Integrating Creative Practice and Research in the Digital Media Arts.

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Introduction
Research is often characterised as the search for new ideas and understanding. The language of this view privileges the cognitive and intellectual aspects of discovery. However, in the research process theoretical claims are usually evaluated in practice and, indeed, the observations and experiences of practical circumstances often lead to new research questions. This feedback loop between speculation and experimentation is fundamental to research in many disciplines, and is also appropriate for research in the creative arts. In this chapter we will examine how our creative desire for artistic expressivity results in interplay between actions and ideas that direct the development of techniques and approaches for our audio/visual live-coding activities.

There is a definitional hurdle that we believe needs to be exposed at the outset of discussions about practice-led research, concerning the term “research” itself. There is a general way in which research is a part of many activities. In this general way, research refers to the act of finding out about something and is involved in learning about a topic, extending a skill, solving a problem and so on. In particular, almost all creative practice involves this general type of research, and often lots of it. In contrast, there is a more limited use of the word research prevalent in academia and about which this article is concerned, where the term refers to uncovering evidence that builds or elaborates upon a theory. Our more limited academic definition also requires that research should be coherent and situated within a broader theoretical framework. In other words, academic research should be situated within a body of extant knowledge, regardless of whether the research supports or challenges existing theory or existing practices.

The distinction we make about general and academic research has parallels to different modes or levels of creativity, what Margaret Boden (1990) refers to as psychological and historical creativity. In a similar way, general research uncovers knowledge that was previously unknown to the individual but known to the field, while academic research aims at uncovering/creating knowledge that was previously unknown to the field. Given that creative practice is often individualistic, the opportunity for tension between individual and collective understanding through artistic expression and experience is unsurprising. Having outlined what we mean by research for the purposes of this discussion we will proceed to a more detailed discussion about digital media practice.

In our digital media work, knowledge is created and expressed through a conversation between research and practice. The nature of this conversation may vary with different types of practice, but we believe there are consistencies that comprise the character and style of this type of research. The research and practice with which the authors have been most involved is the algorithmic generation of digital content, creatively expressed as audio and visual media art works, and in this chapter we will reflect on our practice of live-coding in particular. But first we will discuss the characteristics of digital media practice more broadly and the opportunities it presents for research.

Digital Practice
Digital computing systems have a fluidity and constructability that has made them ubiquitous since arriving on the scene in the middle of the 20th century. Digital systems are fluid, in that bits can be recycled for use almost indefinitely, and constructible because while
their organisation is variable and provisional it is definable by coding in computer programming languages. The fluidity of digital media means that there can be digital representations of various other media including text, image, and sound; along with processes for the manipulation of them. Like their mathematical cousins, digital systems can represent ideas as formal expressions in code, and this is an important feature for their use in research. The different ways in which media practice exploits digital systems can be simply characterised as using or building digital systems. By far the greatest use of digital media by creative practitioners is for media simulation where computers are used for drawing, video editing, music production and the like.

Despite media simulation being so popular, we believe that the greatest research potential of digital systems is to combine this with building media by defining processes through the formal expression of ideas in code. The same fluidity that makes digital systems effective for media editing makes them valuable for idea exploration. This is not to say that ideas are not being explored during editing processes, but rather that even greater leverage can be gained by digitising the representation of ideas as code as well as their effect in media art works. This leverage is present in creative practices that incorporate tool building as meta-creation to exploit the computer as an idea amplifier (Kay and Goldberg 1977), while still making use of its efficient simulation of physical media processes. This combination of tool building and using in practice-led research continues to reflect observations about optimal environments for interactive art by Edmonds (2004:83);

“Our experience suggests that even today, with all the advances in software, the degree of programming and systems expertise is critical to having more artistic control over the developing process.”

The desire for expressive control in artistic work correlates well with the need to be able to express unique and novel ideas in research contexts. The ability for digital systems to enable the articulation of generative processes as a form of meta-creation allows interaction between the expression and exploration of ideas that is fruitful for both creative practice and research endeavours.

**Approaches to research**

There are numerous approaches to research. In particular we see two long-standing traditions that feed into practice-led research; experimental and conceptual research. At the risk of over simplification, we will use caricatures of different research approaches to highlight contrasts and make our points.

Experimental or ethnographic approaches are based on observation in the world. The sciences have largely conducted research this way since the Renaissance. There is, of course, variety in this approach, including direct observation often featured in disciplines such as biology and anthropology, through to the measuring of designed interventions in disciplines including engineering, agriculture and social or political activism.

A conceptual or philosophic research approach is based on logic and argument. It relies on measures of internal consistency, resonances with lived experience and, to a lesser extent, popularity for its merit. While this style of research is aligned with the humanities through its use in disciplines such as philosophy, sociology and literature, it also has a strong home in science disciplines including mathematics, cosmology, and theoretical physics where empirical measures may be impractical.

Both experimental and conceptual researchers can make significant use of digital systems to aid their thinking and experimenting. Mostly this involves the exploration of hypotheses using computer simulations of their domains. Some obvious examples include aircraft design, weather forecasting, economic modelling and game theory. While this research may use many of the same tools and skills required by our research in media art, it
differs in that, for them, the digital system acts only as a model and the “hard” evidence is found in behaviours of the real systems they simulate; while, for us, the computer system is directly in play and its behaviour and outputs are the objects of enquiry. While it can also be argued that for us the “hard” evidence is also found outside the digital system in the behaviours and opinions of people who experience the music and art produced by our digital systems, it is not our primary concern (but may reasonably be for others) to model the cognitive systems that lead to people’s experience of media art.

Our practice-led research draws on elements of both experimental and conceptual traditions. Like the experimental traditions our research creates hypothesis, builds trials and judges their success by evaluating the outcomes “in the wild” through practice. Like conceptual research our digital systems and aesthetic fitness measures are constructs of the collective imagination, with all the inherent recursiveness and provisionality that characterise dynamic cultural contexts. Not surprisingly, practice-led research approaches like ours seem to best fit the disciplines of creative arts, design, and information technology where there is interplay between human culture and physical materiality. The experimental and conceptual dimensions of practice-led research are considered by Richard Vella to be windows onto the creative imagination that produce two layers of metaphorical output, “the work of art and all its symbolic representations” and “the theoretical model” (Vella 2003:4). We are sympathetic to this argument that there are multiple metaphors of understanding, although we differ with Vella’s view that the symbolic metaphorical representation precedes the theoretical; rather we believe they are interdependent.

The interdependent nature of experimental and conceptual aspects of research highlights a pronounced difficulty for practice-led research. It requires that the investigator be both a practitioner of some experience and a researcher of some significance. This appears to cause some confusion for arts practitioners who, incorrectly in our opinion, are often of the view that being a practitioner is in some way equivalent to being a researcher. We feel this confusion is rooted in the confusion between general and academic research we outlined above. We are equally suspicious of researchers who believe that they are practitioners. This leads to often unconvincing creative outputs where it is difficult to differentiate between a failure of conception or expression. We see two different tasks. It is possible, and useful, to combine these tasks, but this requires capability in both domains. If the researcher is a poor practitioner then any findings of the outcomes may be of questionable cultural value. If the practitioner is a poor researcher then there is unlikely to be any significant elaboration of existing theory. Research partnerships can often provide complementary skills to bridge this gap. Within aa-cell we believe we have collectively, and perhaps individually, both researcher and practitioner expertise.

**aa-cell’s live-coding practice**

As a case study we will discuss our creative practice. We perform music and audio-visual live-coding performances under the name aa-cell, and use the techniques developed through this activity for various media art exhibitions and as input to other research activities using generative media. We have creative backgrounds as instrumental music performers and composers, and have in more recent years established a practice around visual and audio visual exhibitions. We have experience at creating computer music development platforms and building software tools for making music. Our live-coding performance practice has evolved alongside the development of the Impromptu software which makes this new performance practice possible.

In mid 2005 Andrew Sorensen began developing the Impromptu live-coding environment (Sorensen 2005). At first this work was conceived at a nexus of extant projects authored by Sorensen but soon grew into a self contained and directed project. The original
inspiration for Impromptu was an article authored by Alex McLean entitled “Hacking Perl in Nightclubs” (McLean 2004). This article outlined a performance practice called live-coding which placed the real-time development of computational algorithms as a central and integral aspect of live computer music production.

Inspired by the notion of real-time music programming, Impromptu was conceived as a tool designed to assist in the construction of musical algorithms in live performance. In the early stages of the development, questions and aesthetic considerations concerning the project could be loosely banded into two separate groups; practical considerations which generally impacted upon engineering related issues such as scheduling models, signal processing architectures, garbage collection strategies and the like; and more philosophical investigations such as the aesthetic nature of computation, broad notions of time, symmetry and order as well as various other ontological issues. Conspicuously, what was not considered in this early development was any specific musical outcome or stylistic intent. In other words, defined artistic outcomes were not an early focus of the project and tool development started with undefined aesthetic goals. Indeed, the primary motivation of Impromptu’s development was a belief that new aesthetic opportunities would arise directly as a result of tool innovation.

This is not to say that there were no creative practice goals established for the project. In fact the opposite was true. Impromptu’s early development was marked by rapid progress made necessary by a fixed performance date. In June of 2005, only three months after Impromptu’s initial conception, we performed using Impromptu at the Australasian Computer Music Conference in Brisbane, Australia. This hard deadline provided the motivation to realise a significant amount of work in a very short period of time. Another result of such a short time frame was a clarity and focus for the project, born of necessity.

The importance of such fixed performance dates cannot be overstated. They provide an invaluable force in directing and constraining the project. Further, these performances provide excellent project milestones and are a primary mechanism for measuring the successes and failures of the project at a given point in time. In quite a direct manner it is the artistic practice that frames the successes and failures of the various approaches being followed by the project. These successes and failures then feed back into the iterative project cycle, informing new research directions and opportunities for public dissemination.

As the tool development and usage patterns matured, and in light of the results of early performances, it became clear that our research would encompass issues around both effective tool construction and new ways of representing generative media processes suitable for live-coding. This investigative path involved explorations of effective data and coding structures and theoretical investigations into the computational notation of artistic methods and structures. Outcomes of our explorations are captured as code libraries and performance files, recorded performances and academic publications.

The availability of outputs in multiple forms is a valuable feature of practice-led research. It allows for a diverse approach to the transmission of the ideas developed during the research without having to rely overtly on the preparation of presentational media, such as video documentaries, to reach audiences beyond academia.

**Reflections on live-coding research**

While, as we have discussed, research approaches can be differentiated by their emphasis on the concrete or the abstract, they also vary according to how open ended or tightly constrained their investigations are. Some research has clearly articulated goals, procedures and measures for success, but our creative practice and research rarely does. Rather the value of our approach is in its agility, enabling us to respond quickly to new insights or changes in context, and in its robust findings that result from having worked
Research projects typically have a number of stages with, potentially, different degrees of specificity at each. A prototypical experimental research project might devise a hypothesis for testing, set up experiments that control for all variables, and measure results statistically. By contrast an ethnographic study may begin by seeking to understand the reasons for a social situation then, after starting select subjects or a site, record all activities in case they might be significant and analyse data by comparing a series of manual summaries. Our practice-led research is often closer to the depicted ethnographic approach in that investigations are often loosely formed at the outset, although the context of the study—our creative practice—is usually well defined.

In our digital media investigations the aesthetic criteria for judging success are, like all aesthetic criteria, negotiable within the bounds of established cultural conventions. Projects involve a series of iterations of small-scale tests until a likely candidate for more extensive exploration is arrived at. Often these early iterations result in the development of small software libraries which are leveraged when working on a larger scale work. The number of such iterations is quite variable and a skill for the practice-led researcher is learning to judge whether an investigative path shows promise or not. A single project often involves several extensive explorations. This iterative hierarchy proceeds until success is clear, failure seems inevitable, or time runs out. At the end of this process there are numerous materials for discussion and dissemination including code libraries that can be used for future projects, outputs from small and larger scale tests, and completed creative works. These data provide a rich resource for discussion, further work, or verification and validation by peers. How general findings derived from such data are dependent on a number of factors. In most cases the multiple tests and small-scale works provide sufficient evidence that the processes or ideas developed can have a life beyond one work or context. But it is likely that more work is required to extract from the project those learnings which are specific and those which are more generally applicable. The issue of generalisation, and thus reuse, is important not only for making contributions to society at large through effective knowledge transfer but also to empower the researcher/practitioner in their future work.

In this way our research is highly iterative, not unlike current trends in software design where the exalted status of “specification” has been somewhat eroded by a realisation that specification is an inherently flawed activity, and that development agility with regular reference to outcome requirements is more efficient. Some research design strategies that require up-front specification have similarly been accused of being potentially restricting. A traditional view of scientific research envisions a clearly defined research goal with an orderly implementation plan that results in an outcome clearly demonstrating the success or failure of an initial hypothesis. The problem with this view is its risk adversity and tendency to drift to the centre. As Peter Downton states “An often-made criticism of this expectation is that it is a convergent view of research whereas the truly inventive demands a divergent view – a seeking of the unknown and unexpected” (Downton 2003:pp).

In our practice we seek to balance the competing interests of specifiable targets and playful exploration by attempting to rapidly develop, deploy and reflect. By iterating over shorter periods and forcing critique and reflection through regular exposition of our research to both public and academic debate we feel better able to explore more novel approaches while still maintaining the healthy pragmatism that performance practice dictates. To quote Steve Jobs, “real artists ship”.

For us practice-led research is a journey, with an emergent set of stops along the way at points of interest. The journey may take a lifetime, while the individual “projects” are the paths between points of interest. Snapshots from these points of interest manifest themselves as performances, exhibitions, recordings, web sites, presentations, papers, and books.
Aesthetics and research

One of the key points about our creative practice and our research is that aesthetic criteria; understood as subjective human preference based on direct experience (Dewey 1934), are central to the undertaking. The role of aesthetics in creative practice is well established, but not so well established is the role of aesthetics in research. Aesthetics does play a role in many research fields where elegance, simplicity, and the like are valued, however, in media art research it generally has a more critical role. In our research the effectiveness of various computational media processes in improving creative output is the most substantial measure of their value. Other criteria for us include the generalisability of a process across many situations, novelty or innovation in the process, and the simplicity or parsimonious representation of a process. While it is possible for practice-led researchers to consider their own aesthetic judgment sufficient validation of success or failure, we prefer to use our own judgment for incremental steps but to subject larger scale works and theoretical advances to peer and public review. Employing collective wisdom as a measure of quality is deeply rooted in both research and arts cultures, particularly in the form of peer review of academic papers or curatorial judgments around art and design. Collective wisdom is also a significant measure in other domains that resist quantitative testing, such as theories about the origins of the universe which are also subject to aesthetic criteria.

Aesthetic judgment is an imprecise measure, it has tendencies toward normative outcomes and expert opinions can be quite divergent. To account for this in our practice-led research we seek peer review regularly and widely, especially when we are unsure about direction, but we also hold fast to a vision for innovation when we are confident about our direction. In the end the results of such practice-led research, like all other research, will stand or fall in the long term by the respect the work commands from others in the field and its impact in the world.

Aesthetic judgment also makes an important contribution to the pragmatism of our research. By focusing on the media outcomes of the research we keep our eye on improving our practice and activity in the world, which keeps in check the potential for us to obsess overly about interesting technical, theoretical, political or philosophical threads. As well, this perspective leads us to make public a large amount of the practical work resulting from our research. Feedback from these disseminations varies significantly. Performances provide immediate feedback, and then a trickle of more considered comment over time, and occasionally a formal review in the press. Web-based information and distribution has a qualitative aspect with regard to the frequency and number of visitors and where they are from. We have also found that when work is released in this way we can scan the web for blog posts and other commentary not directed to us but that we can access and accumulate to paint a picture of how the work is received. We welcome controlled testing of our works, which would typically be through statistical tests of algorithms or as reception studies of people engaging with our work, but have so far made limited use of these approaches.

We also regularly engage in the formal academic dissemination processes which are largely text based and see that it has a place in articulating our ideas and representing our work in established academic discourse. We feel that the exposure of our media outcomes offsets the limitation of textual descriptions to some extent and communicates our research findings more clearly than in text alone. As a corollary of this we often present code as part of performances, exhibitions and as libraries that provide another perspective, insight and description of our work.

Connecting personal and collective understanding

One of the great affordances of creative practice as a research method is the rich
opportunity for public dissemination of information. As discussed briefly above in relation to the role of aesthetics, our performance practice offers us the ability to disseminate information as recorded audio/visual media, as software and code, as printed musical score, in written research papers, as presentations to academic and trade conferences and, most importantly, in performance. Performance has proven to be particularly valuable as this is for many people the initial point of contact with our research. We feel that there really is little better way to prove the value of a new musical algorithm than to have someone appreciating it; for example by dancing to it. We believe that the impact of this rich diversity of output is significant as it allows us to reach audiences outside traditional academic forums, to engage with a broader range of disciplines and to evoke greater public scrutiny and comment.

aa-cell have been performing regularly over the past three years throughout Asia and Europe. During this time we have published regularly on a range of topics related to our practice and reciprocally our research has resulted in new tools for use in our live performances (Brown 2006, Brown and Sorensen 2007, Sorensen and Brown 2007, 2008). These performances continue to provide opportunities for reflection and critical audience feedback. Performances also provide the motivation for exploration and discovery as we strive to innovate and provide exciting outcomes for our audiences.

However, it is not for audiences alone that we search for novel approaches, nor is our research based on aesthetic considerations alone. Indeed, while we highly value the role of aesthetic judgment in practice-led research we question the appropriateness of assigning research outcomes only to results based on aesthetics. Rather, the value of our research is in the knowledge embedded in the practice and, by extension in the computational processes and techniques we use to make it. This is not to say that the quality of the music and visuals is immaterial, indeed we believe it is integral, however we are interested in the understanding and insights that can arise through the development of new methods for creative expression. We constantly strive to discover new artistic knowledge, be that compositional, cultural, creative, or computational and are interested in how what we learn here might be useful for other artists and applied more widely, especially to other applications of computational systems. We also feel that it is our responsibility to report on that knowledge and to transfer our findings to the broader community, which we accomplish using the full range of media at our disposal.

While it is certainly true that research needs to extend and challenge social norms and cultural practice through innovation, we find that the reality check of actually taking our research into the world is revealing and challenging with regard to the relevance of any innovation we may pursue.

From reflection to theory

A critical element of the iterative nature of our creative practice and research is reflection on results. Our experience confirms the findings of Donald Schön that reflection in action is a critical element in developing understanding (Schön 1987). Interestingly Schön’s work also grew out of exploring how technologies precipitate innovations and in trying to understand how people accommodate these (Schön 1967).

In general, artistic knowledge is often intuitive and reflection may not occur naturally. Or, perhaps it would be more accurate to say, practical knowledge is inherent in doing and is often considered implicit and as such not be identified or valued without explicit attention paid to it. It is common for arts practitioners to have significant knowledge without necessarily being able to adequately describe that knowledge. In other words, knowledge embedded in practice is often personal and ineffable. In order to make this personal knowledge more generally useful a process of reflection and contextualisation is often required. Reflection can help to find patterns that make this personal knowledge more
generally applicable and contextualisation helps to place those findings within a broader history of accumulated knowledge. These processes are important because they are essential to transforming personal knowledge into communal knowledge. This knowledge can be accessed through the various presentations of the work; as art works, code libraries, algorithms, written descriptions, critical analysis and commentaries and so on. An integral part of research is this transmission of personal knowledge and understanding that has some novel and general application into communal knowledge.

Sharable knowledge is often expressed as a method, process or theory. The production and dissemination of theory is a distinguishing differentiation between our practice-led research and conventional artistic practice. In our research, theories are frequently associated with patterns of usage, that is with techniques or practices we use regularly. These regular patterns of usage often indicate areas of particular interest in our work and it is through introspection that these patterns may develop into a more general theory or into new techniques and habits. These generalisations, or theories, invariably find their way back into our practice. We feel that this iterative process between expression and reflection is essential to all research and is integral to arts practice.

Experience of the creative output or artefact is also of great importance to understanding the knowledge generated by the research. Firstly, the artefact provides evidence of the knowledge discovered. It stands as a demonstration of the theory and is available as a reference for further investigation and verification. The artefact helps to make the ideas explicit. Secondly, the artefact provides a stimulus for engagement with the knowledge gained. The artefact is integral in communicating the ideas of the research in all its richness and in making the theory available to a wider audience who might otherwise not engage with knowledge in the abstract. In a very real sense practice makes an excellent partner to research because the benefits of practice-led research flow in both directions.

Conclusion

In this chapter we have outlined our approach to research using our live-coding performance practice as a case study. We have argued, based on our experience, that while research and creative practice are not the same activity, there is significant intellectual and cultural benefit to be gained through integration of research and practice.

Our practice of live-coding has involved both the building and using of digital tools and the development of new representations of musical processes. We have argued that this provides a way of exploring both the possibilities of established processes and innovation through the construction of new processes. The ease of controlling digital systems through programming software makes this a particularly attractive option for digital media practitioners. The demands of the live-coding performances we undertake provide hard constraints that serve to propel our work forward and add rigour to the results. In addition, the ability to build new software tools enables an agile approach where avenues for investigation can be explored or discarded with minimal effort.

Practice-led research, as we conduct it, is hierarchically iterative with each large step encompassing numerous smaller steps. Progress and direction are guided by aesthetic judgments, enabled by efforts to engage in a healthy dialogue between our own assessments, the opinions of others in our field, and those of the broader public. This critical dialog is facilitated by making our work available in a variety of formats and forums, including recordings of creative work, code examples, academic and informal writing and, especially, live performance. The documentation of our work in these many forms facilitates reflections on the work that lead to the observations of patterns and theories, as well as highlighting opportunities that lead to new work.

So what drives our work? In the end it is our creative desire for artistic expressivity that
results in an interplay between actions and ideas. And it is our desire for a productive
dialogue with others around this expressivity that leads us to the extensive documentation,
reflection and dialogue that positions our practice within a research framework.

The feedback loop between reflection and action, between speculation and
eperimentation, is fundamental to research in many disciplines and it is an important feature
of our work. We suggest that a deliberate and public interplay between imagining and
expressing is generally productive as a method for practice and research in the digital media
arts.

Acknowledgments

This research was conducted with support from the Australasian CRC for Interaction
Design (ACID), which is established and supported under the Australian Government’s
Cooperative Research Centre program.

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