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# BOUNDARIES AND ACCOUNTABILITIES IN COMPUTER-ASSISTED ETHNOBOTANY

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Designing software alongside ethnobotanists and Indigenous owners and practitioners of traditional knowledge, brings to light a range of issues which expose some of the assumptions underlying both Western ethnobotany and software design. In collaborating over the development of software to facilitate the use of digital objects in knowledge work, issues of knowledge politics, accountability, ontologies, and epistemologies arise. This paper discusses the ways these issues, in a particular context, led to the development of a flexible, ontologically flat, epistemologically open, ethnobotanical software design.

*Keywords*: Traditional knowledge; ethnobotany; software design.

## 1. Introduction: Aboriginal Plant Knowledge in Contemporary Australia

Developing a database of ethnobotanical knowledge is not difficult. There are many hundreds of examples. However, designing software to support the traditional "on the ground" knowledge practices of Aboriginal people working to ensure the intergenerational transmission of knowledge traditions is much more difficult. For many thousands of years, Australian Aborigines have observed, used, identified with, and told stories about the plants they encounter in their environment. Their knowledge has been passed down and renewed from generation to generation. As traditional Aboriginal culture faces increasing pressure from the colonizing influences of Western education, governance, medicine, technology, religion, and popular culture, many old people are passing away and taking with them their knowledge of the plant world in the many different habitats which they and their ancestors have owned and cared for over the millennia. Meanwhile, white Australian ethnobotanists, ethnographers, anthropologists, and linguists have been making notes, books, and databases of Aboriginal knowledge about plants, their names, their place in the world, and their uses as medicines, food, and in the production of technologies.

There are two completely divergent knowledge traditions here, interacting with the same subject matter. The knowledge traditions are at work in two worlds, the world of ethnobotanists who work to enlist traditional knowledge in conservation or

development projects and the world of Indigenous people carrying on the ancestral task of making knowledge alive in the new generation, within the ancestral contexts of identity, ownership, custodianship, and accountability. Each has its own rules, structures and boundaries.

## 2. Boundaries and Accountabilities in Software Design and Use

This paper details aspects of the development and use of software for Indigenous ecological knowledge work with Yolngu Aboriginal people in northeast Arnhemland, on the north coast of Australia. This involves some working with boundaries and accountabilities. I am using the notion of boundaries and boundary crossing following Suchman (2002) in her paper on located accountabilities in technology production. She speaks of the boundaries between the software designers and software users and makes a comparison with the work of Verran (1998) working at the boundary between Western academy-based sciences and Yolngu (Aboriginal) knowledges. "Emerging technologies might be relevant but only if what (people) know assumes a central legitimated place" (Suchman 2002, p. 93). Here we are dealing with both the boundaries between Yolngu and Western knowledge traditions and between the designers of information technologies and their users.

The story emerges from a variety of contexts in the Northern Territory of Australia, where Yolngu people are beginning to explore the use of digital technologies for their own knowledge purposes. The full story of the research project, called Indigenous Knowledge and Resource Management can be found on the website (see http://www.cdu.edu.au/ik). The project was set up to assist collaborations between the Charles Darwin University and industry bodies who work in Aboriginal knowledge contexts, including the Northern Territory Department of Infrastructure, Planning and the Environment, and the Northern (Aboriginal) Land Council.

There was an accountability problem from the start. The three partner organizations were interested in research which would help them in their role of fostering the use of Indigenous knowledge in the work of natural and cultural resource management in the "Top End" of Australia. But the Aboriginal knowledge owners, with whom we worked on the ground, were naturally interested in their own knowledge resources and the ways in which ongoing traditional religious and political work could be supported by the digital technologies which they were beginning to meet. We soon found that processes of exclusion are as important as those of sharing in the work of keeping land and culture strong, and so we determined in the first instance to identify and support emerging solutions, regardless of how diverse and inaccessible they may be.

We had been working since the days of cassette tapes with people making, sharing and concealing audio-recordings of ancestral songs and stories. We worked with people on repatriating audio-recordings from archives in Canberra, with all the complex access protocols these repatriations involved. We helped people make digital collections of their family photos, which they want to keep safe — in some

cases to show only to their immediately family to strengthen family identity, and sometimes to present as evidence in highly contested Australian Native Title land claim cases. We worked with people videoing ceremonials and senior custodians telling creation and kinship stories on contested areas of land, to take home to show those who could not attend, and to allow very old people to comment upon further. One man organized to make a video of himself standing in various very remote places, telling the story of that land for other people (Yolngu and others) who have not been there and may not know the full story of its history, its ownership, and who is taking care of it. Another woman, the teacher in a tiny school in a homeland center on her ancestral land, was keen to find ways of using digital technology to link environment knowledge with ancestral connections "for the children" (see http://www.cdu.edu.au/centres/ik/db_ftc.html).

Plants were quite central to much of this work, but only insofar as they contributed to the ongoing social, political, and religious life of the people who used, sang, danced, and painted them. This proved to be a frustratingly complex state of affairs for our partners in the Darwin herbarium who were primarily focused on plant knowledge.

In our search for a software design which enabled the ongoing accountabilities in Yolngu knowledge production to engage in digital knowledge work, and to cross boundaries between Yolngu knowledge work, and the learning and negotiating agendas of outside bodies (researchers, resource managers, mining and government policy makers, lawyers, etc.), we collaboratively explored and critiqued a good range of existing software and, where possible, preserved the accepted software conventions in our new designs.

The divergent practices of knowledge at work in the two worlds present a fundamental problem to our research. The ways in which Aboriginal people do their knowledge work "out on country," with or without digital technologies, turns out to be quite different from the ways in which Western scientists and bureaucrats do theirs. The prefix "ethno-" has long served to relativize local communities of practice as limited by the everyday life of ongoing ancient Indigenous worlds. The notion of ethnobotany seems to imply a superior Western scientific knowledge regime which naturally supplies the standard against which all other plant knowledge and use systems can be, or should be, measured. Western botany is assumed to bear within it a privileged relation to truth. It is pure, somehow, while local, traditional, Indigenous practices are somehow compromised by the exigencies of everyday life, by the need, now, to do this or that, and by old and young having to collaborate to pull together the necessities of life today and keep alive the possibilities of life tomorrow. They refuse a doctrine of objectivity that promises transcendence (Haraway, 1991) in favor of a knowledge system where ancestry kinship, language, land, and identity are thoroughly integrated (Christie 2005b).

As we worked with databases and related software with Aboriginal knowledge owners and practitioners, we encountered resistance to the promise of a transcendent

knowledge and the embrace of digital technologies to support the ongoing embedded, accountable, negotiated knowledge work put in place by the ancestors.

## 3. Political Boundaries

In his work on Indigenous knowledge and the politics of classification, Agrawal (2002) argued that official databases of Indigenous knowledge are emerging through a particular internationalist instrumental logic that begins with the assertion that Indigenous knowledge is a highly significant and underutilized resource in the development process. He notes the irony that the databasing case studies he comes across are in fact "all examples of collaboration between some international development agency and a local group to initiate a development programme" (p. 290) rather than simply to keep knowledge traditions alive within their communities. In her quite different work comparing the history of the imperial archive with contemporary databasing projects, Verran (2005) makes a similar claim, identifying in both collections a drive to somehow capture knowledge for colonial purposes. According to Agrawal, this instrumental drive leads to a complete transformation of what Indigenous knowledge is seen to signify. "Ultimately, the description (of the plant and its uses) is aimed to give the reader a sense of the potential for generalisation" (2002, p. 290).

Agrawal goes on to identify some of the dangers which accompany the foregrounding of the knowledge itself, rather than its owners — the people in their social, political and ecological context. Only the bits of Indigenous knowledge which are potentially relevant to development are seen to need attention and protection. This particularization is the first necessary step in the creation of a well-funded ethnobotany database. If the knowledge is not useful, the databases will not be funded. There follows a process of validation, where the particularized claims (of the usefulness of this or that plant as a food or medicine, for example) are tested and validated using criteria deemed appropriate by Western science. "Independently, such knowledge has no existence, only possibilities" (Agrawal, 2002, p. 290). The processes of validation are necessarily processes of abstraction. What is true here must be true everywhere. Once the knowledge is abstracted, it can be generalized, that is, taken up by others in other places. Abstraction does not guarantee generalization; it just makes it possible. There are many factors which contribute to the taking up, extension or abandonment of scientific and technological artefacts (Latour, 1987), including pieces of Indigenous knowledge. Argawal's point is that the instrumentality demanded of development or conservation imperatives (which underpin the databasing he observes) means that, whatever its truth value, some knowledge no longer counts, because of its lack of utility.

In their work on classification and its consequences, Bowker and Star (1999) examined other processes through which, by virtue of embedded information architecture, some knowledge no longer counts, not this time because of its lack of utility, but because some things are harder to characterize than others; they do not easily

fit into the structure, and they fall through the cracks. Some phenomena are hard to name or have fuzzy boundaries and are hard to classify. Some are contested, some radically singular. They may get left out, or get lost inside the database. Other things are more "charismatic" than others — in our case, crocodiles and kangaroos, for example, as compared with maggots, or dead logs, both of which are highly significant totemically in the Yolngu world. What gets left out then, is as much a political issue as an ontological one, but it is both. And there will, of course, always be things missing. Odors (algal blooms, paperbark flowerings) and sensations (breezes from particular directions at particular times), for example, are not included, even though they are highly significant totemically. This silent selectivity has the effect of "grooving" where we produce from the digital data a particular view of the world which has its shape, not because the world is so, but because this is the nature of our data structures (Bowker & Star, 1999; Christie, 2004).

The intractable problems of funding and architecture will never be completely resolved. However, the question of how (or whether) software will be useful to Yolngu knowledge work around plants will only be adequately addressed as Yolngu take up the technologies and configure and deploy them in their everyday lives.

Herein lies the first boundary to be crossed. Insofar as the imperative for databasing arises from outside of the community of knowledge holders, the accountability of the knowers to their own community may sometimes be compromised through the privileging of particular logics of conservation or development. Software development will become truly accountable to the knowledge owners only if it takes place as a part of the ongoing traditional work of passing on knowledge practices to the new generation.

## 4. Ontological Boundary Work

In the Western world, botany is understood to be an objective science and a profession, on the basis that plants themselves constitute a particular sort of observable objective set of entities. There is, first of all, assumed to be *such a thing* as a plant. The ontological status of plants as a category is never doubted. But Australian Aboriginal languages tend not to have a word or concept which identifies *plants* as being a separate sort of thing from, say *animals* or *rocks* (Yolngu languages have no word for *animal*, either). In the many hundreds of Australian Aboriginal languages, we do not find a word for *plant* per se, but of course there are thousands of species names for different things we English speakers call plants and detailed knowledge of where they can be found, how their life cycles tell us about the world, and how they can be used for food, medicine, and making things. Yet we cannot say, of course, that *plants* as a *category*, or as a *sort of thing*, actually exist for Aborigines as they do, for example, for Europeans. This fundamentally taxonomic question turns out to be a significant issue in the work of designing technologies for environmental knowledge work in non-Western cultures. A taxonomy, according to several dictionary definitions, is "an orderly classification of plants and animals according to

their presumed natural relationships," and computers are programmed to replicate this structure by (re)producing natural relationships among digital objects.

The Western science of botany is ultimately framed by a Linnaean, taxonomic understanding of the plant world. An evolutionary perspective sees all plants, in fact all living things, as being related to each other in a complex kinship system determined by evolutionary history. Species within a single genus are considered to be closely related because they share a more recent common ancestor. Using the evolutionary paradigm, we find some surprises — the whale as a mammal rather than a fish, for example — but we can still lay everything out on an evolutionary tree, a taxonomic system of organization towards which computer technology itself has naturally evolved. The Linnaean hierarchy inscribed in plant database metadata structures involves a constant act of forgetting the very real, but private, ongoing arguments among taxonomists which reveal the "discovery" of relatedness as a thoroughly culturally and politically invested process.

However, plants, in Australian Aboriginal cultures, are not so much related to each other as species, but to particular animals, or particular ancestors, or clan groups, or songs, or ceremonial designs. How particular species of plant are related to *each other* is much less relevant in Aboriginal knowledge work than how they are related to the rest of the sociomaterial world. Sometimes different stages in the lifecycle of a plant or animal, or different genders, have their own names and complex networks of relatedness. The flowers of a particular plant, for example, may be related (as a calendar) to the abundance of a particular food source (fish species, wild honey, or flying foxes) or ceremonial time. It may also be related to a particular ancestral journey, bestowing particular rights over particular practices and resources to certain people. It has its value through its extensive connections to people, places, events, and entities *outside of* what we know as the plant world.

An ethnobotanical database then, that organizes its contents according to a Western taxonomy and limits itself to the phenomena English speakers call plants, radically limits its usefulness in the local everyday work of Indigenous knowledge production. Software designers developing systems which are truly accountable to an Australian Indigenous knowledge practice cannot assume the objective world of plants, cannot assume the ontological status of the species, cannot limit itself to the plant world, and cannot assume a Linnaean taxonomy.

Nor is it a wise move, conversely, to inscribe Aboriginal taxonomies or patterns of relatedness (person, clan, language, place, totem, for example) into information architecture. Designers, in Australia, have enjoyed very little success in their attempts to replace an embedded Western classificatory system with an imagined Indigenous alternative. One of many examples is the database developed for the Galiwin'ku Indigenous Knowledge Centre, in the Yolngu community of Galiwin'ku on Elcho Island, which claims to be a "42 level relational database to catch the way Yolngu people think about the natural world," (*The Australian*, June 10, 2003, p. 29).

In fact, what is needed are fluid ontologies (Srinivasan & Huang, 2005) which allow the emerging epistemologies of everyday knowledge work (Verran, Christie,

Anbins-King, van Weeren, & Yunupingu, 2006) to remain unfrustrated by any *a priori* assumptions of the nonIndigenous agendas. Verran's "ontics" work with Yolngu, positioning ontology as always "emergent, partial and performative." This important difficult everyday ontological work cannot be pre-empted or prevented by hidden assumptions embedded in software. The software is not ontologically neutral; it is invested with the expectations of the programmers about both the nature of the world, and the nature of work to be done upon it.

## 5. Epistemological Boundaries

Suchman (2002), writing about accountabilities in technology production, noted a tension between "a view of objective knowledge as a single, asituated master perspective that bases its claims to objectivity in the closure of controversy, (and) multiple, located, partial perspectives that find their objective character through ongoing processes of debate" (p. 92).

The real test of a software solution for Indigenous peoples is its usefulness in the context of intergenerational knowledge making. The software and its digital resources are put to use in particular knowledge practices. The database, in Western science, is understood to *contain* knowledge, structured according to the master perspective, "a way of being nowhere while being able to claim to see comprehensively" (Haraway 1991, p. 193). It has its uses as a reference in a library and possibly even a "Knowledge Centre," but in the everyday contexts of Indigenous knowledge reproduction, there is no master perspective. (Knowledge Centres in some remote Aboriginal communities in the Northern Territory of Australia are sponsored by the NT Library and Information Services; http://www.dcdsca.nt.gov.au/dcdsca/intranet.nsf/Pages/ntl_lkc)

Knowledge in the Yolngu world is constantly (re)negotiated in the ordinary intergenerational contexts of living out a life on the land, using all the resources at hand — old people, the land, particular ways of talking, of doing, protocols for agreement making — for finding a way forward (Christie, 1994).

An alternative Australian Indigenous epistemology may emphasize the performative nature of knowledge, its negotiation from multiple perspectives and multiple modes of presentation and prosecution, and its fundamentally narrative base.

The role of a digital artefact (a picture of a plant, or a story about it from within a file management system) needs to be determined in a complex, ongoing, dynamic interaction between resources (digital and real, human and nonhuman) and knowledge makers who are configuring resources and (re)presenting them, and other people who are listening, agreeing, disagreeing, arguing, elaborating, engaging, and disengaging. Narratives and databases, according to Manovich (2001) are "natural enemies." Databases:

> represent the world as a list of items and ... refuse to order this list. In contrast a narrative creates a cause and effect trajectory of seemingly unordered items (events). Therefore ... competing for

> the same territory of human culture, each claims an exclusive right to make meaning out of the world.
> (Manovich, 2001, p. 225; see also Christie, 2005b)

Software in Indigenous "ethobotanical" knowledge contexts, needs primarily to be accountable to the practices through which knowledge owners can rehearse and share their knowledge of plants in their world. A database with formal metadata fields will be fine for some knowledge work which reflects and reproduces a Western knowledge tradition. But, for ongoing work, the software needs to support the dynamic, contested, complex configurations of objects, ideas, images, arguments, stories and claims which keep traditional knowledge communities alive and prevent ossification.

## 6. Three Accountabilities in Plant Knowledge Software Design

Working in everyday contexts with Indigenous knowledge makers, exploring software solutions and tinkering on the edges of software design, we have available two possible strategies.

The first is to stay on the user side of the designer/-user boundary and on the Yolngu side of the divergent knowledge traditions. This becomes the work of supporting the appropriation of computers, cameras, recorders, etc. by Aboriginal people interested in making knowledge together in intergenerational contexts. People everywhere pick up new technologies and play with them, trying to find out how they might be put to use. We work with Aboriginal knowledge owners, teachers, and brokers, who are already exploring the uses of technology, ignoring or subverting the built-in assumptions about knowledge and doing their own things. They eschew databases and focus upon objects as tools in the everyday work of politics, economics, sociality, and religion. Collaborative research around these practices is ongoing (see http://www.cdu.edu.au/ik for details). This work is not without its dangers. Bowker (2000), in his work on biodiversity and datadiversity, has already demonstrated how embedded data structures unconsciously change the way in which we see the world (or to use Verran's expression, how we *do* the world).

The second more difficult but more justifiable solution is to design software solutions which dissolve the boundaries between programmer and user and facilitate the practices of divergent knowledge traditions equally. Our research has gone some distance along this road and come up with a proof of concept which we call TAMI. (For an electronic proof of concept and description, see http://www.cdu.edu.au/ik and find TAMI in the "emerging solutions" section.)

TAMI stands for Texts, Audio, Movies, and Images. The only ontological presuppositions we hope to admit are the inherent digital differences between texts, soundfiles, videos, and images (that is, the necessary technical differences between, say, .doc, .aif, .mov, and .jpg files). We support no other presumptions — taxonomies, hierarchies, fields, categories — and aim to be ontologically flat as far as possible, encoding no assumptions about the nature of the world and of knowledge.

We leave open and enable the contestations and negotiations over what counts as knowledge and what is knowable.

TAMI must afford some particular accountabilities for Yolngu digital knowledge work. The Yolngu digital knowledge resources we come across, or which we helped develop, belong principally to one person and their immediate family rather than to a wider group or community organization. Other people are given access to the resources under particular conditions in particular contexts, and negotiations over access and withholding are crucial to traditional ownership and accountability practices. There are strong traditional principles of rights and responsibilities which govern their management. Individuals develop their own file management systems with their small collections at their personal or family level. Most are uncomfortable about the idea of having all the knowledge of a community put into the one database (access passwords notwithstanding), not so much because they do not want people to have access to their own resources, but rather because they feel responsible and accountable to undertake to manage their own resources properly. They are equally keen to avoid being held responsible in any way for the management of, and access to, the resources of others. TAMIs are to be small, personal, and privately owned and managed.

TAMI, secondly, is designed to be responsive to everyday work of Yolngu knowledge-making. People already use their digital resources as props or artefacts, in a social context of knowledge-agreement production, in the same way that they have always used non-digital resources such as paintings, photos, diagrams, ceremonial objects, and of course the land itself, in talking about and representing themselves and their histories, and making agreements.

In some contexts, this work is just people chatting together, reminiscing, enjoying being able to look at, represent and listen to traces of history, and build the collective memory of the group. In other contexts it is serious business: making claims about ownership, about rights and responsibilities, about appropriate ways to go on together, and about representations to, and agreements with, mining companies and government officials. In these cases, the ways that the resources are identified, validated, accessed, and displayed bear critical accountabilities.

Ease of access to resources, and ease of configuration and display are therefore crucial aspects of a design which may allow negotiations to work across the boundaries of Yolngu and non-Yolngu knowledge practices. The users must take an active role in information design as they bring together resources, group them and order them, and create products (such as DVDs and printouts). The ways in which truth claims are assembled and validated collectively can be supervised in context by authorities who may know nothing about digital technology.

One single screen enables search, upload, and view. A workspace enables different objects to be viewed simultaneously and arranged into folders. Users can upload resources into the database by a simple drag-and-drop, and metadata for objects and collections of objects constantly displayed in the workspace can be altered at any time.

Dependence upon metadata brings another problem apart from the "grooving" described above. It may bias the knowledge work in favor of those with better levels of text literacy. This is a problem when many Indigenous people have not had the chance to develop literacy skills in their own languages, and many young people are developing computer literacy having largely bypassed text literacy.

In TAMI, objects can be uploaded and searched without metadata. Metadata can be added at any time to help text-based search. A "glossarizer" produces a list of all the words which are already in the metadata (including file names) and continues to update the list of words. The list contains English and vernacular words, and is always visible on screen. A "lemmatizer" works to enable fuzzy search mechanisms, and key-in and drop-down menus work to reduce the glossary list to help search (key in b and only b- words remain, key in a and only ba- words remain, etc.). For a full description of the lemma work in terms of the complexities of phonology, see Christie (2005a).

But aside from these text helpers, the natural way to find objects in the database is always without a text-string search; that is, without a text-driven FIND function. Texts, audio files, movies, and images can be searched by flicking through the full set of thumbnail resources (as images can be searched in iPhoto, for example).

Bringing accountability and design back down to the user implies small manageable data sets. The system will not work for large repatriated data warehouses. We assume that each database will be small, and users will generally be looking for something which they know is inside there. A small number of one's own resources seems to be the most useful way of organizing and utilizing a toolbox of artefacts for ongoing conversation and agreement-making. TAMI's focus is to make smaller amounts of valued resources easily enrichable for the purposes of collective memory making. This means that botanical images need to be available alongside maps, ceremonial photos, audio recordings, etc.

In the TAMI design all resources enjoy free and equal status in the architectures. There is no necessary distinction between a plant and a part of a plant or an animal, person, or a name, or an activity inscribed in its metadata structures. Resources can be related to a map interface (if their significance is a link to place) or to any other digital objects. Configurations can be saved and labelled without compromising the radical independence of any resource. TAMI is at this stage only a concept, with a simple logic, simple design, and a single interface.

Using an "innocent" system such as TAMI, those who own the knowledge and the knowledge resources can retain three accountabilities:

(1) political accountability for what goes into the digital system, what is retained, what is removed, and who has access to it. It does not "lose track of its mediations just where someone may be held responsible for something" (Haraway, 1991, p. 187);
(2) ontological accountability for how its contents can be produced, organized, retrieved, configured, and (re)presented; and

(3) epistemological accountability for the way it takes its place in the ongoing work of knowledge production and the ways in which truth claims can be prosecuted, assessed, vindicated, or dismissed.

As a solution to an ethnobotanical problem, it has left the objectivist and utilitarian assumptions of ethnobotany behind and, by paying attention to cultural boundaries and accountability, TAMI is a design for a software system which can keep complex local knowledge of plants alive in the world, while retaining the possibilities of equitable benefit-sharing.

## 7. Conclusion

The journey in search of a software solution to enable Australian Aboriginal people to continue their traditional knowledge work in a digital environment, ended in the exposure of some hidden assumptions, hidden boundaries, and evaded accountabilities embedded within the design of conventional database software. We failed to find a suitable software solution, one which kept the ontological and epistemological options open and retained the highly social and often contested practices of knowledge. It is, however, possible to imagine suitable solutions, if we start with a closer look at traditional knowledge practices, particularly those at the work which is done intergenerationally in an Aboriginal social context. It is in this direction that our work proceeds.

## References

Agrawal, A. (2002). Indigenous knowledge and the politics of classification. *International Social Science Journal*, *54*(173), 287–297.

Bowker, G., & Star, L. (1999). *Sorting things out: Classification and its consequences.* Cambridge, Mass.: The MIT Press.

Bowker, G. C. (2000). Biodiversity, datadiversity. *Social Studies of Science*, *30*(5), 643–683.

Christie, M. (1994). Grounded and ex-centric knowledges: Exploring Aboriginal alternatives to western thinking. In J. Edwards (Ed.), *Thinking: International interdisciplinary perspectives* (pp. 23–34). Highett: Hawker Brownlow Education.

Christie, M. (2004). Computer databases and Aboriginal knowledge. *Learning Communities: International Journal of Learning in Social Contexts*, *1*, 4–12.

Christie, M. (2005a). Words, ontologies and Aboriginal databases. *Multimedia International Australia*, *116*, 52–63.

Christie, M. (2005b). Aboriginal knowledge traditions in digital environments. *Australian Journal of Indigenous Education*, *34*, 61–66.

Haraway, D. J. (1991). Situated knowledges: The science question in feminism and the privilege of partial perspective. In D. J. Haraway, *Simians, cyborgs, and women: The reinvention of nature* (pp. 183–201). New York: Routledge.

Latour, B. (1987). *Science in action: How to follow scientists and engineers through society.* Cambridge Mass: Harvard University Press.

Manovich, L. (2001). *The language of new media.* Boston, MA: MIT Press.

Srinivasan, R., & Huang, J. (2005). Fluid ontologies for digital museums. *International Journal on Digital Libraries*, *5*(4), 193–204. Retrieved September 11, 2006, from http://polaris.gseis.ucla.edu/srinivasan/research/SrinivasanHuangJDL2005.pdf

Suchman, L. (2002). Located accountabilities in technology production. *Scandinavian Journal of Information Systems*, *14*(2), 91–105.

Verran, H. (1998). Re-imagining land ownership in Australia. *Postcolonial Studies*, *1*(2), 237–254.

Verran, H. (2005). *Nineteenth century British explorers and twenty first century Australian databasers*. Published by 'Making collective memory with computers', School of Australian Indigenous Knowledge Systems, Charles Darwin University, Darwin, Australia. Retrieved September 11, 2006, from http://www.cdu.edu.au/centres/ik/pdf/ExplorersandDatabasers.pdf

Verran, H., Christie, M., Anbins-King, B., van Weeren, T., & Yunupingu, W. (2006). *Designing digital knowledge management tools with Aboriginal Australians: Performative knowledge making*. Published by 'Making collective memory with computers', School of Australian Indigenous Knowledge Systems, Charles Darwin University, Darwin, Australia. Retrieved September 11, 2006, from http://www.cdu.edu.au/centres/ik/pdf/DDKMT-AA.pdf