing a composition apart, it is also important to facilitate merging diverging versions.

The activity interview has had far too many additional impacts on our unfolding design to describe here, but the above examples are indicative of their character.

9.2 Higher-level questions

In addition to the checklist items, the checklist paper also provides 23 “sample questions”. The sample questions demonstrate the type of questions that the HCI practitioner could ask about an activity. An example of one of the provided questions is:

Sample 3.4: Does the system provide representations of user's activities that can help in goal setting and self-evaluation?

This question combines checklist items concerning externalisation *and* goals. The sample questions were compelling enough for both Macaulay [13] and Fjeld et al. [11] to use explicitly in their research. Macaulay described them as being “particularly useful.”. However, these are sample questions that are representative of the *type* of questions that should be asked, but far from a complete resource of the questions that should be considered. By using the sample questions as a primary resource there is a very real danger of failing to consider other important questions not included in the samples. The underlying problem here is that the checklist paper provides no guide on how to derive similar

questions. In fact the main body of the checklist paper does not mention them at all.

On closer examination, rather than being merely the checklist items reworded as questions, the sample questions work at a higher level – each synthesising several orthogonal checklist items. The real value of the sample questions lies both in their operational nature (as opposed to the abstract checklist items), and in how they make links between activity theory concerns. The unfortunate consequence of this is that attempting to create an exhaustive list of these higher-level questions would result in a combinatorial explosion which would be far from practical.

Our newly developed activity interview addresses this through use in a semistructured interview context. This takes advantage of the natural ability of people to make linkages between comments over the duration of a conversation. As these linkages naturally occur to the interviewer or subject it is important to follow these connections with followup questions. Such spontaneous questions from the interviewer, and insights from the subject are a natural way to discover relevant replacements for the sample questions.

One of the strengths of our newly developed activity interview is that it provides the vehicle for maximising the number of such connections that will be made. By raising all of the salient checklist items in discussion with subjects, these higher level questions naturally arise. Without such a set of interview questions there is a real danger that the researcher will be limited to only the provided sample questions.

9.3 Hierarchical goal analysis

Our initial activity interview included a question asking about goals and subgoals in the activity.

Interview 1.2: What are the goals, subgoals and super goals you are trying to achieve in your role?

One problem with this question was that it proved to be difficult to get a simple hierarchical account of actions and goals in music production. On reflection it became obvious that this is because there is no simple hierarchical description of music production. As introduced in section 3, this activity is open-ended and non-prescriptive, and as such the actual configuration of actions and goals varies between one musical piece and another, and between each subject depending on their patterns of collaboration, tools, and work habits.

Subjects had some difficulty in knowing how to answer this question. Subjects tended to answer in terms of a “for example” account of the actions they might go through in producing a track. They made it very clear that such an account was merely one possible scenario, and that in actual practice the order and details of their actions varied greatly. As the subject gave their account it was possible to query them about their goals along the way. This example shows the impracticality of asking subjects to develop a high-level and idealised abstract description of their actions and goals. They proved to be much more comfortable giving a concrete account, and providing cues as to how this can vary from case to case.

This interview question needs to be reformulated in concrete terms, with room for the subject to explain how the activity can vary:

Interview 1.2 *Can you take me step-by-step through the process of how you complete your activity, and tell me how this process can vary.*

<Ask about sub-goals during the account where appropriate>

9.4 Conflict

The checklist uses the term “conflict” in checklist items dealing with tensions between various goals or various actions. The paper itself does not explain this term in any more detail. The use of this term here is somewhat confusing. Activity theory literature has typically used the concept of *breakdowns* or the wider notion of *contradictions* as popularised by Engeström [10]. Even the book *Context and Consciousness* [16] which was edited by Nardi herself does not include “conflict” in its index.

Despite the unusual choice of this term, we decided to use it in the activity interview. One of the goals of the activity interview was to embody the checklist and the expertise it embodied. Changing the terminology unnecessarily would not be ideal. Unfortunately this term caused much confusion when used in interview format. One of the questions was:

Interview 1.5 *What conflicts are there between these goals?*

The subjects almost universally interpreted the term conflict to mean interpersonal conflict, rather than the more abstract idea a form of tension or contradiction between the goals themselves. It is interesting to note that the checklist had already limited its analysis of conflict to goal and action conflict, only a small subset of the types of contradictions that can occur between parts of an activity system. For example, contradictions can occur at different levels between tools, roles, and rules in addition to goals and actions. Inadvertently limiting the analysis to just *interpersonal* conflicts over specialised it even further.

This also leads one to wonder how many HCI practitioners new to activity theory may be misinterpreting the meaning of the term “conflict” in this context. With no explanation in the paper, and a very real possibility of confusion, the use of this term is highly problematic. In the latest version of the activity interview we instead use the term “contradiction”.

9.5 Internalisation

The checklist paper claims to address the problem that concepts such as internalisation and externalisation are “somewhat abstract when it comes to the actual business of working on a design or performing an evaluation”. However, the checklist simply reuses these same terms but in an itemised form, which can cause

difficulties. For example, in developing the first version of the activity interview we made the mistake of equating internalisation with the very different concept of a task's transformation to sub-conscious operations. Both internalisation and sub-conscious operations are important concepts in activity theory, but have very distinct meanings. This confusion reduced the effectiveness of the interviews, and as a result hindered the perceived usefulness of activity theory.

Issues regarding internalisation are highly important in our particular domain. In our other complementary interviews using the cognitive dimensions questionnaire, subjects made statements about how they had been "colonised" by the model and work procedures of their music production software. This phenomenon should have been explored in a rich and deep manner by any interview claiming to elicit an activity theory analysis. Our initial interview's flaws stemmed from the ambiguous and jargonised activity checklist. The latest revision of our activity interview has been adapted to remedy these limitations.

9.6 Externalisation

Externalisation is another central concept of activity theory. We found that our activity interview questions about externalisation did not get the detailed answers that we might have expected. Interestingly, the domain of music production is permeated by profound externalisation. Most of the subject's time is spent working with externalised abstract representations of the object of the activity. It is likely that activity in other domains which are more internalised would see an larger benefit from these questions in the interview.

9.7 Evaluation vs. design

Our activity interview merged the evaluation and design checklists. This suited our goal of analysing the *current* activity and tools, while looking forward towards how we would design a new tool.

In our interview's section on change and development of the activity, we asked about what might be possible in a new tool. This was followed with additional questions on how this tool could change the subject's activity. In this case, our subjects found it very difficult to imagine new tools, which we can attribute to their accounts of having been "colonised" by their current tools. Given the difficulty of imagining new tools, further questioning about the impacts of such hypothetical tools gained us little further insight. It is difficult to know how much we can attribute this phenomena to our specific domain, or if there is a more general problem here. One confounding factor is that producers who extensively use computer music tools for composition have by definition found a fit between their activity and their tools. Other potential computer music producers have no doubt been put off by the complexity of the tools, in addition to the patience and tenacity required to complete projects with them.

Presumably in many other domains there will be a well articulated need for new tools, and subjects will have a clear idea of what such a tool might comprise.

9.8 Limitations of the interview

With the interviews completed we can think about which aspects of the activity they failed to illuminate. The above sections highlight problems due to various factors, but there are some things that the interview simply omitted. Some of these limitations can be traced back to equivalent gaps in the checklist, or activity theory itself.

An important aspect of computer music production is how the design of tools affect the resulting musical outcome. We can expect similar concerns to exist in many other domains where we might want to use activity theoretic analysis. We found that the activity interview did not directly lead to discussion in this area. The closest the activity checklist gets to raising this aspect of activity is with the following item:

Eval 4.2: Effect of implementation of target technology on the structure of target actions

However, the structure of actions is only a small part of the concerns here. It is of course important to develop an understanding of how tools affect the structure of our actions. We also need to know how the tool interacts with and shapes our goals, and the object of our goals. Tools both empower and constrain our abilities through their specialisation. When using a tool “we can sense some things better, and we can alter some things better, but others not at all” [15]. This needs a stronger emphasis in both the activity checklist and has been addressed in our interview.

As discussed in section 6.1 Irestig et al. [12] found that the activity checklist “does not highlight the management of signs and symbols in design as a significant and separate aspect of the process”. We also foresaw this limitation, and dealt with it by also interviewed subjects with the cognitive dimensions questionnaire which focuses on important notational and symbolic features of tools. The detailed and crucial information uncovered in these interviews was not duplicated in the activity interview. This validates the claim that this is a limitation of the activity checklist, but we should not conclude that the checklist, or our activity interview, should be expanded to include these aspects. The cognitive dimensions questionnaire worked well in tandem with our activity interview. Finding research methods that complement this weakness seems the best course of action.

10 Conclusion

In this paper we have presented a new interview resource for informing user-interface design. This resource should prove useful to HCI practitioners seeking to understand open-ended and non-prescriptive activities. It consists of a number of interview questions derived from the activity checklist, which is based on cultural historical activity theory. We showed that while the checklist provides an excellent foundation, it has some unfortunate shortcomings for use as a design tool. HCI practitioners who are not steeped in activity theory literature may

find it inaccessible and difficult to apply without significant conceptual work. While the checklist will continue to be useful in many research contexts, our interview resource is a pragmatic, accessible, and instantly applicable alternative, and aims to correct some of the checklist's limitations.

Future work includes the further refinement of the activity interview. This needs to be informed by both the outcomes of our current research, but also from the results of using the activity interview in other complex domains outside of computer mediated music production.

THE ACTIVITY INTERVIEW

<Discuss and define what the activity is for this person and resolve any questions>

GOALS

1.1: What are the different roles of the people involved in this activity? What is your role?

1.2: Can you take me step-by-step through the process of how you complete your activity, and tell me how this process can vary.

<Ask about sub-goals during the account where appropriate>

1.3: How can you tell when you have successfully completed each goal?

1.4: How could the higher-level goals be achieved differently?

CONTRADICTIONS

1.5: What contradictions are there between these goals?

1.6: What contradictions might there be with goals from other activities you or others are involved in?

1.7: How could you / do you resolve these contradictions?

TOOL USE

I will now ask you a series of questions about the tools you use in this activity. Tools include all sorts of artefacts such as pencils and paper, the notes we take, the theories behind them, and more traditional technology tools.

<Give other examples from the specific activity domain>

2.1: What tools do you use and what for?

2.2: What other tools do you or could you use in this activity?

2.3: Do you have access to these tools?

2.4: How could the tool be integrated with your other tools?

2.5: Which tools do you use when, and how do you organise them?

WORKING WITH OTHERS

- 2.6: How are these tools used and shared with others?
- 2.7: How do you divide this activity between people, and at which points do you have to wait for them to complete their work?
- 2.8: What are the explicit or implicit rules, norms and procedures influencing how you work?

INTERNALISE

- 3.1: How have your tools affected how you think and reason about your activity, and how much of your activity do you perform in your head?
- 3.2: How hard did you find it to master your tools, and what should have been easier?

EXTERNALISE

- 3.3: How do you deal with problems in this activity when they become too complex to manage in your head?
- 3.4: How do you use representations of your work – documents, notes, software, and talking etc. – to collaborate and coordinate with others?
- 3.5: How do you externalise processes for simulation?

TRANSITION

- 3.6: How do your tools support the transition between subconscious and conscious use?

HELP

- 3.7: When things go wrong, how do / could your tools help you express these problems and request help?
- 3.8: How does the system provide help to other people?
- 3.9: What knowledge is there about these tools (other than that provided by the tools), and how can you get access to it?

LIFE CYCLE

- 4.1: How do your tools fit into your workflow?

4.2: How do your tools shape how you work, and what you can and do produce?

CHANGE

4.3: What new things could be possible in a new tool?

4.4: How will contradictions change between target actions and higher-level goals?

4.5: How might your working environment change - people, technology, rules, work etc. as a result of new tools?

4.6: What could you do differently with better support from a new system?

4.7: How have previous systems you have used affected how you performed your activity? When you moved from older to newer tools in the past, how did this affect the activity?

ATTITUDES

4.8: What are your attitudes towards new technology, and how do you see them changing over time?

References

1. Ableton. Live: The audio sequencing instrument, 2003. <http://www.ableton.com/index.php?main=live>.
2. L. Bannon, and S. Bødker, Designing Interaction: Psychology at the Human Computer Interface. Cambridge University Press, Cambridge, 1991, ch. Beyond the interface: Encountering artifacts in use.
3. H. Beyer, and K. Holtzblatt, Contextual Design : Defining Customer-Centered Systems. Morgan Kaufmann Publishers, 1998.
4. A. Blackwell, and T. Green, A cognitive dimensions questionnaire, 2000. <http://www.cl.cam.ac.uk/~afb21/CognitiveDimensions/CDquestionnaire.pdf>.
5. A. Blackwell, and T. Green, Notational systems - the cognitive dimensions of notations framework. In HCI Models, Theories and Frameworks: Toward a Multidisciplinary Science, J. M. Carroll, Ed. Morgan Kaufmann, 2003.
6. A. Blackwell, and T. Green, A cognitive dimensions questionnaire optimised for users. In Proceedings of the Twelfth Annual Meeting of the Psychology of Programming Interest Group (2000), A. Blackwell and E. Bilotta, Eds., pp. 137–152.
7. S. Bødker, Through the Interface. Lawrence Erlbaum Associates, 1991.
8. J. Brown, Activity theory: Its use and potential in the field of human-computer interaction. PhD Comprehensive, Psychology Dept, Carleton University, Ottawa, Canada, July 2004.

9. M.M. Cluts, The evolution of artifacts in cooperative work: Constructing meaning through activity. In *GROUP '03: Proceedings of the 2003 International ACM SIGGROUP Conference on Supporting Group Work* (New York, NY, USA, 2003), ACM Press, pp. 144–152.
10. Y. Engeström, Activity theory as a framework for analyzing and redesigning work. *Ergonomics* 43, 7 (July 2000), 960–74.
11. M. Fjeld, M. Morf, and H. Krueger, Activity theory and the practice of design: evaluation of a collaborative tangible user interface. *International Journal of Human Resources Development and Management* 4, 1 (2004), 94–116.
12. M. Irestig, H. Eriksson, and T. Timpka, The impact of participation in information system design: a comparison of contextual placements. In *PDC 04: Proceedings of the Eighth Conference on Participatory Design* (New York, NY, USA, 2004), ACM Press, pp. 102–111.
13. V. Kaptelinin, B. A. Nardi, and C. Macaulay, Methods & tools: The activity checklist: a tool for representing the “space” of context. *Interactions* 6, 4 (1999), 27–39.
14. A. Leont'ev, *Activity, Consciousness and Personality*. Prentice Hall, Englewood Cliffs, NJ, 1978.
15. M. Mc Cullough, *Abstracting Craft: The Practiced Digital Hand*. The MIT Press, London, England, 1996.
16. B.A. Nardi, Ed. *Context and Consciousness*. MIT Press, Cambridge, Massachusetts, 1996.
17. D.A. Norman, *The Invisible Computer*. The MIT Press, 1998.
18. P. Turner, and S. Turner, A web of contradictions. *Interacting with Computers* 1, 14 (2001).
19. L. Vygotskii, *Mind in Society : The Development of Higher Psychological Processes*. Harvard University Press, 1978.