

SOFTWARE CURATING

The Politics of Curating in/as (an) Open System(s)

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A thesis submitted to the University of Plymouth in partial fulfilment for the degree of

DOCTOR OF PHILOSOPHY

**School of Computing, Communications and Electronics
Faculty of Technology**

April 2008

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ABSTRACT

The thesis examines how information technologies have changed the practice of curating. It proposes an interdisciplinary approach that directly links curating (often understood as an activity of artistic programming), computing (the activity of computer programming) and a relatively recent interest in software art (in which programming is understood as artistic practice). Although there is much contemporary critical work and practice that is described as art-oriented programming or software art, the thesis aims to explore a perceived gap in discussions around software curating.

Curators working with online technologies are presented with the challenge of how to respond to new artistic forms that involve programming: for instance program-objects that display dynamic and transformative properties, and that are distributed over socio-technological networks. Although there are many examples of social platforms and highly relevant examples of online 'art platforms', these still largely operate in display mode replicating more conventional models of curating and the operations of art institutions in general. The tendency is for these curatorial online systems to concentrate on the display of executed code and pay less attention to source code. New sensibilities are required that simultaneously reflect the significance of source code as art, and software not as a production tool or a display platform but as cultural practice that is analogous to curating. What is distinctive about the thesis is that it speculates on a curatorial model that emphasises the analogy to programming. Consequently, the thesis argues for online software systems that display properties of curating but reprocess established definitions by deliberately collapsing firm distinctions between the fields of programming, artistic practice and curatorial practice.

To consider these issues, the thesis brings together a number of inter-related fields of critical inquiry and situates curating in the context of theories of immateriality, a critical discourse around software art practice, and an understanding of open systems. The key issue for the thesis becomes how power relations, control and agency are expressed in new curatorial forms that involve programming and networks; in other words, the thesis is concerned with the politics of curating in/as (an) open system(s). Indeed, curating itself can be described in terms of open systems, implying a state in which there is continuous interaction with the socio-technological environment. The system is opened up to communicative processes that involve producers/users and to divergent exchanges that take place and that disrupt established social relations of

production and distribution. Thus, and importantly for an understanding of the power relations involved, software opens up curating to dynamic possibilities and transformations beyond the usual institutional model (analogous to the model of production associated with the industrial factory) into the context of networks (and what is referred to by the Autonomists as the 'social factory'). The suggestion is that the curatorial process is now closely integrated with the dynamic socio-technological networks and with software that is not simply used *to curate* but demonstrates the activity of *curating in itself*. Consequently, the thesis offers an expanded description of curating with respect to software in which agency is reconstituted to include alternative dynamics of networks.

The curatorial model is not only theorised but also deployed in the production of experimental software for curating source code (*kurator*) that forms the practical part of the doctoral research. In addition to a written thesis and software, two further projects produced during the registration period 2002–2008 are included in support of the overall thesis: a conference *Curating, Immateriality, Systems* (CIS) (Tate Modern, London 2005) and an edited book *Curating Immateriality: The Work of The Curator in the Age of Network Systems* (CI) (Autonomedia, New York 2006). The *kurator* software is a further development of the conference and subsequent book, and offers an online, user-moderated curatorial system for further public modification. In so doing, the argument is that the curatorial process is demonstrably a collective and distributed executable that displays machinic agency. This is what is referred to in the thesis as software curating.

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ACKNOWLEDGEMENTS

Thanks to my supervisors Professor Roy Ascott, Professor Malcolm Miles and Dr. Christiane Paul who offered invaluable support in research and production of the thesis.

I extend my thanks to Arts Council England for generous funding of many projects that go towards the doctoral submission, and the Faculty of Arts and Faculty of Technology at the University of Plymouth for ongoing support for my research.

I would also like to thank my collaborators and colleagues who have helped in the preparation of the thesis and related projects: George Grinsted, Karol Kwiatek, Anya Lewin, Hugo de Rijke, Grzesiek Sedek, Duncan Shingleton, Sarah Solftley, and Adrian Ward. Last but not least I am indebted to Geoff Cox – without his enduring encouragement and advice at every stage of my work the research would have never been completed.

AUTHOR'S DECLARATION

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Committee.

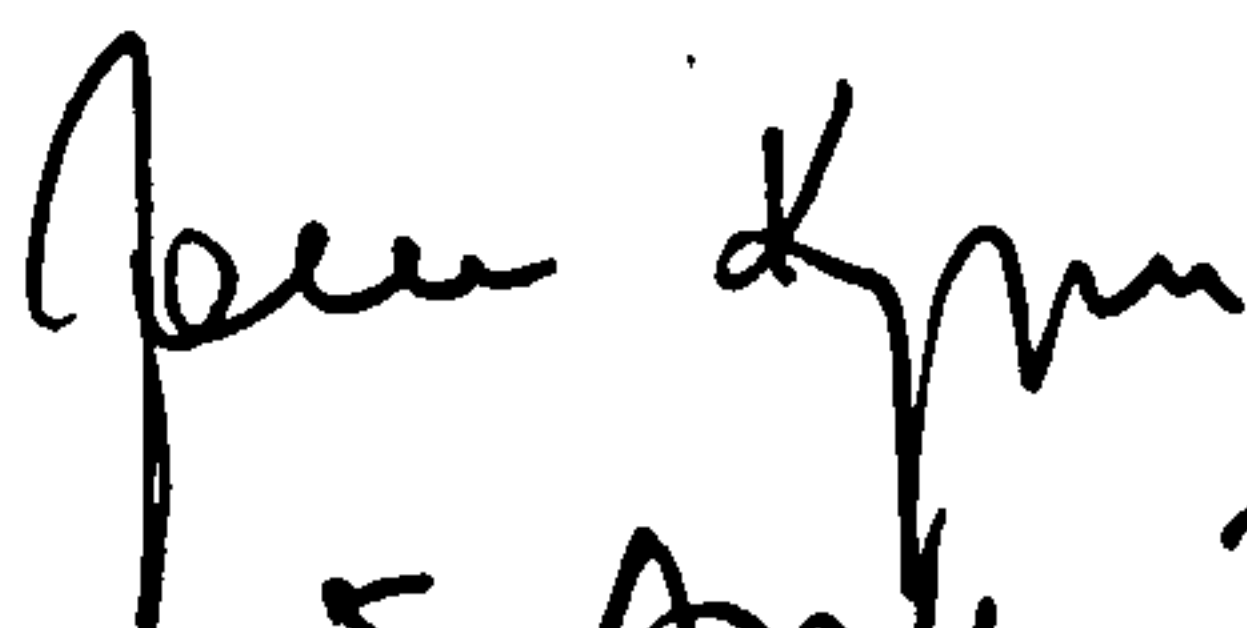
This study was financed with the support of the Faculty of Technology and the Faculty of Arts, University of Plymouth.

Relevant seminars and conferences were attended at which work was presented and several papers prepared for publication. Published papers and projects specifically related to the thesis produced during the registration period (2002-2008) are included in the Appendices. In addition, documentation of three projects (the conference *Curating, Immateriality, Systems*, edited book *Curating Immateriality*, and the *kurator* software) is included on DVD.

Word count of main body of thesis: 41 261

Word count of endnotes: 65 282

Signed:



Date:

5 April 2008

Introduction

The thesis examines how Information technologies have changed the practice of curating. It proposes an interdisciplinary approach that directly links curating (often understood as an activity of artistic programming), computing (the activity of computer programming) and a relatively recent interest in software art (in which programming is understood as artistic practice). Although there is much contemporary critical work and practice that is described as art-oriented programming or software art, the thesis aims to explore a perceived gap in discussions around software curating. The approach the thesis takes reflects the recent shift of attention to the cultural significance of software and programming, and extends its relevance to curating. Analogous to the distinction between software as a tool to produce art and software as artwork, an underlying assumption of the thesis is an understanding that software can not only be used as a tool for curating but also, and importantly, that it can demonstrate *curating in itself*.

A line of inquiry that links curating with information technologies follows earlier work in the cultural field. In particular, it evokes the statement made by Walter Benjamin in his essay 'The Work of Art in the Age of Mechanical Reproduction' of 1936:

'Earlier much futile thought had been devoted to the question of whether photography is an art. The primary question – whether the very invention of photography had not transformed the nature of art – was not raised. Soon the film theoreticians asked the same ill-considered question with regard to film.' (1999 [1936]: 220)

In 1988, this observation was reworked by Bill Nichols in his essay 'The Work of Culture in the Age of Cybernetic Systems', stressing that our presumptions about what constitutes art and life have been radically overturned (2003). In relation to economic and social formations, Nichols considered how cybernetics transformed cultural production to emphasise a shift from mechanical reproduction (symbolised by the camera) to that of cybernetic systems (symbolised by the computer). This thesis extends the line of argument of Benjamin and Nichols by suggesting how a similar false presumption is made about a fixed, or ontologically given nature of curating, rather than discussing how curating itself has been transformed. Furthermore, the thesis suggests a renewed currency for this question in relation to technological networks (symbolised by the Internet) to investigate how technological networks have changed the very nature of curating, and thereby to avoid – paraphrasing Benjamin – futile thinking as to whether they offer curatorial potential. Instead the focus is on the nature of the transformation of curatorial practice as a result of the emergence of the Internet. The thesis makes reference to a technical distinction made by Paul Baran in his model for a distributed network (of 1964) in contrast to what he refers to as centralised and decentralised network models.¹ Baran's interest was in developing an

optimal structure and a more robust communication network using digital computers. This resulted in his pioneering idea of the distributed network model, organised around the principle of dynamic routing based on a mesh-like architecture. This process of dynamic routing becomes the basis for the development of what by the 1980s was officially referred to as the Internet to describe a single global TCP/IP network and for the conception of the World Wide Web (WWW) developed by Tim Berners-Lee in 1989.² Importantly, the technical structure of a distributed network lies in parallel to thinking about the social aspect of computer networks. For example, in his visionary book *The Network Revolution of 1982*, Jacques F. Vallee envisages the social impact of computer networks. He was later to contribute to the development of the first network-based groupware (conferencing) system Arpanet, which was the prototype for the Internet. Even earlier in 1978, Starr Roxanne Hiltz and Murray Turoff published the book *The Network Nation: Human Communication Via Computer* that introduced the concept of computer-mediated communication (CMC). These references inform an understanding of social networking enabled by network technologies; what in more contemporary discourse is referred to as socio-technological networks.

Taking Baran's starting premise as an analogy to curating, a key question becomes what would be the optimal curatorial structure – a system and a process (or protocol) appropriate for the context of information technologies. Curators working online are presented with the challenge of how to respond to new artistic forms that involve programming: program-objects that display dynamic and transformative properties, and that are distributed over socio-technological networks.³ These forms such as software, computer viruses, or lines of code display technical and conceptual qualities associated with 'systems' and 'networks'; emphasising a further shift towards an understanding of an artwork as process and system, towards its openness and the focus on users. In this way they further challenge established aesthetic and curatorial conventions. The development in understanding source code as a meaningful expressive form in its own right, rather than in its functional aspect as merely instructions and notes, can be seen as analogous to other disciplines that in a similar way developed notation systems (such as a score in music or a formula in chemistry or physics).⁴ Although there are many examples of social platforms and highly relevant examples of online 'art platforms' dedicated to bringing these new artistic forms into the public domain, they still largely operate in display mode, replicating more conventional models of curating and the operations of art institutions in general. The tendency for these curatorial online systems is to concentrate on the display of executed code and to pay less attention to source code. New sensibilities are required that simultaneously reflect the cultural and social significance of source code as potential art, and that reflect software⁵ not as a production tool or a display platform but as cultural practice that is analogous to curating. What is distinctive about

the thesis is that it speculates on a curatorial model that engages more overtly with programming and networks, and that emphasises the analogy between the activities of programming and curating.⁶ Consequently, the thesis argues for online software systems that display properties of curating but that reprocess established definitions by deliberately collapsing firm distinctions between the fields of programming, artistic practice and curatorial practice.

The key concern for the thesis becomes how power relations, control and agency in particular are expressed in new curatorial forms that involve technological open systems. In other words, the thesis is concerned with the politics of curating in/as (an) open system(s).⁷ Indeed, curating itself can be described in terms of open systems, implying a state in which there is continuous interaction with the socio-technological environment. The system is opened up to communicative processes that involve producers/users and to divergent exchanges that take place and that disrupt established social relations of production and distribution. Thus, and importantly for an understanding of the power relations involved, software opens up curating to dynamic possibilities and transformations beyond the usual institutional model (analogous to the model of production associated with the industrial factory) into the context of networks (and what is referred to by Autonomist Marxists as the 'social factory'). The suggestion is that the curatorial process, already collaborative and involving other agencies in addition to a singular curator, now becomes closely integrated with dynamic socio-technological networks and software; software that is not simply used *to curate* but demonstrates the activity of *curating in itself*. Consequently, the thesis offers an expanded description of curating with respect to software and suggests a curatorial model in which agency is reconstituted to include alternative dynamics of networks and software.

To consider these issues, the thesis brings together a number of inter-related fields of critical inquiry, or rather operates across the fields of political economy, social science and systems theory in particular. What these fields have in common are ways of understanding and interpreting systems, as well as the issue of agency within these systems. The thesis situates curating in the context of theories of immateriality (chapter 2), an understanding of open systems (chapter 3), and current critical discourse on software art, including descriptions of source code as artwork (chapter 4). In addition to this, a large number of selected examples of curatorial projects that are representative of the field are presented to suggest an emerging curatorial tendency (chapter 5). Taken together, the theoretical arguments and a catalogue of projects constitute a body of work that is interdisciplinary in character and simultaneously presents a very particular view of the practice of curating.

The model offered is not only theorised but also deployed in the production of experimental online software for curating source code (*kurator*) that forms the practical part of the doctoral submission (presented in chapter 6.1) in parallel to the written thesis.⁸ The appendices include documentation of two further projects in support of the overall thesis: a conference *Curating, Immateriality, Systems* (Tate Modern, London 2005) that I organised and introduced, and an edited book *Curating Immateriality* (Autonomedia, New York 2006) that followed and extended the conference (included in appendices 8.1). The software project and the conference are available online and are additionally documented along with the book on a DVD included with the thesis. Research towards the production of the thesis led to publication of a number of papers and conference presentations during the PhD registration period (included in the appendices 8.2 and 8.3).⁹ The multiple formats the submission takes reflect the area of applied research investigated in the thesis and the conceptual approach taken. To paraphrase Ned Rossiter's *Organized Networks*, the thesis is 'about conditions of possibility, the immanent relation between theory and practice and about the potential of constructing transdisciplinary' curatorial forms that 'enlist the absolute force of labour and life' (2006: 17).¹⁰

In summary, the thesis extends existing online curatorial platforms to suggest the possibility of an open, user-moderated, collaborative software system for further public modification. However, the contribution is not to be understood in terms of software engineering or programming per se but rather as a contribution to a critical discourse and a practice at the intersection of computer programming, software art and curating, and ultimately as a contribution towards the development of curatorial theory and practice.¹¹ The argument is that with open technological systems, the curatorial process is demonstrably a collective and distributed executable that displays machinic agency.¹² This is what is referred to in the thesis as software curating.

1.1 Defining The Field of Research

The thesis is centrally concerned with the practice of curating and the literature overview provides historical detail in this respect. Whereas there is a wealth of key references that deal with curating indirectly as part of other theoretical disciplines such as cultural studies, anthropology, art history or museology, the critical discourse around curating per se is relatively limited.

From the perspective of cultural studies and anthropology, examples of references that are of relevance for curating include: James Clifford's 'On Collecting Art and Culture' (2000), Susan Stewart's 'On Longing' (2000), John Elsner and Roger Cardinal's (eds.) *The Cultures of Collecting* (1994), and an earlier historical text by Walter Benjamin 'Eduard Fuchs, Collector and Historian' (1978). The particular importance of these

references for curating is that they all suggest a relationship between curating and collecting, and emphasise collecting as part of a wider cultural system, expressing human desires and social stratifications.

In relation to museology and art history, examples include: Karsten Schubert's *The Curator's Egg: The evolution of the museum concept from the French Revolution to the present day* (2000) that explores curating in relation to the development of museums; and Reesa Greenberg's et al (eds.) *Thinking about Exhibitions* (1996) that provides a collection of critical essays exploring construction of meaning in relation to gallery spaces and the interactions of audiences. The latter book is perceived as the most comprehensive curatorial resource in this respect to date. Two essays in Greenberg's collection are particularly interesting: Rosalind Krauss's 'Postmodernism's Museum without Walls' (originally published in French as 'Le Musée sans murs du postmodernisme', 1986) that further explores André Malraux's (1978) earlier concept of *musée imaginaire (museum without walls)*¹³, and Jean-François Lyotard's 'Les Immatériaux' (originally published in *Art & Text*, 17, 1985) in parallel to the exhibition that he curated with Thierry Chaput at the Centre Georges Pompidou in Paris (1984) that introduces the term 'immaterial' in relation to 'new materials' in creative practice.¹⁴ For Lyotard, the immaterial contradictorily denotes a material that is 'not a matter for a project' (1996: 160). Lyotard's approach also relates to the critical tradition of post-structuralism with its focus on language. From this position, Jean Baudrillard's 'The System of Objects' (1969) extends the Marxist critique of capitalism, replacing the productivist metaphor with a semiological model to discuss the status of the commodity. Furthermore, Douglas Crimp's 'On the Museum's Ruins' (1990) explores the modern institution of the museum and the social function of art as an institution.

More relevant for the concern of this thesis, a series of publications have emerged to address artistic practice that involves the Internet and the World Wide Web (hereafter referred to simply as the Web). For example, Julian Stallabrass's *Internet Art: The Online Clash of Culture and Commerce* (2003) provides a brief overview of current examples (at the time) of online art and online economy, and Rachel Greene's *Internet Art* (2004) situates 'art for networks' in an art-historical context and the context of the history of development of network technologies. A further pertinent example in this connection is Christiane Paul's *Digital Art* (2003) that not only explores of the concept of 'digital art' while identifying the influences that science, technology and historical art movements had on the shaping of the concept, but more importantly in the context of the thesis provides an introduction to issues directly relating to curating digital art.

There have also been a number of key references and historical texts exploring the link between art and developments in computational technologies, that address the focus

of the thesis by considering the organising principles of systems. For instance, in the late 1960s, Jack Burnham's work emerged at a time when the field of digital computing and the conception of the Internet were in early stages of development.¹⁵ In particular, Burnham's essays 'System Esthetics' (1968) and 'Real Time Systems' (1969) used informational systems as a metaphor to describe technological culture and the changing role of the artist within the art system. His exhibition *Software* in the Jewish Museum in New York (1970) explicitly used the term 'software' as a metaphor for ideas, processes and systems, as opposed to the 'hardware' of traditional object-based practices.¹⁶ Other historically significant exhibitions and projects that dealt with the increasing impact of communication technologies on art were: the *Cybernetic Serendipity* exhibition curated by Jasja Reichardt at the ICA (The Institute of Contemporary Art) in London (1968);¹⁷ the *Art and Technology* project developed by Maurice Tuchman and Jane Livingstone at the Los Angeles County Museum (1966–1971);¹⁸ the *Information* exhibition curated by Kynaston McShine at the Museum of Modern Art, New York (1970); and research projects by the *Experiments In Art and Technology* (EAT) group (set up in 1967 by engineers and artists Billy Klüver, Fred Waldhauer, Robert Rauschenberg, and Robert Rauschenberg)¹⁹ and by the *Center for Advanced Visual Studies* at MIT (founded in 1967 by Gyorgy Kepes).²⁰ A further example is the exhibition of computer generated art *Tendencije 4* in Zagreb (1968) which along with the contemporaneous magazine on aesthetic and media theory *Bit International* was recently revisited in a major 'retrospective', *Bit International: [Nove] Tendencije computer and visual research* curated by Darko Fritz in Neue Galerie am Landesmuseum Joanneum, in Graz (2007).²¹ This is one example of many recent projects that have used the common strategy of revisiting earlier works to draw historical parallels and analogies. Similarly, the title of Charlie Gere's essay 'Jack Burnham and the Work of Art in the Age of Real Time Systems' (2005) explicitly draws upon references to Burnham and Benjamin, if not Nichols (all mentioned earlier in the chapter).

There seems to have been an unprecedented revival of interest in historical work that attempts to contextualise and archive developments in this field, resulting in a number of large-scale historical surveys, conferences, digital repositories and archives that bring together critical theoretical references and art works. Like the example of *Bit International* mentioned earlier, other examples include: the series of conferences on the histories of media art, science and technology *Refresh!* (2005) and *Re:place* (2007);²² a digital repository examining the histories of media art, science and technology *MAH Archive* (Media Art Histories Archive);²³ the exhibition series *New Media: Who, What, Where, When and Why?* at the Neuberger Museum of Art (research project with the State University of New York, 2004–2007);²⁴ the recent exhibition and symposium *Open Systems: Rethinking Art c.1970* at Tate Modern, London (2005);²⁵ and more specifically related to new models of curatorial practices an online survey

project *[PUBLIC]_curating* by the Vienna-based organisation CONT3XT.NET.²⁶ Another pertinent example of the work that sets out to map art historical connections to current new media art and to 'cast a broad historical look at art that is responsive' is the *FEEDBACK* exhibition that was launched at the opening of LABoral Art and Industrial Creation Centre, in Gijón (2007).²⁷ The particular importance of this project is that it served to 'emphasize the much overlooked and often marginalized historical context of technology-based art' and to 'bridge categories that are often considered mutually exclusive by showing interconnections between software-based projects, net art, light works, early performance, and kinetic sculpture amongst other forms'. In this way, the show traced a 'historical lineage from instruction-based, generative, and conceptual art to telematics and networks' (Cornell 2007). The term feedback (central to cybernetics and understanding the dynamics of complex systems) operates as the subject of the show and describes its approach to historical work.

More recently, a range of references that deal with curating, not as part of other theoretical disciplines but as a separate critical inquiry and an interdisciplinary field of study in itself has emerged. This is reflected in the number of new curatorial educational programmes and courses over the last decade that explore curating within and outside established institutions.²⁸ There is also a proliferation of publications by key contemporary curators that explore independent curatorial practice. For example, *Words of Wisdom: A Curator's Vade Mecum on Contemporary Art* (2001) edited by Carin Kuoni is a collection of sixty essays presenting curatorial strategies in relation to changes in the field of contemporary art and curatorial practice, with particular reference to the Independent Curators International (ICI) project. Other examples of critical writing include: Anna Harding's *Curating: The Contemporary Art Museum and Beyond* (1997); *Curating in the 21st Century* (2000) edited by Gavin Wade, that explores new contexts for curating in relation to non-gallery spaces; Christoph Tanner and Ute Tischler's *Men in Black: Handbook of Curatorial Practice* (2004), a very extensive compendium of essays and statements on diverse approaches in contemporary curatorial practice; and Paul O'Neill's *Curating Subjects* (2006) that charts the ways in which curatorial practice has diversified to an unprecedented extent, particularly in the 1990s. In this connection, an example of *The Documenta: Museum of 100 Days* programme (since 1955) could be cited as historically pertinent in developing independent curatorial practice outside established arts institutions.²⁹

There are also publications and resources that deal with curatorial practice specifically in relation to 'new media'.³⁰ One of the key examples in this field is the CRUMB online discussion list and its website, providing a specialist resource for 'new media curators',³¹ as well as the related publication *Curating New Media* as part of the *B.Read* series of publications (2002). Of particular relevance to the thesis is Steve Dietz's 'Curating (on) the Web' (1997) (discussed in more detail in chapter 5) that considers

how new media have influenced the way museums operate and the way they increasingly respond to the potential of the Web as an independent presentation and distribution platform. In a later essay of 2004 'Art After New Media', Dietz asks how 'curating new media might change the practice of curating'. Although not referred to directly in the Dietz essay, the principle introduced by Benjamin and Nichols is once more evoked in that presumptions about art, life or curating are not fixed but subject to continual reappraisal. Similarly, a more recent book *circulating contexts--Curating Media/Net/Art* (2007) edited by the curatorial group CONT3XT.NET, was published as a timely response to the growing number of curatorial projects that explicitly involve social technologies, particularly since the emergence of Web 2.0.³² The focus of the publication responds to the expanding curatorial field and itself presents an experimental format, including edited extracts from the moderated online discussion list titled *[CC]* that ran for a period of three months (between June and August 2007), examples of selected projects, essays submitted through an open call process, and fragments of research gathered on a dedicated online platform *[Public] Curating*. Finally, the forthcoming anthology *New Media Curating* edited by Christiane Paul (2008) promises to offer the most extensive compendium of critical texts and case studies, with a particular focus on emerging approaches to curating new media. The book aims to provide an overview of the field and addresses the conceptual, philosophical, as well as practical issues of new media curation.³³

The references mentioned above are by no means an exhaustive list but are offered as a starting point for further development of a critical discourse around curating. The thesis aims to contribute to this discourse and builds upon my own edited collection of essays *Curating Immateriality: The Work of the Curator in the Age of Network Systems* (2006). As suggested in the subtitle, the book makes reference to the Nichols essay of 1988 in which he considers how cybernetics have transformed cultural production.³⁴ The thesis, like the book before it, continues this general line of inquiry, and extends its argument to curating in the context of immateriality and networks. The argument is that with the emergence of information networks the very nature of curating is open to question and is arguably transformed to a model based on distributed and immaterial forms of production. This is not to say, however, that the emerging tendency replaces or even eradicates older forms of curating but extends its potential and redefines its parameters. The approach the thesis takes does not argue for redundancy but is pragmatic in suggesting the coexistence of old and new forms and possibilities.

1.2 Defining Terms and Structure

To begin to investigate the critical field outlined by the research, the next section defines some of the key terms in parallel to an overview of the structure of the thesis.

The emphasis in this introductory section is on the term curating and begins with a brief definition. In its etymological sense, *curating* (to curate) derives from the Latin 'curare' – to care (for something or someone). Similarly, *curator* derives from the Latin 'curatus' (a curate) and literally refers to a person who is invested with the care, or cure (*cura*) of souls of a parish. In their essay 'On Misanthropy', Alexander Galloway and Eugene Thacker emphasise the etymological relationship in this way:

'The act of curating not only refers to the selection, exhibition, and storage of artifacts, but it also means doing so *with care*, with particular attention to their presentation in an exhibit or catalogue. Both "curate" and "curator" derive from the Latin *curare* (to care), a word, which is itself closely related to *cura* (cure). Curate, care, cure.' (2006: 160)

In relation to cultural (heritage) institutions such as the museum, gallery, library, archive, or garden, a curator is a person who 'cares' for the institution's collections. Traditionally, the curatorial remit in such institutions includes research, the selection of objects (artworks) for display (and/or collections), interpretation, making provision for the effective preservation, conservation, documentation, and the public display of the collection.³⁵ In a more contemporary sense, and with the changing model of cultural production and the art-culture system in general, there is an emergence of far more diverse descriptions of curating – with freelance curators, or those outside of institutions (independent curators) operating in multiple roles (such as publishing, collecting, installing, designing, etc), and developing idiosyncratic methodologies for curating. For example, the term 'tactical curating' is used by Roger McDonald (of Arts Initiative, Tokyo) to describe the peculiar characteristics and advantages of operating independently (making reference to 'tactical media'³⁶). In the contemporary art world, the proliferation of curating (and curators) from the 1980s and 1990s onwards can be partly linked to an increasing demand for art-mediation on the part of artists in a system which places economic value on contemporary art production (Funken, in Tanner and Tischler 2004: 23). In a general sense, curators assist in the production of economic and non-economic value. Other definitions of curating that have emerged in a more current context point to its understanding as a technology, or rather one of the technologies – a form of production and a creative activity in itself – used by cultural institutions to frame and juxtapose artworks. This position, advocated by Alf Rehn for instance, defines curating as a collaborative practice that establishes connections, creating mashup and collage-work, a technology to reinforce the shift away from the focus on artwork as the 'work of individual genius'.³⁷

However, it should be emphasised that curating is neither exclusive to museums and galleries nor to contemporary culture. The motif of curating was already present during the Middle Ages in Christianity, most often with reference to a spiritual guide or a curate, a person invested with the spiritual care, or cure (*cura*) of souls. In this sense, a curator (a curate) technically means a parish priest. Furthermore, the etymology of

the term relates it to the dominant Biblical metaphor of the shepherd and flock that encompasses the idea of spiritual care (of those 'chosen') but also extends it to leadership and thus certain forms of governance (Galloway and Thacker 2006: 166). For Elsner and Cardinal (1994), the Biblical metaphor is particularly relevant in relation to three aspects of traditional curating: that of classifying, collecting and preserving. They point to the Biblical figure of Noah as the first and an extreme case of the collector who, driven by his need to save the world, undertakes a conscious and systematic act of rescuing animals from extinction, an act that Elsner and Cardinal describe as 'collection as salvation' through which the 'complete set' is achieved. They quote the original source to emphasise the curatorial impulse:

'And of every living thing of all flesh, two of every sort shalt thou bring into the ark, to keep them alive with thee; they shall be male and female. Of fowls after their kind, and of cattle after their kind, of every creeping thing of the earth after his kind, two of every sort shall come unto thee, to keep them alive.'
(Genesis 6.10-20, in Elsner and Cardinal 1994: 1)

According to Elsner and Cardinal, in the myth of Noah all key elements of curating are present: the act of collecting, constructing inventory and preserving, with Adam's act of classification (of all 'creatures that God has made') that precedes and makes possible the collection. The myth is also useful in highlighting the etymological duality and inherent paradox involved in curating – that the aspect of 'care' exists in parallel to mechanisms of control:

'To collect up to a final limit is not simply to own or to control the items one finds; it is to exercise control over existence itself through possessing every sample, every specimen, every instance of an unrepeatable and nowhere duplicated series. [...] Absolute control is only realized at the pitch where it can actually extinguish that which is controlled.' (Elsner and Cardinal 1994: 4)

The paradoxical aspect of care and control in curating is also emphasised by contemporary critical commentators. For Galloway and Thacker, the act of curating 'enframes, contextualises, bounds, manages, regulates and controls. In doing so it also opens up, unbridles, and undoes the very control it seeks to establish.' (2006: 160) In this way, curating encapsulates control and management leading to an outcome on the one hand, and on the other represents the possibility of an intervention or transformation from outside parties. Galloway and Thacker describe this in the following way:

'The role of *curare* (care) in curating and the activity of the curator plays a dual role. On the one hand, the care in curating conceptually tends towards the presentation of the static: collecting, archiving, cataloging and preserving, in a context that is both institutional and architectural. [...] But there is also always an excess in curating, an opening, however wide or narrow, through which the unexpected happens. As a visitor to an exhibit, one's interpretations and opinions might vary widely from both the curator's original vision and from those interpretations and opinions of other visitors. Or one might not notice them at all, passing over all the care put into curating. Such is the scene: there is either too much ("what's your opinion?") or too little ("I didn't notice").'
(2006: 172)

The paradox is even more apparent in relation to online curating. The dynamic relations of care and control reflected in the dynamics of technological networks open up possibilities of unpredictable and unexpected curatorial processes. This tension, also identified by Nichols (as mentioned earlier) in relation to the cultural use of computer systems, between control and openness, is a consistent concern for the thesis.

The following chapter situates curating in the context of theories of Immateriality to consider the transformation of characteristics and patterns of curatorial work as a result of an increased involvement of information technologies.³⁸ The term is employed with reference to the Autonomist Marxist tradition that examines the transformations undergone by labour in post-Fordist or, to use Manuel Castells's term, network societies. In his book *The Rise of the Network Society* (1996), Castells offers an extensive understanding of the work process in an analysis that emphasises the importance of the network for the development of the global information economy and the figure of the net-worker (hence the reference to it in the title of chapter 2). The importance of the approach developed by the Autonomists for the thesis is in the description of labour as immaterial (termed as immaterial labour)³⁹ and subsequently, the transformation of cultural work from the production model associated with the industrial factory into the context of networks referred to by the Autonomists as the 'social factory'. The theory of Immateriality takes into account creative work more fully, which has a particular relevance to the process and practice of curating.

This discussion is extended in chapter 3 to explore the issue of agency (the power to act) in curating that involves open technological systems. The critical approach of this chapter is informed by references derived from a number of interrelated fields of inquiry relevant for the focus of the thesis, including systems theory, cybernetics, chaos theory, complexity theory and social science with respect to the issue of agency. What they all have in common is an attempt to explain complex systems (i.e. systems made up of a large number of interacting and interrelated parts) and the complex interactions that take place within those systems. Subjects such as complexity, self-organisation, emergent properties, open and adaptive systems are at the core of inquiry for these disciplines and the thesis draws upon these to various degrees. Of particular relevance however is systems theory and cybernetics. Although distinctive fields of inquiry – cybernetics emerged from engineering and is credited to Norbert Wiener's work *Cybernetics* (1948) while the general systems theory derives from biology and the work of Ludwig von Bertalanffy's *General Systems Theory* (1968) – the terms 'systems theory' and 'cybernetics' have been often and rather confusingly used as synonyms.⁴⁰

In this chapter the focus is on understanding the dynamics of socio-technological systems and their relevance for curating. Drawing upon the understanding of curating as immaterial (established in chapter 2), the suggestion is that curating not only increasingly involves open technological systems but can itself be considered in terms of an open system. Subsequently, chapter 3.1 explores the dynamics of open systems to further investigate organisation and forms of power and control. This is undertaken with respect to computational systems (i.e. computers as a combination of hardware and software) and information networks (i.e. the Internet as the physical infrastructure connecting computers and even more precisely a network of routers that communicate with each other through protocols, as well as its applications in communication formats such as email and the Web). The chapter asks whether the technical protocols underlying technological open systems can be seen as analogous to curatorial protocols and whether curating itself can be considered an open system. In the use of the term protocol it refers to an understanding offered by Alexander Galloway in his book *Protocol: How Control Exists after Decentralisation* as: 'a type of controlling logic that operates outside institutional, governmental, and corporate power, although it has important ties to all three' (2004: 122).⁴¹ He adds further detail to this definition:

'Protocols are highly formal; that is they encapsulate information inside a technically defined wrapper, while remaining relatively indifferent to the content of information contained within. Viewed as a whole, protocol is a distributed management system that allows control to exist within the heterogeneous material milieu.' (2004: 7)

The next section (chapter 3.2) introduces the issue of agency in contrast to unpredictable phenomena described by complexity theory. It is easy to see how protocols are required within complex systems to try to derive order from what appears to be disordered or outside of control. But this opposition does not take sufficient account of how complex systems are not random or chaotic, but on the contrary underpinned by deep-seated order and subject to self-organisation.⁴² Paul Cilliers in *Complexity and Postmodernism* offers a definition of complex systems:

'The interaction among constituents of the system, and the interaction between the system and its environment, are of such a nature that the system as a whole cannot be fully understood simply by analyzing its components. Moreover, these relationships are not fixed, but shift and change, often as a result of self-organisation. This can result in novel features, usually referred to in terms of emergent properties. The brain, natural language, and social systems are complex.' (1998: ix)

The argument is that despite the lack of predetermined or fixed structure, behaviour expresses emergent properties that can be understood. And consequently, despite the perceived lack of predictability in (complex, technological, open) systems there is emergent agency and transformation. It is this emergent sense of agency that the chapter refers to, reconstituted to account for distributed and partly automated forms of organisation negotiated through software and networks. Drawing upon the previous chapter, the suggestion is that agency is both restricted but also extended and

enhanced by immaterial forms of socio-technical organisation. In relation to curatorial agency, the use of technological networks can be utilised in such a way for reinvention. In this sense curating can be characterised as open and distributed, to both reflect the organisation of systems of which it is part and the reconstitution of curatorial agency as an emergent property of the system.

The focus of the subsequent chapters is on software, to reflect an extended understanding of software as cultural expression and artistic practice, with reference to online curatorial platforms. However, rather than making an issue of how curators might respond to new art forms such as program-objects, it emphasises the more pressing issue of how new forms of artworks to be curated are increasingly *like* curating. Here, examples include wikis and art platforms underpinned by social technologies that allow for user-generated content.

Firstly, chapter 4 focuses on the critical discourse surrounding emergent software art practices (what can be described as software cultures) followed by a description of technical and conceptual qualities associated with source code as artwork.⁴³ The discussion on source code as artwork to be curated is important to the thesis and for the *kurator* project, an online software system for curating source code (presented in chapter 6.1). In chapter 5, software is discussed in relation to online platforms as demonstrating ambiguities over what constitutes a space for curatorial practice (understood as both production and presentation site). Chapter 5.1 charts a historical overview of the development of curatorial practice that engages with technology, with a particular focus on the use of the Internet and the Web as one aspect of this. Tracing the historical lineage in the field is important, as it allows for the introduction of a number of more current examples in chapter 5.2 and at the same time helps to demonstrate a certain logic in the development of what appears to be an emergent curatorial practice. Software is considered first for its functional aspects as a tool for the production of new online curatorial projects and platforms but the discussion is subsequently extended to consider software as an integral part of the curatorial process. Historically, the idea of using software as part of the curatorial process has been variously referred to as *automated curating*, *software-aided* or *software-enabled curating*. The issue of automatising in relation to curating that involves technology (as suggested in the term 'automated curating'), although clearly relevant to the thesis, is a separate thread that in some ways deserves a more thorough examination, which is outside of the scope of the thesis.⁴⁴ This is a point of departure for the final and concluding chapter.

The concluding chapter develops critical thinking about curating and open technological systems to posit the idea of software curating. It introduces the concept of curatorial practice that involves online software as an integral part of the curatorial

process (software as curating), while collapsing earlier distinctions between software as artwork (discussed in chapter 4), software as a tool (referred to in chapter 5), and software as exhibiting emergent agency (in relation to examples described in chapter 5.2). The first section of the chapter speculates on a curatorial model termed in the thesis as software curating, thus making a direct reference to software art and collapsing firm distinctions between curating, programming and artistic practice. In this model, although it would appear that any sense of agency is reduced, the argument is that agency is reconstituted to include the possibilities offered by open technological networks (such as the Internet and networked computers) and software for human and machine intervention. The proposition is to implement the principles of open source development on a practical and metaphorical level, as well as a methodology for curatorial practice more generally. Importantly, the thesis not only theorises such a model but also deploys it in practice in the production of the *kurator* software that is presented in the final chapter. *kurator* is online software for curating source code: an open and user-moderated system for collecting, storing, processing and viewing source code arranged into displays. In addition, users can add further functionality and make modifications to the *kurator* software itself. In this way, the project brings together the practice of curating (often understood as an activity of artistic programming) with computer programming and software art practice in an open and dynamic online system. Here I am drawing upon a simple definition of a dynamic system proposed by Katherine Hayles in her essay 'Boundary Disputes: Homeostasis, Reflexivity, and the Foundations of Cybernetics' (of 1994) as the system that changes over time. The change is 'expressed through differential equations, which describe how the behaviour of variable changes with respect to time' (1994: 16). Thus, *kurator* provides a platform for curators to organise and arrange source code into meaningful displays, for programmers and the general public to engage in curatorial activity by arranging scripts, as well as by the possibility of modifying and programming their own versions of the system (software).

It is important that the work demonstrates the principles articulated in the earlier text but is not simply to be seen as an illustration. It aims to carry and extend the argument in its own right. The working method for researching and writing the thesis in itself can also be described broadly as a curatorial approach in that I commissioned and selected, assembled and contextualised essays for a book which have become the basis for my research material (*Immaterial Curating*). Prior to this, I curated a project that involved the conception of a topic based on a research question and explored it in the format of a conference, commissioning speakers/presentations, structuring content, contextualising and documenting the event (*Curating, Immateriality, Systems*). Taken together, these activities are expressions of a curatorial sensibility. On the surface this may seem like speculative thinking, but in referring back to the genealogy of the word and a historical understanding of the term, the claim is less contentious.

Finally, the ideas explored in the conference and the book have formed a conceptual framework for the development of the online software project, that attempts to implement these ideas into a practical manifestation of the research.

2. Net-Work

Following the assertion that curating cannot be dissociated from socio-technological developments, this chapter situates curating in the context of Immateriality.⁴⁵ The term Immateriality is employed with reference to the Italian Autonomous Marxist tradition and the transformations undergone by labour in post-Fordist, or network societies. The emphasis throughout the chapter is on the redefinition of the processes of production and labour (subsequently termed 'immaterial labour')⁴⁶, and how power relations and control are currently organised. Despite this stated conceptual focus, there are also a number of other important references that attempt to provide a comprehensive view of recent economic, social, political and cultural changes from different critical perspectives. In particular, Manuel Castells' book *The Rise of the Network Society* (1996) offers an extensive understanding of informational work processes, in an analysis that emphasises the importance of the 'network' and the figure of net-worker (hence the hyphenated title of the chapter).

The importance of the theoretical approach offered by the Autonomists is in that it not only attempts to fully understand the transformation of relations of production and characteristics of work patterns in the context of the increased use of network technologies and communication systems, but more specifically that the analysis is extended to forms of creative labour exemplified by artistic and curatorial practice.⁴⁷ Furthermore, it provides a critical response to the unreconstructed 'cyberlibertarianism' of commentators (such as Kevin Kelly, in *Out of Control*, 1994), and what is referred to as 'new humanism'. To Tiziana Terranova, such views do not account for a critical theorisation of 'collective intelligence' in information networks and its relation to capital (in addition to Kelly, her further examples are Pierre Lévy's *Collective Intelligence*, 1994, and Arthur Kroker's *Digital Humanism*, 1997). She asks: 'How can we hold on to the notion that cultural production and immaterial labour are collective on the Net (both inner and outer) without subscribing to the idealistic cyberdrol of the digerati?' (2000)

Drawing upon the work of the Autonomists, and as Marina Vishmidt points out, Immateriality is a useful concept in current attempts to 'index the characteristics of curatorial, critical and media sectors to the wider structural transformations in the landscape of work' (in Terranova 2006: 27). Thus, to situate curating in the context of Immateriality offers an understanding of it not only as a creative and critical practice but also as a thoroughly political one. It allows discussions to develop about the transformations of work and the structures of control expressed through curatorial work. To explore this in more detail, the concept of Immateriality is considered firstly with relevance to creative work (chapter 2.1), and secondly, in relation to technological

open systems (chapter 2.2). At the end of the chapter, I will return to the work of the curator as characterised by managerial attributes in being highly self-motivated and organised across networks. The practice of curating is analogous to a content-management system.

2.1. Immateriality and Creative Work

The cultural and political implications of information technologies, communication networks, and the increasingly 'immaterial' form of social relations have been examined by writers and political theorists associated with Autonomia, in the late 1960s and 1970s.⁴⁸ Their focus was on the change from a Fordist to a post-Fordist (sometimes referred to as post-Industrial) economic model and new dominant forms of production that extend an understanding of the 'factory' under industrialism to involve information systems and communications networks.⁴⁹ The discourse around immateriality is – according to Michael Hardt and Antonio Negri – a particularly useful one in that it offers a deeper understanding of a relationship between social production and 'biopower'. It recognises the centrality of a biopolitical dimension of productive labour and 'its living development in society' articulated through key terms such as 'mass intellectuality', 'immaterial labour' and 'general intellect' (Hardt and Negri 2000: 28–29). They derive the genealogy of this critical perspective from a poststructuralist understanding of biopower (and the key term of 'social machines') developed by Gilles Deleuze and Felix Guattari (1987), drawing upon the work of Foucault, to focus attention on the question of the production of 'social being'. By this, they are attending to the ontological substance of social production and the recognition of productivity of social reproduction (creative reproduction, production of values, social relations, affects, becomings). However, Hardt and Negri also point to the limitations of the critical approach developed by Deleuze and Guattari in that it largely fails to positively conceive 'creative elements and the radical ontology of the production of the social' (2000: 28). This is precisely where the Autonomists succeed in recognising new figures of subjectivity (that imply a social and communicative dimension) in terms that account for both their exploitation and their radical potential for transformation.

To the Autonomists, the emergence of new forms of production is demonstrated in an increasing dominance of the service-sector, creative industries, research, symbolic management and so forth, and this results in the production of 'immaterial goods' (goods that have no physical form and are not durable; that have different form of materiality) such as a service, cultural product, knowledge, or communication. These are characterised by their informational and cultural content and, consequently, the labour that produces such commodities is referred to as 'immaterial labour'. Immaterial labour is a key term in this theoretical field of inquiry that came to

prominence especially with the writings of Hardt and Negri (2000) and Maurizio Lazzarato whose essay 'Immaterial Labour' of 1996 provides an extended analysis of this concept and emphasises its particular relevance to creative work.⁵⁰

Lazzarato explains that labour takes more abstract and affective forms:

'The various activities of research, conceptualization, management of human resources, and so forth, together with all the various tertiary activities, are organized within computerized and multimedia networks. These are the terms in which we have to understand the cycle of production and the organization of labor. The integration of scientific labor into industrial and tertiary labor has become one of the principal sources of productivity, and it is becoming a growing factor in the cycles of production that organize it.' (1996: 137)

To Lazzarato, the concept of Immaterial labour refers to two different aspects of labour:

'On the one hand, as regards the "informational content" of the commodity, it refers directly to the changes taking place in workers' labor processes in big companies in the industrial and tertiary sectors, where the skills involved in direct labor are increasingly skills involving cybernetics and computer control (and horizontal and vertical communication). On the other hand, as regards the activity that produces the cultural content of the commodity, Immaterial labour involves a series of activities that are not normally recognized as "work" – in other words, the kinds of activities involved in defining and fixing cultural and artistic standards, fashions, tastes, consumer norms, and, more strategically, public opinion.' (1996: 133)

In summary, Negri and Hardt refer to the combination of these two aspects as 'abstract labour', emphasised by the computerisation of production resulting in further removing the worker from the object of her/his labour, and 'affective labour' expressed in human contact and interaction, such as the activity of caring in health services or the creation and manipulation of affect in the entertainment industry (2000: 292).

A genealogy of Immaterial labour draws upon the concept 'general intellect', outlined in Marx's *Grundrisse* in a section entitled 'Fragment on Machines' (written 1857–8, first published 1939). What Marx described as 'general intellect' (or to be precise, 'mass intellectuality') was an increasing investment of human knowledge in the work process, and the recognition that wealth is no longer the immediate work of the individual, but a general productivity of the social body (or 'the ensemble of knowledges') that utilises both workers and technologies. However, the Marxist identification of general intellect with fixed capital (of the machine) is, to Autonomists, problematic in that it neglects the fact that 'the general intellect cannot exist independently of the concrete subjects who mediate the articulation of the machine with each other' (Terranova 2000). To address this, the Autonomists developed a concept of general intellect as an articulation of both fixed capital (the machine) and living labour (the workers) that also necessarily includes an aspect of 'linguistic communication' and thus emphasises an investment of subjectivity in the productive

process. The latter is an important aspect of knowledge according to Terranova, in that it cannot be 'deposited to machines and automation and comes into being only as the direct interaction of the living force' of labour (Terranova 2000).

Such an assemblage of machines – the Internet being the latest manifestation of fixed capital – and living labour in its function of communication, realised through interaction and cooperation as the determining articulation of the general intellect, constitutes a social body. This is what the Autonomists call the 'social factory', wherein wealth is socialised and can no longer be measured by money but resides in the intensive value of social relations, affections, modes of expressions, and forms of life (Terranova 2006: 29). Following from this, immaterial labour is inherently collective, is always a result of a collective and social production of knowledge. The problem for capital is how to extract as much value as possible out of general intellect?

In his essay 'Cultural Labour and Immaterial Machines' (2006) Matteo Pasquinelli suggests that rather than talk of general intellect we should talk of 'general intellects' as it comes in multiple forms. By his use of the phrase 'immaterial machines', he is making an analogy to the Marxist concept of material machines – as an embodiment of collective intelligence. In the age of network technologies, the network itself is a machine that links other machines of collective desire into a 'meta-machine'.⁵¹ He emphasises that collective intelligence can be expressed in negative forms such as 'totalitarian systems, the military-managerial ideology of the neocons or Microsoft empire, social-democratic bureaucracies, police control, or the maths of stock market speculators' (2006: 268). At the same time, general intellect can be expressed in more positive forms, such as 'international networks of cooperation including, free software developers, media activism, sharing of knowledge in universities, the Creative Commons open licenses and participative urban planning' (Pasquinelli 2006: 269). The concept therefore produces new contradictions of immaterial machines and labour.

What interests many contemporary theorists such as Pasquinelli, Terranova and Lazzarato, are the ways in which the concept of 'general intellect' can be usefully applied to explain productive activity that integrates various relations, such as those between different types of labour (manual and intellectual, material and immaterial), between labour and creation, between authors and publics, and so on. What is evident in a post-Fordist economy, is the collapsing of clear differentiations between types of work and the levels of involvement required of workers. For instance, manual labour increasingly involves procedures normally characteristic for 'intellectual' activities and 'the new communications technologies increasingly require subjectivities that are rich in knowledge' (Lazzarato 1996: 134). To Lazzarato, a consequence of this process is expressed in the emergence of general intellect, 'created out of a combination of the demands of capitalist production and the forms of "self-valorization" that reconciles

the old dichotomy between manual and intellectual labour in new types of productive activity. Indeed, Lazzarato claims:

'Immaterial labour finds itself at the crossroads (or rather, it is the interface) of a new relationship between production and consumption. The activation, both of productive cooperation and of the social relationship with the consumer, is materialised within and by the process of communication. It is immaterial labour, which continually innovates the form and the conditions of communication. [...] The particularity of the commodity produced through immaterial labour [...] consists in the fact that this is not destroyed in the act of consumption, but enlarges, transforms, creates the "ideological" and cultural environment of the consumer. This does not produce the physical capacity of the workforce, it transforms the person who uses it.' (1997: 137)

What the description emphasises is that the immaterial worker not only serves to satisfy consumer demand but, importantly, creates the demand at the same time. Furthermore, immaterial labour not only produces economic value but at the same time it produces subjectivity – and both are stolen by capital. This lies at the core of an understanding of 'how capitalist production has invaded our lives and has broken down all the oppositions among economy, power, and knowledge' (Lazzarato 1996: 143). Thus, the new qualities of labour and its organisation described by the Autonomists suggest a shift from an emphasis on technological capital to an emphasis on human subjectivity, in as much as they contribute to the technological apparatus. Lazzarato explains how years of restructuring big factories under post-Fordism, a process that started in the 1970s, led to a simultaneous re-conceptualisation of the worker as central to the system of production. The worker expresses 'living labour' that is increasingly rich in knowledge (that defines its professional capacities to contribute to the process of production of the cultural-informational content of the commodity), and carries an increasing degree of responsibility in decision making (that defines its ability to coordinate the labour of others, manage its own activity and act as interface between various levels of hierarchies). This re-conception of working class labour into a labour of 'management' (involving decision making, the handling of information, and control) involves, as Lazzarato explains, the investment of subjectivity on a much deeper level than previously. The labour is no longer based solely on the industrial model of production, but increasingly extends to social relationships, life-styles and subjectivities. As mentioned, this is characterised through its managerial aspect: an 'ability to manage social relations' and to 'elicit social cooperation' (1996).

The model of social cooperation is of particular importance for the description of immaterial labour in that the 'cooperation is completely immanent to the labouring activity itself'. It is not organised or imposed from outside and, consequently, according to Hardt and Negri, 'it expresses a possibility of the constituent power of labour' (2000). They explain further:

'Today productivity, wealth and the creation of social surpluses take the form of cooperative interactivity through linguistic, communication and affective

networks. [...] The mode of production of the multitude re-appropriates wealth from capital and so constructs a new wealth, articulated with the powers of science and social knowledge through cooperation [...] and] the constitution of new bodies outside of exploitation is a fundamental basis of the new mode of production' (2000: 294 & 410).⁵²

Less optimistically, according to Lazzarato the new mode of production is inherently linked to new forms of management and the redefinition of the figure of manager, or foreman, to that of 'facilitator'. In this model, workers themselves are required to take on managerial responsibility – for their own motivation and organisation of work based on cooperation within the team and to contribute to the communicative process distributed across networks. He explains:

'What modern management techniques are looking for is for "the worker's soul to become part of the factory." The worker's personality and subjectivity have to be made susceptible to organization and command. [...] workers are expected to become "active subjects" in the coordination of the various functions of production, instead of being subjected to it as simple command.' (1996: 135)

So-called participatory management is precisely where Lazzarato and others see new structures of power and control as particularly pronounced and effective. Lazzarato defines it as 'a technology of power, a technology for creating and controlling "subjective processes"' (1996: 135), in which the worker's personality and subjectivity are involved in the production of value. For Pasquinelli too, control and exploitation have become more immaterial, cognitive and networked, and as a result more totalitarian. Like Lazzarato, he describes a scenario where:

'Meta-machines are ruled by a particular kind of cognitive labour which is the administrative, political, and managerial labour that runs projects, organizes and controls on a vast scale: a form of general intellect that we have never considered, and of which the central figure in the second half of the 20th century became that of the manager.' (2006: 273)

Consequently, the increased centrality of symbolic management in the economy has contributed to a loss of measure or the inapplicability of the established laws of value that characterised earlier modes of production (as conceptualised by Classical Marxism). In the context of curating, Marina Vishmidt, in her essay 'Twilight of the Widgets' (2006), argues that what is changed is the site of value production, that expands to include new types of art objects – adding immaterial objects and not the conditions of production – as 'immateriality' displaces value from object to process and symbolic analysis in art production. Similarly, Josephine Berry Slater, in 'Unassignable Leakage' (2006), confirms that the 'crisis of immaterial production' is bound to the issue of value. By this, she refers to the crisis of the categorical definitions of art and the crisis of aesthetic judgement of which art for technological networks is symptomatic. The immeasurable and unknowable quality of art in the age of immaterial production has 'placed a properly productive thorn in the side of the whole gamut of art world practices' (2006: 144). Berry Slater draws a parallel between

the crisis of measure in the economy and the crisis of judgement in the arts, in which curators and artists have become largely indistinguishable. She asks:

'how can (art) value be extracted, let alone measured? As with something like free/libre open source software (FLOSS), when collaborative and creative production becomes so widespread, how is scarcity reinvented and this generalised productive power brought back under control?' (2006: 139)

For Vishmidt too, the issue of measure and value is of concern in relation to the changing field of creative practice; and in response she evokes the figure of the 'amateur'. The amateur reflects a potentially ideal model of engagement 'beyond measure' by being semi-autonomous from institutions and the dominant economy, and semi-independent from 'external validation beyond a network of like-minded enthusiasts'. To Vishmidt, the amateur:

'embodies the indiscernibility of life and work, a desideratum for capital that would incorporate "whatever" moment of existence as potentially creative of value. On the other hand, the amateur precisely marks the split between life and work as he/she spurns the profits of specialisation, preferring to keep their field of amateur virtuosity apart from financial gain or professional legitimacy. Thus, the amateur is a sort of border marker between real and formal subsumption, between a life that could be maintained in the parlous distinction between life and work and life that is indistinguishable from work, as nothing is so irresistible to a capital that operates on sites of affect and self-instigated value creation as a private enthusiasm.' (2006: 52)

Although the figure of the amateur may seem contradictory and open to exploitation, at the same time it seems to offer radical potential. In the strategy of marking out an ideological split from professionalisation it simultaneously 'implies re-appropriation of production models that seem to be grounded in a sort of elitism', and provides a challenge to what Vishmidt refers to as 'the impoverishment of experience brought about by specialisation', in itself a commodification of abilities of a sort. Rather, it follows the model of 'a non-specific production structured by goals other than economic, whether these be social, political, ethical or artistic' (Vishmidt 2006: 52-53).

The issues arising from immateriality discussed in this chapter thus far have complex implications for cultural practices, including curating. In this connection, Terranova in her essay 'Of Sense and Sensibility: Immaterial Labour in Open Systems', suggests how the concept of immaterial labour might be useful in thinking through such themes as:

'the decomposition of models of aesthetic production which relied on stable notions of the author, the work and the public; the crisis of spaces such as the museum or the gallery and figures such as the curator; and the challenges of a new mode of aesthetic production which operates through the semi-autonomous power of automated cybernetic systems - logarithms, algorithms and networks.' (2006: 27)

This is something Vishmidt responds to also, describing curating in terms of communication and as 'immaterial' practice, in particular when it deals with art that is 'substantively information-based and not traceable to a single authoring subjectivity, like most software and net art' (2006: 42). Chapter 4 deals at length with the issue of

emergent information-based art forms and its impact on the work of the curator; here it is only important to highlight this issue insofar as it contributes to the description of what is referred to as 'immaterial curating'.

The emphasis on 'abstract' and 'affective' aspects of immaterial labour referred to earlier in this chapter, apply to what I refer to as immaterial curating. The 'abstract' aspect refers to an increased distance from 'the object of the curatorial work' and a homogenisation of the practice as a result of computerization, whereas the 'affective' aspect evokes a definition of curating that relates it back to its genealogy in the term 'caring' – caring for 'objects' or 'collections' in a more traditional understanding of curating, and caring for social 'interaction' and 'cooperation' that involves technological systems. As with 'immaterial workers' examined at length by Lazzarato and others, curators increasingly engage with information technologies, work across communication networks and increasingly operate outside of the usual structures of art institutions (i.e. within society at large and with practices that involve participation). Curators increasingly operate within what Lazzarato calls a 'communication model' (1996: 136). As a result, their work necessarily implies a combination of various types of skills such as intellectual (to produce cultural-informational content of their projects), manual (to combine creativity and imagination with technical aspects), and entrepreneurial skills (in the management of social relations and eliciting and structuring of social cooperation that they are part of and at the same time required in order for any project to be realised). The source of productivity and innovation in relation to curatorial work is at the point of integration of scientific, research, industrial and tertiary labour. Associated value is primarily derived from 'active' involvement of subjectivities (of users/contributing public) within the work (curatorial project) on a much deeper level than ever before. To paraphrase Lazzarato, subjectivity (of both user/public and curator) and the ideological environment in which this subjectivity lives and reproduces is the raw material of immaterial curating. The post-Fordist mode of (curatorial) production is precisely defined by 'putting subjectivity to work both in the activation of productive co-operation and in the production of the "cultural" content of commodities' (Lazzarato 1996: 143). The status of immaterial curatorial work (or informational commodity) is the result of a creative process that involves both the producer/curator and the consumer/users/public. What Lazzarato describes as 'relations of service' – the integration of the relationship between production and consumption, 'where in fact the consumer intervenes in an active way in the composition of the product' (1996: 143) is one of the key characteristics of a post-Fordist model and applies to most curatorial work that deals with various forms of immaterial cultural production. For instance, this is particularly evident in curator-run online discussion lists, wikis, online curatorial platforms, or curatorial projects that involve social media tools (chapter 5 discusses this in more detail and provides examples of curatorial projects that engage with social tools). In such examples, like

immaterial labour, immaterial curating produces first and foremost a social relation. In Lazzarato's terms:

'the production of subjectivity ceases to be only an instrument of social control [...] and becomes directly productive because the goal of our postindustrial society is to construct the consumer/communicator - and to construct it as active' (1996:143).

Indeed, the process of social/curatorial communication (in which user/public subjectivity is produced) itself becomes productive. Furthermore, curators increasingly are required to involve subjectivities (users/public) that are, like curators themselves, 'rich in knowledge' (information, communication, cultural, technical) to be able to contribute sufficiently and valuably to the project they facilitate. In such a cultural model of production (that is creative and social at the same time) and that involves 'authorship', 'reproduction' and 'reception',⁵³ the transformation of post-Fordist conditions works on two levels, according to Lazzarato: firstly, 'the three stages of this creation process must be immediately characterized by their social form'; and secondly 'the three stages must be understood as the articulation of an actual productive cycle' (1996: 144). Consequently, when applied directly to curating, this model of cultural production suggests that the curator 'must lose its individual dimension and be transformed into an industrially organized production process (with a division of labour, investments, orders, and so forth)', and the curatorial work/project 'becomes a mass reproduction organized according to the imperatives of "profitability"', and the user/public (reception) becomes 'the consumer/communicator'.⁵⁴ In this way, the application of immateriality to curatorial production produces new contradictions.

From the earlier analysis, it would follow that under new conditions of cultural production the immaterial curator becomes more akin to the figure of the manager, or in Lazzarato's terms 'facilitator', and is central to the new forms of participatory management. The curator is concerned with facilitating and organising a productive process that is now extended to involve the contributing public as active participants and thereby to involve their subjectivity directly in the curatorial process. Furthermore, the process involves communication networks and technology and thus implies a redistribution of power and control. But contrary to what many would claim, the Autonomists emphasise that this produces even more intense forms of power. Thus, immaterial curating implies increased collective forms, in which solicited social cooperation lies at the basis of the organisation of work and control is expressed in regulating the subjectivity of those who contribute at various stages of the process.

2.2. Immateriality In Open Systems

To the Autonomists, new qualities of labour and its organisation (described earlier in the chapter) suggest a redistribution of power in such a way that it is expressed in even more intensive forms of control, 'as implied by the management mandate to be

active, that is to become subjects of communication' (Lazzarato 1996: 135). At the same time, certain characteristics of Immaterial labour such as the involvement of 'cooperative interactivity' (that is not imposed or organised from outside but inherently self-constructed) and its distribution across 'linguistic, communicational, and affective networks' expresses a certain potential for what Hardt and Negri describe as the 'constituent power of labour'⁵⁵ and 'the constitution of new bodies outside of exploitation' (2000: 336, 410). These contradictory relationships between Immaterial and networked forms of control and collectivity (also evoked in Benjamin in relation to mechanical reproduction technologies, and Nichols in relation to computational technologies, both referred to in the introductory chapter) is pronounced with even more intensity in open systems.

This is particularly important for developing an understanding of the dynamics of Immaterial curating operating under the conditions of socio-technological networks, rather than the organisation model of the assembly line. While the previous section focused on introducing key issues arising from Immateriality and extending it to the work of the curator in more general terms, this section takes a closer look at the new diagrams of power and control that Immateriality produces in (technological) open systems and the implications of this for curating both as/in open system(s). To discuss how Immateriality (and more precisely Immaterial labour) is played out in open systems, the section starts by establishing an understanding of open systems.

A brief definition of the term system, derived from the field of biology, as 'a collection of interrelated parts, both maintaining its internal order and also drawing the resources necessary for its survival and reproduction from the external environment' (Edgar and Sedgwick 1999: 400-401) provides a starting point to consider the idea of how both labour and technological networks can be considered open systems. The concept of open systems was first developed in thermodynamics and systems theory, credited in particular to the work of Ludwig von Bertalanffy that emphasises how 'complex components in interaction' work together and within wider systems (1967: 69). To Bertalanffy, open systems (such as living systems, as opposed to engineering systems that he considered closed) exhibit dynamic properties maintaining disequilibrium (1967, 1968). Subsequently, the term was applied to other fields such as the social sciences to indicate a process that exchanges material, people, capital and information with its environment. Summarising from various entries in Wikipedia that itself is a contemporary example of an open system, the term defines a condition in which the system continuously interacts with its environment but at the same time maintains its state.⁵⁶ However, the emphasis is on the understanding of systems as neither open nor closed but demonstrating *tendencies towards* one or other state. In computer science, open system refers to 'a collection of interacting software, hardware, and human components with well-defined, publicly available interfaces

maintained by a consensus process'. Consequently, some of the basic characteristics of open systems include environment, input and output. In computer systems, it broadly refers to open software standards, allowing open access, open operability and portability, originating in the late 1970s mainly to describe systems based on Unix, and in turn Linux. In this sense, open systems stand for the same working principles as open source.

The more comprehensive analysis of the term open system is provided in chapter 3 of the thesis with respect to the issue of curating and agency. This chapter explores the issue of open systems in the context of information networks (exemplified by the Internet) and further problematises the question of openness and self-organisation of technological open systems that are distributed and organised around technological protocols. In her book *Network Culture* (2004), Terranova introduces a useful distinction between a network as a description of a specific system and a 'network of networks' (or hypernetwork). A network of networks describes the entire 'multidimensional information milieu' connecting various communication channels and diverse modes of circulation. To Terranova, the Internet has been 'conceived as a "network of networks", a topological formation that presents insights into the dynamics underlying the formation of a global network culture' (2004: 41). The Internet expresses a combination of technological systems and its relation to cultural and political formations. As a technical system, the Internet 'consists of a set of interrelated protocols, abstract technical diagrams that give the network consistency beyond the rapidly changing hardware environment of computers, servers, cables and wires' (2004: 42). She further explains that beyond a concrete assemblage of software and hardware, the Internet 'is also an abstract technical diagram implying a very specific production of space', expressed in 'a tendency to understand space in terms of biophysical properties of open systems'. The Internet thus expresses 'open network spatiality' and thus becomes a 'general figure for the process driving the globalisation of culture and communication at large' (2004: 42). Understood in such terms as a 'network of networks' and open system, the Internet is deployed to symbolise the shift from an industrial to informational economy and the decentralisation of the site and processes of production – what Terranova calls the 'internetwork'.

There is a certain ambiguity in the term network expressed in the number of contexts and traditions in which it is used. This is what Bruno Latour, in his book *Reassembling the Social* (2005), attempts to clarify in describing networks: firstly as in technical networks (such as electricity, trains, sewages, Internet, etc); secondly as a term used in sociology to refer to the differences between organisations, markets, and the state (here network represents one informal way of associating together human agents); and thirdly represented in the 'active and distributed materialism' of Deleuze and Henri Bergson. The first two meanings come together for Latour in the way Castells (2000)

uses the term, in which the network 'becomes a privileged mode of organisation thanks to the very extension of information technology'. Broadly, Latour's interest is in recovering a conception of the social in terms of associations rather than objects (although it should be stressed that Latour considers objects to have agency too) so his view of network is rather different. Drawing upon Actor-Network Theory, he stresses the network as 'a string of actions where each participant is treated as a full-blown mediator' (2005: 128). He further explains:

'As soon as actors are treated not as intermediaries but as mediators, they render the movement of the social visible to the reader. [...] Thus, the network does not designate a thing out there that would have roughly the shape of interconnected points, much like a telephone, a freeway, or a sewage "network". It is nothing more than an indicator of the quality of a text about the topics at hand. It qualifies its objectivity, that is the ability of each actor to make other actors do unexpected things. A good text elicits networks of actors when it allows the writer to trace a set of relations defined as so many translations.' (2005: 129)

In terms of technological networks, production is distributed across multiple 'sites' (nodes) on micro and macro scales simultaneously. With the increasing dominance of service industries, the industrial factory as a centre of production has now been effectively dispersed across communication networks and specialised productive sites but requires much greater cooperation between actors or agents. Hardt and Negri note that the tendency towards the deterritorialisation of production is even more pronounced in the process of immaterial labour and relies on abstract cooperation.

They explain:

'The circuit of cooperation is consolidated in the network and the commodity at an abstract level. Production sites can thus be deterritorialized and tend toward a virtual existence, as coordinates in the communication network. As opposed to the old vertical industrial and corporate model, production now tends to be organized in horizontal network enterprises.' (Hardt and Negri 2000: 296)

The consequences of this in relation to the organisation of control and power are significant and new tensions appear to emerge. The decentralisation and distribution of productive processes across communication and technological networks suggest that the decentralisation of control would follow too, thus empowering smaller, more individualised sites of production. However, this simultaneously provokes a corresponding centralization of the control over production. The open network spatiality allows control to be exercised: 'from the local perspective, the computer networks and communications technologies internal to production system allow for more extensive monitoring of workers from a central, more remote location' (Hardt and Negri 2000: 297). This is even more pronounced on a global level where the geographical dispersal of production sites/units demands an increasing centralisation of management and planning as well as a 'new centralization of specialized producer services', such as financial and trade-related services, which Hardt and Negri describe as 'global cities, real cities of control' (2000: 297).

As a result, Terranova refers to the emergence of 'new machines of control and

subjectification which reimpose hierarchical relations at the service of social reproduction and the production of surplus value' (2006: 33). She develops this issue to examine what she describes as 'new diagrams of control' within open systems.⁵⁷ She argues that this is not simply a matter of two opposite and fixed models of production, one with control and the other with the lack of it, but the organisation of control is subject to 'messy local assemblages and dynamic compositions', to processes of 'bifurcation, resonance and interference between the corporeal and the incorporeal, the material and the immaterial, dissipation and accumulation, and autoorganisation'. Thus open systems, and open computational networks are 'radically open to the Outside, that is they are relentlessly traversed by a flow of matter that is informationally compressed in logarithms, organised by algorithmic code and modulated by technical machines' (Terranova 2006: 34).

Even on a technical level, technical networks express both vertical and horizontal lines of organisation. In his book *Organised Networks* (2006), Ned Rossiter argues that while 'there is a prevailing consensus that experience of sharing, feedback, flexibility, and friendship are primary to the culture of networks', it would be naive to think of 'the horizontal, decentralising and distributive capacities of digital networks as immune from a tendency to fall back into hierarchical and centralising modes of organisation and patterns of behaviour'. Exposing the pseudo openness of distributed technological networks, he further explains that:

'the so-called "open" systems of communication are frequently not only not open, they also elide hierarchical operations that enable networks to become organised. Let us not forget that flexibility is also the operative mode of post-Fordist labour and its attendant double-edged sword of economic precarity and ontological precariousness' (Rossiter 2006: 15).

Open systems are evocative structures and important to sustain the interactions that lie at the heart of the informational economy. Lazzarato considers open systems more generally in terms of an 'open process of creation' – established between immaterial labour and the public, and organised through communication networks – that is in itself a locus of the innovation in immaterial production (1996: 137). To sustain the consumption and its perpetual renewal, the capitalist/entrepreneur draws from the values produced by the public in an open process of creation. Applied to examples of current creative practices that involve technological open systems, such as online social platforms or similarly curatorial platforms that necessarily imply a direct public involvement in the process of creation, the question remains as to what can be capitalised. If the analogy holds, the source of innovation would extend to the forms of life itself. To paraphrase Lazzarato, what is productive is the whole of social relations involved in immaterial curating.

More specifically in relation to the potential of open technological systems for creation, Vishimdt points out that:

'this projection of greater openness, greater and more effective inclusion of more diverse engaged publics, is too schematic an account. The critiques of unreconstructed openness are out there, all stressing that a technologically-led open-source agenda does not take into account structures of domination. These structures would strategically and semiotically delimit its impact on the wider world, but also covertly delimit the effects and perspectives produced within the cultures prioritising "openness", be it programmers or horizontally organised political activists. The reluctance to deduce social relations from technical protocols is particularly apparent in the art context, which has been on and off celebrating and resisting this impulse for much longer than software, or software art, has been around' (2006: 44-46).

Software (or rather 'softwares') is a case in point, considered by Pasquinelli as an instantiation of immaterial machines and Free Software as the dominant metaphor in media criticism, network culture, curating and the art world more generally. The conceptual and technological application of Open Source / Free Software or more generically FOSS platforms, into much of contemporary art production and mediation (such as the practice of curating) renews the currency for 'questions of organisation, hierarchy, economies and economics, ownership and creativity' (Vishmidt 2006: 54). To Vishmidt, FOSS is a political programme that 'seems to centre on collaboration, spontaneity and self-valorisation, articulating these as techniques that would form a post-capitalist stage of social organisation in the here and now' (2006: 54). However, and importantly, this does not suggest that it is any less adaptable to the capitalist mode of production (sometimes expressed as the term 'communism of capital'⁵⁸) and can 'pose a more far-reaching encroachment on property relations, with wholesale appropriation and free distribution of media commodities' (2006: 54). Therefore, rather than seeing free software as simply liberating, Pasquinelli regards it as symptomatic of current immaterial conditions, alongside other examples produced by cognitive labour and cultural products in general. The global cooperative network (of programmers) mobilised in a free software model is a positive example of action in the digital world but this does not seem to lend itself to producing new forms of action in the real world. In the light of this, he polemically asks:

'How can we turn the sharing of knowledge, tools and spaces, immaterial labour and cultural work, into new radical revolutionary productive machines [that once upon a time was called re-appropriation of the means of production], beyond the inflated Free Software? (2006: 274)

The Internet, a manifestation of self-organising and collective intelligence is what Pasquinelli refers to as 'imperial meta-machine'. In contrast he is imagining radical machines that are able to express 'technomanagerial intelligence'. Similarly, Terranova is attuned to how the structures of power and control operate in open systems, and how capital extorts value from this. She describes the class of 'NetSlaves', not simply a typical form of labour on the Internet but importantly the embodiment of a complex relationship of labour that more generally extends to the characteristics of labour in the information society. Through this concept, she investigates the issue of 'free labour', which she recognises as a trait in the cultural economy at large and an

undervalued force in advanced capitalist societies. The claims of free software are too easily seen in contrast to capital when clearly they express some of the inherent contradictions described so far in this chapter.

The Internet, the site of production where the issue of free labour is particularly pronounced, is an instantiation of the connection between the 'digital economy' and what the Autonomists refer to as the 'social factory'. The social factory embodies the shift of the work process from the factory to society, setting in motion what Negri calls 'a truly complex machine' (1989). The acknowledgement of the collective aspect of labour implies that it is not equivalent to waged labour, and therefore that free labour associated with the Internet economy and new media industry more generally should not be taken lightly, or simply regarded as oppositional. On the contrary, it should be acknowledged for its importance as affective and cultural labour.

Like other net-workers, online curators often display properties of voluntary, unwaged, and exploited free labour. However, this is not simply a case of mere exploitation or appropriation of value but also of other more positive possibilities. For instance, the model of the immaterial curator as 'amateur' applies, in describing those increasingly working outside of mainstream art institutions, or within but semi-independent (Vishmidt 2006: 52). In this way, curators operate semi-autonomously in an economy of project-based, temporary creative production units (from one new media festival to the next, from conference to conference, from project to project for different institutions or venues each time). Lazzarato refers to this class of self-employed workers as the 'intellectual proletariat' – characterised by increased mobility and precariousness. To some extent, this might apply to the class of curators/amateurs too; some working under the same precarious conditions whilst others as a privilege of choice. Certainly, the amateur curator is significant here:

'The unremunerated enthusiast is the key actor of narratives enfolded free software programming, p2p networking, file sharing, free networking, any endeavour that centres on the appropriation of information into the public domain from proprietary regimes. [...] Much as it is a rare Open Source coder who can afford to survive by free labour alone, the amateur must devise a path meandering across elitist disdain and abject participation, retaining the most promising moments of each to fashion a real "prefigurative" strategy.'
(Vishmidt 2006: 54)

As much as the curator/amateur is open to exploitation, it also offers radical potential as a challenge to the dubious professionalisation of practices tied to the market. To Vishmidt, 'curation [as a form of mediation, arrangement, communication, a de facto 'immaterial' practice] registers the influence of collaboration, distributed production, "openness", community "engagement", intervention and contingency, perhaps even more strongly than other positions in the art world'. (2006: 42) As a result, she asks if immaterial curating can influence production outside of a value system based on commodity and social reproduction – as counter-action. The suggestion is for a

repositioning of the curator from *administrator* to a *manipulator* of information and systems, as a direct challenge to what appears to be an increasingly *functionary* role in cultural management. In the context of open systems (such as technological networks), might curating be usefully considered in terms of an open management system, and one in which information is not simply administered efficiently but truly curated – stored, manipulated and redistributed? Perhaps this is an image of a radical productive machine that demonstrates general intellect in a positive sense.

3. Open Systems

The underlying concern of the thesis is the politics of curating in/as (an) open system(s). The thesis returns in this chapter to the assertion that curating cannot be dissociated from its socio-technological conditions. Thus the key question becomes how power relations, control and agency are expressed in new curatorial forms that involve open technological systems. The suggestion in the introduction that curating itself can be described in terms of open systems is central to this. Describing curating in such terms implies a state in which there is continuous interaction with the socio-technological environment: the system is opened up to communicative processes that involve dynamic networks of producers/users, and to divergent exchanges that disrupt established social relations of production and distribution. Thus, and importantly for an understanding of the power relations involved, software opens up curating to dynamic possibilities and transformations beyond the usual institutional model (analogous to the model of production associated with the industrial factory) into the context of networks (and what is referred to by Autonomist Marxists as the 'social factory').

The importance of systems thinking for an understanding of curating in terms of open systems (or more specifically online software systems) is in establishing how nothing happens in isolation, how everything is interlinked as part of a larger structure that is thoroughly networked, and most importantly how complex components in interaction work together within wider systems (Barabási 2002: 7; von Bertalanffy 1967: 69). The development of a modern systems approach is credited to the work of Ludwig von Bertalanffy and in particular his book *General Systems Theory* published in 1968.⁵⁹ Although von Bertalanffy's description of a system as a collection of interacting elements and part of a larger whole derives from the field of biology (for instance a living organism), his aim was to apply it to a wider set of principles common to systems in general, and ultimately to create a more general systems theory to explain all systems in all fields of science.⁶⁰ Organisation and operation, or in von Bertalanffy's terms 'developmental organisation', are key to this. More currently, this is also what Lazzarato emphasised in relation to immaterial labour:

'Systems theory, by eliminating the constraint of the market and giving pride of place to organization, is more open to the new phenomenology of labor, and in particular to the emergence of immaterial labor. In more developed systemic theories, organization is conceived as the ensemble of factors, both material and immaterial, both individual and collective, that can permit a given group to reach objectives. The success of this organizational process requires instruments of regulation, either voluntary or automatic.' (1996: 139)

The work of von Bertalanffy is particularly relevant in the context of the thesis in that the concept of open systems emphasises their complex dynamics and resulting inherent creative power. To von Bertalanffy, open systems (to which he dedicated an

entire chapter 'The Model of Open System') such as living systems (as opposed to engineering systems that he considered closed) exhibit dynamic properties maintaining disequilibrium, and thus have creative and transformative potential. This description of system runs in parallel to a cybernetic approach associated with the work of Norbert Wiener, that extended the study of the operation of complex systems ('whether in the machine or in the animal' ([1948] 2000: 11) to the entire field of control and communication. With respect to communication processes, control mechanisms and feedback principles were especially important in 'first-order cybernetics'. In turn, feedback loops, self-referentiality and self-organisation were important to 'second-order cybernetics', termed by Heinz von Foerster as the 'cybernetics of observing systems' or 'cybernetics of cybernetics' (1979).

Drawing upon such references derived from systems theory and second order cybernetics, this chapter explores the complexity and dynamics of open systems with respect to curating and the issue of agency. In chapter 3.1, computational systems and information networks are considered to further investigate forms of power and the (re)organisation of control in an open network model. The chapter investigates the protocols underlying technological systems and asks whether they can be seen to some extent as analogous to curatorial protocols, and furthermore whether curating itself can be considered an open system. The suggestion is that curating not only increasingly involves open systems but also can itself be considered an open system. Chapter 3.2 introduces the issue of structure and agency in contrast to unpredictability, emphasised by complexity theory. Despite the lack of predetermined or fixed structure and predictability in complex systems, the behaviour expresses emergent properties that can be understood. It is the emergent sense of agency that the chapter refers to, reconstituted to account for *distributed* and partly *automated* forms of organisation negotiated through software and networks. Drawing upon the previous chapter, the suggestion is that agency is paradoxically both restricted and at the same time extended by immaterial forms of socio-technical organisation. In relation to curatorial agency, the use of computational systems and information networks can be utilised in such a way for reinvention. In this sense curating can be characterised as open and distributed as a reflection of the organisation of the system of which it is part, and within which it unfolds.

3.1 Systems and Networks

Systems are of particular importance for an understanding of expanded curatorial work, referring not only to the computer and the network but also increasingly to the technical and conceptual properties of artworks to be curated. In earlier critical work in the late 1960s, Burnham used informational systems as a metaphor to describe technological culture and the changing role of the artist within the art system. Drawing upon von Bertalanffy's understanding of systems, Burnham suggests a

'transition from an object-oriented to a systems-oriented culture', in which 'change emanates not from things but from the way things are done' (1968: 15-16) and subsequently proposes the term 'system esthetic' that evokes systems thinking in relation to art - through the focus on 'processing, circulation and development' (Lillemoose 2006: 120). Burnham further explains:

'A systems viewpoint is focused on the creation of stable, ongoing relationships between organic and non-organic systems, be these neighborhoods, industrial complexes, farms, transportation systems, information centers or any other of the matrixes of human activity.' (Burnham 1968: 16)

More contemporary, the notion of art as a system that is capable of transforming behaviour was explored by artists drawing upon references from systems theory and cybernetics. For instance, these concerns were fundamental to Roy Ascott's practice. He explains this:

'The participational, inclusive form of art has as its basic principle "feedback" and it is this loop that makes an integral whole of the triad artist/artwork/observer. For art to switch its role from the private, exclusive arena of a rarefied elite to the public, open field of general consciousness, the artist has had to create more flexible structures and images, offering a greater variety of readings than were formally needed in art. [...] While the general context of the art experience is set by the artist, its evolution in any specific sense is unpredictable.' (Ascott 2003: 111)

To Ascott, as with Burnham, working with the conceptual properties of systems offered a way of extending the transformative possibilities of art. A longer history of systems theory applied to art is outside the scope of this thesis, although some of the issues that relate systems thinking to software art will be followed in chapter 4. The emphasis in this chapter is on the notion of open systems, in so far as this relates to the openness of technological systems and the practice of curating.⁶¹ That the curator is part of this entire system but not central to it will be discussed in more detail in subsequent chapters. Here, the suggestion is that the term system might also apply to the structure and organisation of the process of curating itself, when it becomes distributed across technological networks and dynamic networks of users.

The entire 'information technology paradigm', as Castells refers to it,⁶² is defined by openness, or a tendency towards openness. It evolves not: 'towards its closure as a system, but towards its openness as a multi-edged network. It is powerful and imposing in its materiality, but adaptive and open-ended in its historical development. Comprehensiveness, complexity, and networking are its decisive qualities.' (1996: 65)

Work in this area that deals with complex systems (whether computational, mechanical or biological), their organisation and underlying mechanisms of control, is founded upon the interdisciplinary scientific examination and comparative study of communication and control systems formulated by Wiener in *Cybernetics: or Control and Communication in the Animal and the Machine* (1948). In a later book, *The Human*

Use of Human Beings: Cybernetics and Society (1950) he popularised the social implications of cybernetics – described by Friedrich Kittler as ‘the theory of guidance and feedback loops’ (1999: 259) – drawing analogies between automatic systems (such as a regulated steam engine) and human Institutions.⁶³ Of particular relevance to the thesis however is second-order cybernetics, originating from the work of von Foerster, that acknowledges factors of noise and entropy (disorder and deterioration), self-referential relationships, and crucially the possibility of transformation in systems – the relationship of the observer and the observed.⁶⁴ This approach accounts for the fact that those who engage in any investigation are simultaneously part of the system that they investigate (Foerster 1979). Paul Pangaro, in his entry for Macmillan’s *Encyclopedia of Computers* ‘Cybernetics – A Definition’, describes the transition from the first order to the second order cybernetic as follows:

‘In working to derive functional models common to all systems, early cybernetic researchers quickly realized that their “science of observed systems” cannot be divorced from “a science of observing systems” – because it is we who observe [von Foerster 1974]. The cybernetic approach is centrally concerned with this unavoidable limitation of what we can know: our own subjectivity. In this way cybernetics is aptly called “applied epistemology”. [...] The shift of interest in cybernetics from “observed systems” – physical systems such as thermostats or complex auto-pilots – to “observing systems” – language-oriented systems such as science or social systems – explicitly incorporates the observer into the description, while maintaining a foundation in feedback, goals, and information. It applies the cybernetic frame to the process of cybernetics itself.’ ([1991] 2006)

This sense of reflexivity is what Hayles describes as ‘the self-making of a complex system’ and ‘turning a system’s rules back on itself so as to cause it to engage in more complex behaviour’ to emphasise ‘change over constancy’ and ‘complexity over predictability’ (1994: 446).⁶⁵ In this approach, the importance of self-referentiality, self-organisation and the subject-object problem lies at the core of the concern. The issue of reflexivity was developed in particular by Humberto Maturana and Francisco Varela in their work *Autopoiesis and Cognition: The Realisation of the Living* (1980) to suggest a view of the world as a set of ‘informationally closed systems’; that is systems determined by their internal self-organisation (reproducing the organisation that defines them as systems). With the contribution from others such as Niklas Luhman, this was developed into a theory of autopoiesis as self-making or self-creation. Hayles explains that from such a perspective nothing is outside the system, including the cyberneticians themselves:

‘In a sense, autopoiesis turns the cybernetic paradigm inside out. Its central premise – that systems are informationally closed – radically alters the idea of the informational feedback loop, for the loop no longer functions to connect a system to its environment. In the autopoietic view, no information crosses the boundary separating the system from its environment.’ (1999: 10–11)

In the same way, to Luhmann (1995), social systems are autopoietically closed systems of communication in that they use and rely on resources from their environment but these resources do not become part of the systems’ operation. In his later book *Art as*

a Social System (2000), Luhmann likens the operation of autopoiesis (the filtering and processing of information from the environment) to a computer program:

'We speak of self-organisation whenever an operatively closed system uses its own operations to build structures that it can either reuse and change later on, or else dismiss and forget. Computers depend on external programming, although computer-generated programmes may be developed eventually. By contrast, autopoietic systems produce their own structures and are capable of specifying their operations via these structures (structural determination).'
(2000: 85)

In turn, Hayles suggests a shift of attention from autopoietic (informationally-closed) feedback loops to emergent (informationally-open) transformative processes that can be usefully applied to a more contemporary interpretation of socio-technological networks.

The idea of a system defined in this way is important for developing an understanding of curating that involves information systems. Indeed, building upon these earlier references, there are a number of more current attempts to rework second-order cybernetics for the context of networks. For instance, in Rossiter's (earlier mentioned) book *Organised Networks*, the notion of feedback loops is 'homologous with the concept of "organisational closure" that acknowledges the role of the observer in the functioning of the systems, and hence introduced the concept of reflexivity where the observer constitutes a node within the scene or operation of observation' (2006: 183). Drawing upon the work of Humberto Maturana and Francisco Varela in which the central feature of the system consists of 'organisation of organisation' and where the 'difference mingles with the operations of a system in order to maintain a dynamic equilibrium', Rossiter notes that this is somewhat similar to a 'post-structuralist critique of the subject and the concern with questioning the primacy of the individual and the autonomy of the subject/consciousness from the environment in which it is embedded' (2006: 183). Consequently, this indicates the porous nature of 'boundaries' of systems that are understood to be constructed, and therefore open to change. In Rossiter's argument, this allows him to 'recast the limits of organisational closure' and to account for self-generating, distributed informational systems in the organisation of institutional forms. The connection to the institutional forms of curating will be explored later in this chapter, but for now some historical references will be introduced to examine issues of organisation and control.

With reference to the essay 'The Work of Culture in the Age of Cybernetic Systems', Nichols argues that a tension exists between 'the liberating potential of the cybernetic imagination and the ideological tendency to preserve the existing form of social relations' (2003: 627). If computer systems are indeed indicative of significant changes in the mode of cultural production, they also indicate contradictory tendencies inherent in these systems. For Nichols, the contradiction lies between the 'negative,

currently dominant [potential], towards control, and the positive, more latent potential 'towards collectivity'. He argues that:

'if there is liberating potential in this, it clearly is not in seeing ourselves as cogs in a machine or elements of a vast simulation, but rather in seeing ourselves as part of a larger whole that is self-regulating and capable of long-term survival. At present this larger whole remains dominated by arts that achieve hegemony. But the very apprehension of the cybernetic connection, where system governs parts, where the social collectivity of mind governs the autonomous ego of individualism, may also provide the adaptive concepts needed to decenter control and overturn hierarchy' (2003: 640).

The positive potential of cybernetic systems rests on their ability to self-regulate within predefined limits and in relation to predefined tasks demonstrating a degree of 'intelligence'; a capacity to process information and execute actions. Feedback simulates a further interaction to affect a desired outcome. These systems do not only offer (and demand) almost immediate response but also offer the possibility of control to the user expressed in interactivity of the system. This however is a spurious control, as the decision making ability of the user is linked to a chain of command. According to Nichols, users are not allowed choices regarding the ultimate purposes and values of the system and their choices are 'always the permutations and combinations of a predefined set' (2003: 632). Clearly the issue of feedback is crucially important in any discussion about the regulatory mechanisms involved in systems, whether to maintain or disrupt equilibrium. Positive potential relies on the dynamic interactions between feedback and controlling mechanisms.

For curating, the issue of feedback and the effect on the otherwise fixed and hierarchical chain of command is crucially important and evocative. There is currently a lot of interest and work in this area. For instance, the recent exhibition *Feedback* (2007) provides a useful reference in this connection, exploring models of open systems and their inherent characteristics while simultaneously tracing a 'art-historical lineage from instruction-based, generative, and conceptual art to telematics and networks'.⁶⁶ In an interview for *Rhizome*, Paul (one of the exhibition curators) considers the significance of the use of feedback:

'Feedback is a broader term referring to the process by which a system is modulated, controlled, or changed by the output or response it produces. Of course feedback also is a commonly used term for an evaluative response and the return of information about the result of an activity, and we [as curators] wanted to include this meaning. On a more metaphorical level, the projects assembled in the exhibition function as a response to each other, returning information about their context to the viewer.' (Paul, in Cornell 2007)

In the same way as feedback is inherent to curating and computational systems, so are instructions and rules to art in general. Art history provides many examples of an emphasis on instructions and rules, from art movements such as Dada, Fluxus, and Conceptual Art in the 20th century connecting these movements, to algorithms that are at the core of any software and computer operation. According to Paul, paraphrasing a

common definition, 'Instruction-based practice is closely related to contemporary generative art in which a process, such as software, a machine, or a procedural invention, is set into motion to create a work of art' (Paul, in Cornell 2007).⁶⁷

However, if one applies Nichol's argument to this larger context, one could argue that there simply is not enough feedback in the art-culture system to decenter control. This compromised sense of control, or illusion of interactivity, on the part of the user also contributes to an understanding of the relations of production that manifest themselves in the curatorial struggle between the collectivity of production and control over the process and its outcome. As Nichols puts it, 'where the social collectivity of minds governs the autonomous ego of individualism' it becomes possible to 'provide the adaptive concepts needed to de-center control and overturn hierarchy' (2003: 640); the suggestion is to redistribute levels of control in an entirely different way that recognises the openness of the Internet and information networks as open systems.

While Barabási proposes to use the term Internet in its technical sense as a physical infrastructure connecting computers, literally a network of routers that connect computers and that communicate with each other through protocols (2002: 147), others apply it in a much broader sense, referring to an entire 'online universe' (including computers, routers, optical cables, and WWW). An example of this is the way Terranova defines the Internet as 'a combination of technological system (technological diagram) and its relation to the cultural and political formations'. In this sense, she refers to a 'network of networks' (or an 'internetwork') as a 'topological formation that presents insights into the dynamics underlying the formation of a global network culture'. To her, the Internet exists beyond its definition as a technical system and can be also considered analogously to wider networks; it is:

'an abstract technical diagram implying a very specific production of space – a tendency to understand space (space over networks) in terms of biophysical properties of open systems. The Internet thus expresses open system spatiality and becomes a general figure for the process driving the globalisation of culture and communication at large' (2004: 42).

In much the same way, Castells considers networks 'that combine communication technologies and social structures' as 'fundamental to the form of late capitalism that, commonly referred to as "globalisation"' (1996: 165). The distinction made between the Internet as a description of a specific technical system and the network as a dynamic topological formation ('the network topos') is an important one in that it describes 'the formation of a single yet multidimensional information milieu connecting various communication channels and diverse modes of circulation, a meshwork' (Terranova 2004: 41). It allows the deployment of the description of Internet architecture (based on principles of universal address space, a layered and modular structure, the distributed circulation of data packets and various technical protocols that regulate its operation) to a much more abstract analysis of

contemporary forms and structures of power in the network society. This is also what Hardt and Negri argue when they present distributed networks in terms of a general condition: 'It is not that networks were not around before or that the structure of the brain has changed. It is that networks have become a common form that tends to define our ways of understanding the world and acting in it' (2004: 142).

To further speculate in this way, the technical and topological architecture of the Internet also require more description. Barabási characterises the Internet as an example of a scale-free network topology based on a 'power laws degree distribution' that operates 'preferential attachment'.⁶⁸ In this model, nodes have only a few links and are held together in a network by a few highly connected hubs (nodes-connectors with an anomalously large number of links). The emergence of hubs is based on 'preferential attachment' driven by the product of the node's 'fitness' and the number of links it maintains (2002: 96). A good example of this principle is the Web, where hubs are websites such as Google, Yahoo, Amazon, etc. Thus, in this highly competitive environment, hubs represent the 'highly important organising principle that governs network evolution' (Barabási 2002: 72). Furthermore, this model is characterised by continuous growth and evolution, both of which are effected by, in the case of the Web: 'internal links, rewiring, removal of nodes and links, ageing, nonlinear effects, thus changing the number and size of the hubs'. Analysing the structure of the Web in this way according to Barabási and others, demolishes the myth of the web as a democratic model and a truly egalitarian (cyber)space (2002: 58). From this perspective the Google search engine becomes a clear manifestation of a mechanism of control as it works its way through the vastness of online information filtering and thus controlling access to certain kinds of information over others. This is somewhat similar to the argument Martin Knahl and Geoff Cox make in their paper 'Internet Governance: Towards a Non-Representational Democracy':

'To describe a network simply as a set of interconnected nodes is deceptive. Nodes with a large number of links or connections account for uneven distribution within a given system. For instance, the WWW is dominated by highly connected nodes or hubs and thus can be seen as not to be the egalitarian space that many imagine it to be. Hubs represent power not centrally but in a decentralised and even distributed manner [...]. Thus hubs, like the network itself, may be dynamic, open ended, multiple and without limits, yet at the same time demonstrate the process of inclusion and exclusion. The switches connecting networks together, or more accurately routers that connect different IP networks, is where power is located - where power is switched on or off.' (Knahl and Cox 2007)

Much in the same way, Internet protocols can be considered in terms of mechanisms of control. The protocol development of the Internet, that started with the TCP/IP set of protocols (Transmission Control Protocol / Internet Protocol), operate as a distributed management system coding packets of information, documents and communications.⁶⁹ Computers in a network agree technical standards of action such that the protocol governs usage at the level of code: 'protocol is a technique for

achieving voluntary regulation within a contingent environment' as Galloway puts it (2004: 7). What he calls 'voluntary regulation' is a particularly successful and subtle mode of social control, and this makes a particularly good example of how power is exercised within distributed networks:

'This is not to say that control is necessarily bad and certain protocols have no vested interest in themselves. The problem lies in the fact that standards are set and applied according to certain ruling interests – making it a political issue. The network is largely non-hierarchical in structure conforming to the way TCP/IP connects one machine to others, but it is also subject to DNS information stored in decentralised databases but organised in hierarchical, inverted tree-structures (Galloway 2004).

Knahl and Cox add further detail to this:

At the top of the tree are a relatively small number of 'root' servers – mostly in the USA, Europe and Japan – that extend control over lower branches. The technical detail reveals the operations of "control societies" fraught with political contradictions rather like "free market itself". (2007)⁷⁰

The example of ICANN (The Internet Corporation for Assigned Names and Numbers) is a case in point, reflecting both horizontal and vertical 'axis of influence'. Established as a non-profit corporation (by the US government in 1998) it manages the allocation of IP address, assignment of protocol parameter, domain name and root server (in conjunction with GNSO – Generic Name Supporting Organisation). The IP addresses are allocated by means of a central authority that franchises them to interested organisations while at the same time the US government continues to act as an overseeing body putting into question the independence and neutrality of ICANN. Thus, the Internet is not an embodiment of the utopian vision of democracy but instead implies a certain centralisation of power in a few large hubs and the allocation of addresses, but at the same time it is also a collection of various networks. All the same, as Barabási explains, it consists of independent but interlinked networks that coexist and operate on the basis of distributed decisions – anyone can add nodes and links with no need for permission from the central authority (except for domain name assigning) and thus extend the network (2002: 148). In this sense the Internet is structurally closer to an ecosystem that constantly evolves but is locally guarded. Perhaps it is best understood as 'a multitude of loosely interconnected and layered entities as opposed to one closed medium or infrastructure', and consequently as a dynamic open system 'with constantly changing operational and governance requirements' (Knahl and Cox 2007).

Responding to the particularities of this architecture, Galloway asks 'how control exists after decentralisation' (and indeed this is the subtitle of his book *Protocol*).⁷¹ Drawing together the structural form of a distributed network, the technology of a networked computer, and the organisational principle of management characteristic to the Internet, he claims that all three factors come together in the term 'protocol' to define

a new apparatus of control that 'problematizes issues of connectivity, collectivity and participation'. He states:

'With the network metaphor, one only has a tool that does something in accordance to the agency of the human-user (a computer that downloads at your command, an information network that makes everything freely accessible at the click of a mouse, etc.). Click-download, cause-effect. If we dispense with convenient metaphors and actually ask how a network functions (not "what it is?" but "what does it do?"), then several noteworthy realisations emerge. [...] a network is not simply a free-for-all of information "out there", nor is it a dystopia of databanks owned by corporations. [...] On the one hand, TCP/IP (Transmission Control Protocol / Internet Protocol) enables the Internet to create horizontal distributions of information from one computer to another. On the other, the DNS (Domain Name System) vertically stratifies that horizontal logic through a set of regulatory bodies that manage Internet addresses and names. Understanding these two dynamics in the Internet means understanding the essential ambivalence in the way that power functions in control society.' (2004: xv)

Indeed, control is no longer centralised or even decentralised any more and is not hierarchical but still exists in a distributed form of organisation. Like Nichols, Galloway identifies a contradiction between two opposing tendencies: one that radically distributes control into autonomous locales and at the same time another that focuses control into rigidly defined hierarchies. To address this, he shifts emphasis from 'networks' to 'protocols' - from a generalised understanding of networks to a more specialised and particular one in which the 'protocological' systems of TCP/IP and DNS operate as 'political technologies' (to evoke Foucault's description). To Galloway, the political economy of the protocol is that of management, modulation and control. In this way:

'power relations are being transformed in a way that is resonant with the flexibility and constraints of information technology. The Internet is not simply "open" or "closed" but above all the form that is modulated. [...] Information does flow, but it does so in a highly regulated manner. [...] Viewed as a whole, protocol is a distributed management system that allows control to exist within a heterogeneous material milieu' (2004: xix, 7-8).

This position reflects a broader understanding of a new exercise of power and control in open systems.⁷² Hardt and Negri claim that 'the new paradigm is both system and hierarchy' and demonstrate the structural logic of 'governance without government' (2000: 13-14) demonstrating the paradoxical ways that power is now expressed. From these descriptions, it is clear that control and governance are enacted in new ways reflecting the topology of distributed network systems, and more positively that 'file exchange within peer to peer networks demonstrates how the network itself is adaptive and somewhat resistant to control' (Knahl and Cox 2007). The area of intellectual property rights become a key area of contestation here, with the hierarchical tendency to enforce or extend existing power structures, set against free and open source principles. The suggestion is that 'despite the severe limits on democratic structures, there remain opportunities to rethink politics within network cultures' (Knahl and Cox 2007). Much in the same way, Rossiter emphasises the

urgency of rethinking the model of institutional forms in response to the logic of social-technical networks. He states that:

'while networks are in many ways regulated indirectly by the sovereign interests of the state, they are also not reducible to institutional apparatuses of the state. And this is what makes possible the creation of the new institutional forms as expressions of non-representational democracy' (2006: 39).

What is required is a negotiation of the relation between structure and dynamics. This comes close to what Terranova imagines as a new type of 'production machine' that demonstrates emergent behaviour and demands flexible strategies of control (2004: 100). Open systems offer a much broader range of input and expertise. She continues:

'The openness, then, constitutes the conditions that give rise to the most general of the political concerns expressed by a network culture. The tension between universality and divergence that informs the open space of 'internetworking' in fact produces a rich cultural dynamics and a set of political questions that are taken up again and again across network culture at large.' (2004: 61-62)

The new emergent institutional form envisaged by Rossiter is the 'organized network', reflexive of 'relational processes' and inherently driven by the 'elemental force of self-organisation'. It thus presents a challenge to the existing systems of governance and representational structures.⁷³ In contrast, older forms of 'networked organisation' are characterised as hierarchical and centralising, despite claiming otherwise. The new institutional form is characterised as horizontal, collaborative and distributed in character, offering a distinct social dynamic and transformational potential. The distinction is summarised by Rossiter, as follows:

'The network models of sociality made possible by information and communication technologies have resulted in new forms of social-technical systems, or what I am calling emergent institutional forms of organised networks. While these networks can be called institutional forms in so far as they have a capacity to organise social relations, they are radically dissimilar to the moribund technics of modern institutional forms - or 'networked organisations' - such as government, unions, and firms whose logic of organisation is predicated on vertical integration and representative tenets of liberal democracy. Such dynamics are profoundly unsuited to the collaborative and distributed culture of networks peculiar to digital communications media and their attendant socialities.' (2006: 14)⁷⁴

In this way, the relation between structure and dynamics, control and collectivity can be negotiated if the technical and organisational infrastructure is better understood. Like Rossiter, who imagines new emergent institutional forms driven by the 'elemental force of self-organisation', Ascott too provides a critique of educational institutions deeply unsuited to 'collaborative and distributed culture of networks' (Rossiter 2006: 14) and imagines an 'emergent organism' concerned with 'advancement of learning through collaborative inquiry and shared experience'. In his chapter 'The Planetary Collegium. Art and Education in the Post-Biological Era', Ascott creates a vision of a university suited for 'telematic culture'; evoking a sense of the global community 'in which each member has more or less equal power and authority both in access to

knowledge and in the means of its reconfiguration and distribution'; a form of 'collegium', or 'Planetary Collegium' in his terms (2003: 312). Envisaged as a global network of centres for advanced research, the new form combines 'the necessary face-to-face transdisciplinary association of individuals with the nomadic, transcultural requirements of a networking community', and could potentially replace old redundant educational institutions (Ascott 2003: 368).⁷⁵

Applied to curating, open systems offer opportunities for acknowledging the role of the curator as an active part of the system. But it is not simply a question of one choice over the other; the opposition of collectivity over individualism in open systems is far more complex, as has been discussed in the first part of the chapter. Current forms of curating are not well suited to the collaborative and distributed culture of networks. The thesis is arguing for new forms of curating that better respond to the logic of social-technical networks and open systems.

3.2 Agency in Open Systems

A better understanding of the dynamics and structures of open systems thereby establishes some of the working principles for curating in open systems, and curating as an open system. This takes its cue from systems theory and the second-order of cybernetics, to understand some of the nodes of power and forms of control therein, as well as the importance of feedback loops and self-organisation. In addition, the urgency of rethinking organisational models decoupled from centralised power are derived from network cultures in recognition that new paradigms demonstrate the paradoxical structural logic of 'governance without government' (Hardt and Negri 2000: 13-14) or 'non-representational democracy' (Rossiter 2006). This reflects the fact that the network itself is adaptive and somewhat resistant to control, despite all attempts to exert control over it. Relational and adaptive processes suggest new organisational models for online curatorial practices, that extend previous descriptions of immaterial curating in chapter 2. This chapter consequently explores the issue of agency in parallel to the ways in which control has been characterised within open systems.

The idea of agency is a highly contested idea in philosophy and the social sciences, one that relies on a certain view of the human subject's ability to act in the world, or to be able to make a choice to act. This basic understanding of agency is important, as it establishes the ability of humans to act autonomously or independently and to make interventions. Human agency in this sense lies in contrast to natural forces involving deterministic processes. In the Marxist tradition, human agency is a collective and historical dynamic, allowing for the ability to transform society. The difficulty of the concept for many is that it assumes a relatively stable view of the human subject and a

simplistic view of subjectivity. Although only briefly touched upon in the last chapter, post-Marxist positions have attempted to establish a revision of political subjectivity to account for a more complex formulation. For instance, Hardt and Negri characterise the 'multitude' to take account of the global condition of *Empire*:

'New figures of struggle and new subjectivities are produced in the conjecture of events, in the universal nomadism [...] The deterritorializing power of the multitude is the productive force that sustains Empire and at the same time the force that calls for and makes necessary its destruction. (2000: 61)

It is this lack of certainty over the role of the working class as agents of change that has led post-Marxists to take account of subjectivity at a deeper level. This is evident in Autonomous Marxism, both in terms of the way collective subjectivities are described (as above) and broadly in the use of the phrase autonomy – to emphasise the possibility of developing relative autonomy over work and as agents of social change. It is also clear that an understanding of systems theory is evident in the description by Hardt and Negri of deterritorialised power.

The question of agency in the curatorial process works in a similar way, by demonstrating the constitution of the system and the ability to change it. Agency is necessarily linked to action. Agencies are always doing something, as Latour puts it, and furthermore, 'an invisible agency that makes no difference, produces no transformation, leaves no trace and enters no account is *not* an agency' (2005: 53). Or to put it the other way around, action is a consequence of a multiple interaction between agencies.⁷⁶ In the case of curating, the process is distributed across multiple agents such as programmers, networks of users, artists, and curators. Perhaps it is possible to imagine the figure of a collective curator operating a kind of deterritorialised power in this way. Importantly, it is a network of users that constitutes the system, along with the technological apparatus in its broadest sense. An emphasis on the user in the curatorial system is particularly significant in this context, as it is the user who dynamically determines its openness. Thus, it is also important to note that the openness of such systems may vary considerably. Similarly, Hayles points out that systems may well be 'technologically open' but 'informationally closed'. By describing systems as informationally closed, she is drawing upon an understanding of second-order cybernetics in which systems respond to stimuli of their own internal self-organisation. To further explain, an understanding of systems is determined by their internal self-organisation, and the informational feedback loops 'no longer function to connect a system to its environment' and 'no information crosses the boundary separating the system from its environment' (1999: 10–11). Her suggestion, and one followed by this thesis, is to shift attention to emergent transformative processes that can offer an understanding of systems as 'informationally open' and that are in keeping with more current interpretations of socio-technological networks.

Consequently, if agency can be seen to be distributed across multiple agencies, it is

also possible to conceive of a collective curatorial agency that is relatively open. The argument becomes more complex, however, when distributed socio-technological systems are also considered an active part of the curatorial process – when human and technological agents act together in the world.⁷⁷ If human agency outside of more complex (post-structuralist) formulations of subjectivity is considered inadequate, so too is the agency of social technologies, unless combined into complex collective forms of influence and emergent transformative processes.

For the purposes of the argument here, it is not necessary to draw out a definition of agency for there are countless versions across a range of disciplines. What is important is that agency is tied to action, and what the many definitions have in common is the notion that 'agency makes a difference between something that just happens [...] and something that is an action to which a cognitive dimension is attached' (Mackenzie 2006: 8). In *Cutting Code: Software and Sociality*, Adrian Mackenzie (2006) claims that attaching agency to software is essential. He explains how software is sometimes explicitly envisaged as possessing 'full-blown agency' (as with artificial intelligence), but more often it is regarded as 'possessing secondary agency': supporting or extending the agency of the code, the programmer (originator), the artist, the corporation, the prototype, or the user (recipients). He argues that 'because the same thing or person can be both agent' and what he refers to as 'patient', and can switch roles relatively quickly, attributing agency offers 'interesting instabilities, and different varieties of agency proliferate'. To demonstrate this point, he makes reference to Alfred Gell's *Art and Agency* (1998) that indexes the variety of permutations of agency found in 'art-like situations' ranging from: 'pieces of code to which people delegate specific actions, architectural models of software systems based heavily on social relations such as server, client, manager, worker, producer, consumer, and so on'. He further explains that 'contrary to the idea that software obscures these agential transactions, code renders them all the more vividly'. (Mackenzie 2006: 9) Consequently, according to Mackenzie, code is 'agency-saturated', even when it is invisible or hidden; 'agency behaviours' are more and more expected in contemporary situations.

The issue for this chapter is how agency is distributed between humans, machines and software. It is distributed across the interactions of agents and across the network they inhabit. According to Mackenzie, this has been well established in various fields such as cognitive anthropology (Hutchins 1995), cognitive science (Clark 1997), social anthropology (Gell 1998), and social studies of technology (Callon 1987). If agency has become more expected, then when does it become useful in exerting meaningful influence over changes to the system? With the recognition that human *and* machine processes express agency, the 'critical agent becomes hard to identify, and to locate'. The once straightforward definition of agency, lying in the power to act, becomes

something expressed in humans, things, systems, and code, all distributed across multiple interactions and networks. Importantly, agency remains thoroughly political in that it is 'distributed unevenly and it entails widely divergent transactions' (2006: 11). The new modes of production and processes of identity formation, commodification or consumption carry with them the notion of agency in relation to 'software as sometimes a tool (what software does as a technology) and sometimes as a force (what people do with software as they make or use it)' (Mackenzie 2006: 172).

Of relevance here is sociology of consumption, that takes the issues of agency and autonomy in relation to new modes of production, identity formation and consumption as central. Here, autonomy is understood as the degree of self-control, self-determination and ability to act independently by individuals and institutions determined by the wider socio-historical structure. This is of concern for Conrad Lodziak who in his book *The Myth of Consumerism* (2002) provides a critique of the current ideology of consumerism, that associates consumption with freedom (in which consumption is suggested an arena of choice) and that proposes consumption as symbolic and as identity value based on an increased choice. The ideology is that an increased choice promotes active, creative engagement in 'the pursuit of difference and individuality' and this is where autonomy resides (2002: 68). This is in opposition to the older competing view of standardised, consumption-evoking, passive mass conformity. While asserting the individual capacity for autonomous action (a central assumption in the theory of consumption he develops) Lodziak takes an issue with how the ideology of consumerism conceptualises autonomy. To him, the current form of consumerism simultaneously produces new needs and precarious conditions of work. Hence to consider consumption as an arena of freedom is highly contentious. In contrast he argues that contemporary forms of production result in 'active passivity'; that consumption 'constitutes a field of dependence by virtue of the alienation of labour', and that 'consumer choice gives a semblance of freedom only', reinforcing 'the negation of freedom' (2002: 69). Lodziak's critique of pseudo-autonomy and pseudo-agency evokes the Autonomists' position, in particular the arguments made by Terranova and Pasquinelli (see chapter 2.2) in relation to networks and free software, and extends to some forms of curating that involve social technologies (as discussed in more detail in chapter 5.2).

The particular importance of the position offered by Mackenzie in relation to software is in understanding agency as thoroughly complex and dynamic. For him, software allows for the recognition of significant differences in agency that arise 'from the involutions and distributions of relations in code', where code is understood to be itself 'structured as a distribution of agency' (2006: 19). The analytical distinction between code as expression and code as action, is fundamental for developing an

understanding of curating that involves software. Software curating is both a tool and more importantly a force of change – it expresses agency in this way.

Agency associated with software curating expresses emergent properties. This emergent sense of agency suggests new organisational forms that are partly derived from network cultures. Curatorial agency responds to open and distributed forms as a reflection of both the organisation of the system in which it unfolds and its power to act within such a system. What happens when a curatorial system that involves software and is distributed across networks is envisaged as an immanent part of the system necessary for curating to take place? In such a system, the curator becomes a function of a wider collective endeavour, what Vishmidt refers to as ‘collective executable’ (2006: 48). The software expresses the agency of the curator–programmer, the machine that it runs upon, and the network. The network expresses the agency of the cultures that surround it, and its own dynamic operations. Thus, software curating encompasses the collective agency of these dynamic interactions. To reiterate, the curatorial process, already collaborative and involving other agents in addition to a singular curator, now becomes closely integrated with dynamic socio-technological networks and software; software that is not used simply *to curate* but that demonstrates the activity of *curating in itself*. Agency is reconstituted beyond the collectivity of human agents to include software and the dynamics of the system, as the collective executable that acts in the world and is able to transform it.

4. Software and / as Curatorial Object(s)

Building upon the critical understanding of curating in the context of Immateriality and open systems in previous chapters, this chapter extends these theories to situate curating within the broader context of software cultures and coding practices. This concern reflects a relatively recent interest in software art practice, in which computer programming is understood as artistic practice (art-oriented programming) and program code as potential artwork. Thus, the emphasis is on new artistic forms to be curated – on program-objects that display dynamic and transformative properties, and that are distributed over networks involving social processes. If, according to Galloway and others, the network form has come to symbolise the contemporary organisational structure, to Mackenzie it is software that ‘embodies a mixture of mutability, contingency and necessity symptomatic of recent times’ (2007: 1–2). For Mackenzie, the term software encompasses different practices of production, consumption, use, circulation and identity and cannot be understood as separate from code:

‘Code, even defined in the minimalist technical sense as a “rule for transforming a message from one symbolic form (the source alphabet) into another (the target alphabet)” cuts across every aspect of what software is and what software does. [...] Attending to code as practice and material might show how software becomes invisible, how its occlusion from analysis occurs and how it nonetheless becomes at times very visible and significant. [...] Despite appearing “merely” technical, technical knowledge-practices overlap and enmesh with imaginings of sociality, individual identity, community, collectivity, organisation and enterprise. Technical practices of programming interlace with cultural practices.’ (Mackenzie 2007: 3–4)

Such an understanding of software is evoked in the term software cultures.⁷⁸ The idea of software in relation to art is not new, and there is a wealth of critical works in the field that explore various historical lineages in this respect. For instance, Peter Weibel in his essay ‘It Is Forbidden Not to Touch: Some Remarks on the (Forgotten Parts of the) History of Interactivity and Virtuality’, notes that ‘the attributes of programmability, immersion, interactivity, and virtuality did not first appear in the media and computer art produced from 1970 onward, but were already present in the op and kinetic art of the 1960s’ (2007: 21–22). The history of the basic elements of ‘algorithmic art’ (drawing in this sense on the definition of an algorithm as a set of instructions to act) is traced back to major movements of the 1960s, and in particular op and kinetic art, Fluxus happenings, computer graphics and animation. In more general terms according to Weibel, reconciling art with the ‘machine’ can be traced back not least to the writing of the ‘Macchinismo’ manifesto in 1952 by Bruno Munari, and the exhibition ‘Arte Programmata: Arte cinetica, opera moltiplicata, opera aperta’ curated in 1962 by Munari and Giorgio Soavi (2007: 21, 38), if not the Futurist Manifesto of 1909 by Filippo Tommaso Marinetti. The description of properties displayed by these early examples is indicative of, and extends to, more contemporary

forms that are discussed in the context of the thesis. Weibel summarises this tendency in the following way:

'Arte programmata is a form of kinetic art in which on the one hand the movement is predictable because it more or less follows the rules of mathematical programs, but on the other hand, it at the same time permits random processes. That is to say, the course of movement fluctuates between random and programmed, between precise predisposition and spontaneity, and therefore occurs within a system we would today term dynamically chaotic. Programmability – at least as a concept – had taken its place alongside the notions of virtuality, the environment, the internal observer and/or interactivity (the user sets in motion the mobile work of art, the kinetic sculptures, co-constructs the "kinetic construction").' (Weibel 2007: 38–40)

Similarly, the emphasis on 'controlled randomness', formal instructions, rule-based processes, appropriation and the manipulation of 'found' materials, and audience participation can be traced through Dada, Fluxus and conceptual art movement in the 20th century. These are the basic principles of more contemporary art forms that are often described under the wider term 'digital art' (of which software art is considered a part). In *Digital Art*, Christiane Paul notes that in particular the 'idea of rules being a process for creating art has a clear connection with the algorithms that form the basis of all software and every computer operation: a procedure of formal instructions that accomplish a "result" in a finite number of steps' (2003: 13).

A number of other examples of works that attempt to historicise this field were referred to in the introductory chapter. In this chapter the discussion shifts from the concept of programmability and the algorithm as an organising principle of artwork (in a functional and/or technical sense) to a consideration of programming and code as cultural and aesthetic expression – under the broader and more contemporary term 'software practice'. Central to the discussion is the more general idea that the act of computer programming itself can be considered *artistic activity* and that software can be considered *an artwork*, as opposed to the functional activity of programming and software as a means to facilitate the *production of an artwork*. Such a differentiation, between software seen as functional tool, and software as cultural production in itself, and as art form, is common to the software art scene. This is explained by Olga Goriunova and Alexei Shulgin in their introduction to the *read_me festival 1.2* catalogue:

'artistic software is, first and foremost, software created for purposes different than traditional pragmatic ones. Such programs are not seen as tools for the production and manipulation of digital objects – from online bank accounts to works of art – they are works of art in their own right.' (2002: 6)

To investigate these ideas, the chapter is structured into two sections. The first of these directly relates to the critical discourse around software practice and argues that software represents both technical and cultural processes that cannot be disassociated. Furthermore, it builds upon an understanding of the complex relations of hardware and software embedded in the computer, and the idea of assemblage and

resemblance, to explore the critical potential of software. An example of the computer virus is offered as a way of instantiating the idea of technological accident, capable of disrupting contemporary sites of power and control in informational capitalism. Section 4.2 extends this discussion and introduces the idea of source code as a more specific example of software artwork. A fuller description of what constitutes 'source code' in technical and cultural terms is provided, to inform the subsequent analysis of software curating and *kurator software* in chapter 6. The cultural understanding of source code is introduced with reference to discussions on 'open source', 'free software', or the more generically used term FLOSS. Such a cultural understanding of source code, both as artwork and as a core production principle, underpins what Armin Medosch (2007) describes as 'Open Source Culture'.

4.1 Software Cultures

Software represents both technical and cultural processes, and these two aspects cannot be disentangled. In general terms, software is defined as a set of formal instructions or algorithms, a logical score that can be translated into a computer program and executed by a machine. It also includes associated documentation concerned with the operation of a data processing system (e.g. compilers, library routines, manuals and circuit diagrams). There is a distinction made between 'system software' (the operating system and database management system (DBMS)) and 'application software' (any program that processes data for the user such as a word processor, etc.). In *A History of Modern Computing* (1998), Paul E. Ceruzzi emphasises the complexity of the relationship between software (the set of instructions that direct a computer to do a specific task) and hardware (a general-purpose machine on which software runs):

'A computer system is like an onion, with many distinct layers of software over a hardware core. Even at the center – the level of the central processor – there is no clear distinction: computer chips carrying "microcode" direct other chips to perform the processor's most basic operations. Engineers call these codes "firmware", a term that suggests the blurred distinction.' (2003 [1998]: 80)

The complexity of this relationship is what I have tried to identify in relation to the concept and description of 'software curating': as both a set of curatorial instructions and a networked system (an online software and a dynamic network of users) within which these instructions are executed. More detail on this is provided by Ceruzzi, who delves into the history of the development of software, from the writing of first computer instructions by way of punching a row of holes on a piece of paper tape (first written by Grace Murray Hopper to be processed on the electromechanical *Harvard Mark I* machine in 1944), to early programs stored on computers (on tape in libraries of sequences) and more contemporary computer languages and system software that run on digital computers. The term 'software' itself was first used around 1959 after the development of early (high-level) programming languages such as FORTRAN

(Formula Translation; Introduced by IBM In 1957) and COBOL (Common Business Oriented Language; Introduced In 1959) that derive in turn from earlier examples of writing shorter programs and collecting them into libraries of subroutines and

'then [...] getting the computer to call these up and link them together to solve a specific problem. That gave way to a more general notion of high-level computer language, with the computer generating fresh machine code based on a careful analysis of what the programmer specified, in something that resembled a combination of algebra and English' (Cerruzi 2003 [1998]: 108).⁷⁹

The technical description of libraries and subroutines lends itself to the analogy the thesis makes to wider cultural practices that involve the storage, re-use and display of data in general. The parallel might be further emphasised by thinking about how on visiting the traditional white cube of a gallery or museum, the work of the curator (or artist for that matter) is relatively hidden from the display of artwork. Similarly, with the installation of digital artworks, the work of the programmer is relatively hidden and under-acknowledged as creative practice in its own right. This issue is emphasised by Florian Cramer, who states:

'The history of the digital and computer-aided arts could be told as a history of ignorance against programming and programmers. Computer programs get locked into black boxes, and programmers are frequently considered to be mere factota, coding slaves who execute other artist's concepts. Given that software code is a conceptual notation, this is not without its own irony. In fact, it is a straight continuation of romantic philosophy and its privileging of aesthesis (perception) over poesis (construction) cheapened into a restrained concept of art as only that what is tactile, audible and visible.' (2002: 18)

It is this lacuna that festivals such as *read_me* have sought to address in drawing together aesthetics and poesis. The jury statement of 2002 (*read_me 1.2*) defines software art as neither placing emphasis on the formal and aesthetic aspects expressed in the beauty and elegance of the code, nor an emphasis on the cultural aspects (Goriunova and Shulgin 2003: 8; Cramer 2002: 23).⁸⁰ In *Behind the Blip: Essays on the Culture of Software* (2003), Matthew Fuller develops critical thinking about software that takes into account the emerging practices within the software culture. What he calls 'software criticism' places an emphasis not merely on pre-formatted notions of functionality and technical aspects of software but also on critical conditions of software processes – production, execution and consumption. This goes some way towards formulating a theory of software, and shifts debates on software to an engagement with processes and the context of production (the programmer) and distribution/consumption (user). It places value on experimentation and the idea of software as necessarily unfinished; software as the 'activation of the process of becoming', as Fuller puts it (2003: 11–15).

The line of thinking that Fuller develops builds upon earlier work, including Ellen Ullman and Donald Knuth, who had previously argued for the separation of thinking about software from its corporate context and as an autonomous cultural activity

(Fuller 2003: 17). The engagement with process draws together historical and technical references from the programming community, and responds to the work of Deleuze and Guattari, in which software processes are recognized as deeply embedded in the ways we understand the world. Fuller posits:

'a proposal for the understanding of software as a form of digital subjectivity – that software constructs sensoriums, that each piece of software constructs ways of seeing, knowing, and doing in the world that at once contain a model of that part of the world it ostensibly pertains to and that also shape it every time it is used' (2003: 19).

Consequently, expanding on Ceruzzi's earlier description of the complex relationship between software and hardware, the computer is understood as an 'assemblage' (after Deleuze and Guattari, 1987) of levels of the operating system.⁸¹ To Fuller, this provides opportunities for critique and forms of theorisation and 'practice that break free of any preformatted uniformity', and that form further assemblages. This is where criticality might reside and be expressed in models of practice that emerge within software production and that challenge normalised understandings of software. In formulating such an understanding of software criticism that takes account of practice, Fuller explores the potential for new forms of software practice and describes emerging models under three categories: *critical software* (that undermines and questions normalised understandings of software); *social software* (produced and consumed outside of the commercial context, developed and changed through social networks of users and programmers and that emerges from a different set of social relations than the orthodoxy of software production); and *speculative software* (that creates new connections between data, machines, and networks) (2003: 22–32).⁸²

By taking account of emerging models of practice and criticism, other layers of the operating system can be made open to reassemblage. Fuller describes these potential spaces as 'blips', and this is where politics lies ('behind the blip', as he puts it). This speculation on reassemblage (and critical potential) draws upon a deep understanding of the computer and the complex relations of hardware and software, especially once distributed over networks. Jussi Parrika also suggests in his book *Digital Contagions: A Media Archaeology of Computer Viruses* (2007) a 'certain totalitarian technological basis' in the cultural logic of information society, that is simultaneously open for disruption by 'technological accidents' such as the computer virus.

Similarly for Deleuze, the computer virus evokes strategies of resistance in a wider sense: 'Computer piracy and viruses, for example, will replace strikes and what the nineteenth century called "sabotage" ("clogging" the machine)' (Deleuze 1990).⁸³ Thus, the disruption of contemporary sites of power and control, relocated from the industrial factory to technological networks in information capitalism (discussed at length in chapter 2) takes on a current form that impacts on a global scale. Parrika explains this:

'More than ever, a single technological accident, a computer virus or a bug, could wipe out major parts of Western cultural memory, invested in the digital products and networks of the cybernetic era. A virus can accomplish a rupture in such a symbolic frame of media culture both incorporeal and in the form of the very material interruption it can achieve in the normal functioning of a society – a virus is a disruption to the everyday logic and rhythm of the social order, a catastrophe. By adding itself, for instance, into executing code, a virus can translate a portion of technical code into repercussions across scales from economics to politics.' (2007: 7)

The ability of computer viruses to spread and invade other systems, whether invited or uninvited, reveals both their destructive potential and the inadequacy of the host system's defences. In this sense, the cultural phenomenon of computer viruses provides a radical example of a dynamic system distributed over a technological network that extends beyond its destructive potential. Massimo Ferronato defines a computer virus as 'a program capable of altering other programs, including a copy of itself, by means of infection' (2002: 22) that exhibits properties similar to biological viruses: self-replicating, mutating, and re-arranging their working patterns to infiltrate a host system or organism and spread throughout it. In other words, the virus adapts and transforms quickly in response to its environment (Ludovico 2002: 40).

Programmed in languages such as Assembler, PASCAL, C++, Visual Basic, or PERL, computer viruses are situated at the intersection of craft (that of computer coding) and potential artistic expression. In keeping with the discourse around software art, commentators such as Ferronato argue that the programming of computer viruses should be seen not 'as a means of producing art but [as] an art form in its own right', validated by the traditional aesthetic criteria of beauty, proportion, elegance and effectiveness (Ferronato 2002: 24).

There are numerous examples of works that emphasise the aesthetic function of computer viruses and programming as a means of combining form and function, such as those created by the free software programmer Jaromil.⁸⁴ He explains his thinking:

'The digital domain produces a form of chaos – which is inconvenient because it is unusual and fertile – on which people can surf. In that chaos, viruses are spontaneous compositions, which are like lyrical poems in causing imperfections in machines "made to work" and in representing the rebellion of our digital surfs.' (2002: 64)

There are a growing number of artists working with viral principles and aesthetics, using the concept of 'cultural viruses' metaphorically and programming actual viruses. For example, the artists' group etoy utilise viral marketing techniques to infiltrate systems of commerce, while for JODI the aesthetics of abnormal and unpredictable computer behaviour serve to mislead computer users into believing that there is something wrong with their machines (for instance, in their work *OSS*).⁸⁵ More extreme again are those artists who program actual computer viruses and present them in an art context, while drawing attention to the aesthetics of the viral code itself. The latter tendency is exemplified by the recent work of the artist collective *epidemiC*, which in

collaboration with the net art group 0100101110101101.org, created the self-reproducing program *blennale.py* that spread through the media system from an infected computer in the Slovenian Pavillion of the Venice Biennale (2001).⁸⁶ [Fig. 1]

Viruses are complex programs – not least in the knowledge required to compile them – but they also present an aesthetic challenge related to the code itself and what it does once executed.⁸⁷ With direct reference to viruses, Ferronato describes an aesthetic approach to programming ‘as the assumed link between the beauty of the code and the result it produces’ (2002: 24). Beauty, an aesthetic qualification for conventional artworks, also includes an appreciation of ugly, disruptive and destructive works. To the critic Alessandro Ludovico, this particular aspect is emphasised in the source code of *blennale.py* as it does not produce disruptive or malignant properties as such but inhabits the Biennale computer network like an uninvited guest (Ludovico 2002: 38–40).

A more extensive analysis of computer viruses is beyond the scope of the thesis. We shall return to the main focus of this chapter, that relates programming and code to curating.⁸⁸ If programming viruses can be seen as creative and critical practice, and viruses themselves can be appreciated for their destructive and aesthetic qualities, they can also be considered an artwork to be brought into the public domain in a meaningful way; in other words, to be curated. This was the radical assumption of the *I Love You [rev.eng]* (2002–2004) exhibition, that presented computer viruses in an art-culture context.⁸⁹ The exhibition was inspired by the (in)famous ‘I Love you’ computer virus that in 2000 caused an unprecedented ‘sabotage’ and effectively a crash of communication networks on a global scale. [Fig. 2]⁹⁰ Franziska Nori, one of the curators of the show, explains:

‘The ‘I love you’ computer virus, with its declaration of love accompanied by a destructive code in an attachment and sent by the thousands round the world, has made each one of us aware of the presence of these self-reproducing digital beings.’ (2002: 12)

For the exhibition, curators compiled about 400 active viruses, both as executable code and as viral metaphors, to highlight some of the controversial positions of net artists, programmers, IT experts and code poets on computer viruses, that challenge a number of the economic and aesthetic grounds on which the art world is founded. The underlying purpose of this was a reconsideration of the role of cultural institutions and the practice of curating in relation to digital culture. It raised a number of questions concerning an artwork’s cultural value, its ontological status, its presentation to the public, and its longevity.

Although *I Love You [rev.eng]* was a radical exhibition in its choice of subject and selection of works, and brought extensive research in the field into the public domain,

it was perhaps less daring in its approach to the curatorial process itself. Could the curatorial approach engage more overtly with such concerns by asking what curatorial process would be appropriate to respond to the works included – the idea of ‘viral curating’ perhaps? Certainly the thinking applied in this thesis suggests an analogy between the curatorial and viral process. Likewise, Galloway and Thacker offer an interesting approach and speculate on curating exhibitions dedicated to epidemics and disease. By drawing on the Latin etymology of the term ‘curate’ (previously described in the Introduction), they add the biological dimension to curating and explain:

‘with the act of curating an exhibit of viruses or epidemics one is forced to “care” for the most misanthropic agents of infection and disease. One must curate that which eludes the cure. [...] Curare thus presupposes a certain, duplicitous relation to transformation. It enframes, contextualises, bounds, manages, regulates and controls. In doing so it also opens up, unbridles, and undoes the very control it seeks to establish. It is the point where control and transformation intersect.’ (Galloway and Thacker 2006: 167)

Such an approach evokes the idea of reassemblage – exemplifying critical practices that challenge normalised understanding of systems. In this chapter, some possibilities are offered in this direction that develop criticism and practice in software towards a criticism and practice in *software* and *curating* (see further chapters 5 and 6). With reference to Fuller’s categories, this may well be critical, social and speculative, but taken together it serves to stress the possibilities embedded in these complex technical and cultural processes. The idea of computer and curatorial programming combines these processes well and clarifies that software offers curatorial potential, both as art form and as process for reassemblage.

4.2 Curating Source Code

Whereas the previous section considered software as an expression of cultural production, this section more specifically considers source code as potential artwork. The discussion around the conceptual and technical qualities of source code as artwork to be curated, is central to the thesis and for the subsequent description of the *kurator* software project in chapter 6.

If viruses can be considered as artwork to be curated, then to focus on source code provides an even more radical example in this respect, by highlighting the process of curating as a set of instructions to be executed. Source code stands as both artwork that can be curated and simultaneously as an analogy for the curatorial process. The first aspect of this is well established in the field of software culture, with numerous examples of artistic projects that highlight source code as artwork. For instance, *WebStalker* (1997) by the group I/O/D was an experimental web browser that instead of formatted pages displayed their source code and link structures.⁹¹ Similarly, the exhibition *CODEDOC* (2002) curated by Christiane Paul for the Whitney Museum’s

artport website, examined the relationship between software art and its underlying source code.⁹² [Fig. 3 and Fig. 4] The particular significance of the *CODEDOC* exhibition is in shifting curatorial attention directly to source code (displayed in the exhibition alongside its results as executed code). The conceptual idea behind the project was, according to Paul, to take 'a reverse look at software art projects by focusing on and comparing the "back end" of the code that drives the artwork's "front end"'. The curatorial process itself is interesting in that it takes the idea of instructions (expressed as the assignment for artists) as a methodology for commissioning artworks for the exhibition. The project website explains:

'A dozen artists coded a specific assignment in a language of their choice and were asked to exchange the code with each other for comments. The assignment was to "connect and move three points in space," which obviously could be interpreted in a literal or abstract way. The "core" of the code (commonly referred to as the "main") was not to exceed 8KB, which equals a fairly short text document. [...] what visitors to this site encounter first is a text document of code from which they can launch the front end of the project. The languages in which the code is written are Java, C, Visual Basic, Lingo and Perl.'⁹³

The second part of the description is the more important concern for this thesis, and necessitates a fuller understanding of what constitutes 'source code'.⁹⁴ In technical terms, source code (sometimes referred to as simply 'source' or 'code') is the uncompiled, non-executable code of a computer program stored in source files. It is a set of human readable computer commands written in higher level programming languages such as C, C++, Java, Pascal, BASIC, Ada, Algol, FORTRAN, or COBOL amongst many others. Defined by a higher level of abstraction from machine language, these 'artificial' languages share some of the characteristics of natural language, such as rules of syntax. When compiled, the source code is converted into machine executable code (binary) – a series of simple processor commands that operate on bits and bytes.⁹⁵ In principle, any language can be compiled or interpreted and there are many languages such as Lisp, C, BASIC, Python or Perl that incorporate elements of both compilation and interpretation.⁹⁶

Exploring the cultural dimension of source code, Knuth suggests an analogy between programming and recipes in a cookbook, as a set of instructions to follow. In his book *The Art of Computer Programming* (1981, first published in 1968) he argues that algorithms, much like cooking recipes, provide a (computational) method; a set of defined formal procedures to be performed in order to accomplish a task in a finite number of steps (1981: 8).⁹⁷ Thus, examining the source code of a particular program reveals information about the software in much the same way as the ingredients and set of instructions of a recipe reveals information about the meal to be consumed.⁹⁸ The importance of source code for the description of software is that, alongside computer commands, it also usually provides programmers' comments – a documentation of the program including a detailed description of its functionality and

user instructions.⁹⁹ Furthermore, the importance of source code is that any modifications (its improvement, optimisation, customisation, or bug fixes) are not carried out on compiled binary code (object code or machine code) but on the source code itself. The significance of this is that the source code is the locus of influence that can be exerted by the programmer. In the example of recipes, further descriptions are provided in the accompanying narrative and explanation, with modifications to the instructions implemented by human intervention.

Significantly, in the history of computation programs they were first written and circulated on paper before being compiled or executed, in the same way that recipes were shared before being compiled in cookbooks. The first case of an algorithm written for a computer is credited to Ada Lovelace, who interpreted Charles Babbage's *Analytical Engine* (of 1835) not merely as a calculator but as a logic machine, capable of arranging and combining letters and other symbolic systems (Bolter 1984: 33). The source code of a modern digital computer derives from the further adaptation (in the 1940s) of Babbage's ideas.¹⁰⁰ What later became known as 'von Neumann architecture' (originating in von Neumann's formal description of the design of stored program architecture in his paper 'First Draft of a Report on the EDVAC', published in 1945) is important, as it presented a single structure to hold both the set of instructions on how to perform the computation and the data required or generated by the computation. It demonstrated the stored-program principle that led to the development of 'programming' as separate from hardware design; the separation of software in other words. Remington Rand's UNIVAC (Universal Automatic Computer, 1951) was one of the first machines to combine electronic computation with a stored program, capable of operating instructions as data on its own.¹⁰¹ With a stored-program computer, a sequence of instructions that might be needed more than once could be stored. The computer could store the sequence in memory and insert the sequence into the proper place in the program as required. By building up a library of frequently used sequences, a programmer could write a complex program more efficiently. In *A History of Modern Computing* (2003 [1998]), Ceruzzi explains this development, from building up libraries of subroutines and then getting the computer to call them up and link them together to solve a specific problem, to a more general notion of a high-level computer language with the computer generating fresh machine code from the programmer's specifications (2003: 84, 108). The principle of re-using or sharing code is reliant on storing collections of code lines or functions in 'libraries'. The subroutine, often collected into libraries, is a portion of code within a larger program, which performs a specific task and is relatively independent of the remaining code. A subroutine is often coded so that it can be executed several times or from several places during a single execution of the program. It can be adapted for writing more complex code sequences, and is thereby a labour-saving programming tool and an important mechanism for sharing and reusing code.

In *Free Software, Free Society* (2002) Richard Stallman suggests that the sharing of software is as old as computing, just as the sharing of recipes is as old as cooking. However, the reverse of this analogy holds too. Just as much as recipes might be shared (open) they also might be kept secret (closed recipes) in the same way that software licensing reinforces two radically opposite models of production, distribution and use of software – ‘open source’ and ‘closed source’ respectively.¹⁰² In general terms, under open source conditions, source code is included with a particular software package to allow its viewing and further modifications by the user (i.e. source code distributed under the terms of licenses such as BSD, GNU/GPL, MIT), whereas a proprietary model of closed source prevents its free distribution (and indeed modification) and software is released as already compiled binary program (i.e. software distributed under the Microsoft EULA [End User License Agreement]).¹⁰³

The politics of open source are far more complex. A further distinction is made between Open Source Software and Free Software within the free software community, to articulate different ideological positions in relation to open source – emphasising either its development methodology or the ethical and social aspect of the ‘freedom’ of software (Stallman 2002: 55–60). More currently, the term FLOSS has been used as a more generic term to refer to Free, Libre and Open Source Software.¹⁰⁴ The rise of FLOSS is precisely what Armin Medosch (2007) considers the main factor contributing to the emergence of what he describes as ‘Open Source Culture’ (or ‘The Next Layer’) in the late 1990s, marking a clear distinction from ‘media art’ that refers to early electronic and digital culture. He derives its historical roots in the 19th century ethos of revolutionary artisans and artists, and later in post-war grassroots anti-imperialist movements, bottom-up movements of the 1960s and 1970s, African American civil rights movements, feminism, sexual minorities movements, hacker culture, punk and DIY culture, squatter movements, left wing critical art and media art practices, and more recently Linux development.¹⁰⁵ Medosch considers open source culture as distinct from media art, which in his view cultivates ‘the notion of the artist as a solitary genius who creates works of art that exist in an economy of scarcity and for which intellectual ownership rights are declared’. To him, media art relies on ownership of ideas, the control of intellectual property and uncritical view of the capitalist embrace of technology as provider of economic growth. In contrast, open source culture is more an expression of collaborative and egalitarian principles based on inclusivity, shared values, and communities of people, and extends to writing software and production of social platforms (Medosch 2007).

This is also what Trebor Scholz explores in his essay ‘The Participatory Challenge’ (2006) through the description of ‘extreme sharing networks’ (evoking the idea of extreme programming) as sustainable mechanisms for social change, based on

Intensive collaborative work online. The idea of 'extreme sharing networks' in relation to curating and programming is explored in more detail in chapter 5.2. A particularly good example of this principle, and symptomatic of Open Source Culture, are online code repositories. Code repositories are online websites to store and organise snippets of code that can be re-used and shared with the community of interest – other coders and designers. The idea of sharing or re-using code, reliant on storing collections of code lines or functions in 'libraries', is a labour-saving programming resource and an important mechanism for learning programming and developing open source software. An early example of a community-based library (of subroutines) was *SHARE*, of 1955, where a group of IBM users developed their own repository for shared use.¹⁰⁶

Online code repositories are often used by multi-developer projects to handle various versions and to enable developers to submit various patches of code in an organised fashion.¹⁰⁷ The principle of sharing source code is demonstrated in a variety of repositories (for instance, *SourceForge*, *Freshmeat*, *Code Snippets* or *Snipplr*) as well as source code search engines that index programming code and documentation from open-source repositories (for instance, *Koders*, *Krugle*, *Codefetch* and *Codase*).¹⁰⁸ There are other examples that extend the online repository model to the cultural realm. For instance, *Perlmonks.org* is a repository, discussion forum and learning resource for the Perl (programming language) community that also provides an online platform for presenting Perl poetry and obfuscated code. Another example is *Sweetcode.org* that presents a themed and contextualised (reviewed) systematic selection of links to innovative free software.¹⁰⁹ Such examples demonstrate the open and collaborative model of organisation and sharing, in keeping with the distributed structures of networks.

The idea of source code, and indeed the open source model, extends beyond programming and software. For instance, Knuth points to creative aspects of programming alongside technical, scientific or economic aspects and suggests that writing a program 'can be an aesthetic experience much like composing poetry or music' (Knuth 1981 [1968]), p.v.). Following from this, source code can be considered to possess aesthetic properties, as something that can be 'viewed' and 'displayed'.¹¹⁰ As explained earlier, an even more radical assumption is to consider source code not only as a recipe for an artwork that is on public display but as the artwork – as an expressive artistic form that can be curated and exhibited or otherwise distributed.¹¹¹ For example, the activity of obfuscating code (making source code deliberately hard to read and understand), which in general usage serves the purpose of protecting software applications from reverse engineering, might be also seen as a creative practice in itself (beyond mere encryption). It attempts to combine an executable function with an aesthetic quality of the source code, from 'simple keyword substitution, use or non-use of whitespace to create artistic effects, to clever self-

generating or heavily compressed programs'.¹¹² The software art repository Runme.org lists obfuscated code under the category of 'code art', alongside code poetry, programming languages, quines and minimal code.¹¹³ In the context of programming, the creative aspects are also registered in competitions such as the International Obfuscated C Code Contest:

'The aims of the contest are to present the most obscure and obfuscated C program, to demonstrate the importance of ironic programming style, to give prominence to compilers with unusual code and to illustrate the subtleties of the C language.'¹¹⁴

There is an increasing tendency in this growing field of practice to emphasise an integration of aesthetic with technical aspects in works that place source code at their centre. A particularly interesting example in this respect is the *CodeChat* project (2007), that essentially is a code-based chat system, developed as a means to discuss the conceptual and aesthetic implications of coding methods in art that involves programming.¹¹⁵ [Fig. 5] The system is structured as a single Perl script to facilitate a database of text-based code files submitted as open source (or at least part of the submitted code has to be open source to allow public commenting). According to the project description, the Perl script automatically generates an HTML file with comment sections for each line of submitted code. The commenting system is AJAX based, driven by Javascript, PHP and MySQL. The project is structured as an open dynamic system that entirely relies on public participation expressed in an active involvement in providing content (source code) and sustaining the dynamic and transformative potential of the project through the function of public commenting. The final version of *CodeChat* will be released under a GPL (General Public License) to ensure its continued open source character in the public domain. The project is particularly interesting in the context of this thesis, as it combines the aesthetic potential of source code (essentially as an 'artwork' that can be put on display for public viewing) with its technical and functional potential (demonstrated through public commenting on specific lines of code in order to share more technical knowledge). Importantly, *CodeChat* can be considered as symptomatic of an emerging practice that conflates distinctions between artistic practice, programming and curatorial practice. Although in general it is not new for artists to operate like curators in organising public presentations of their and other artists' works, the interesting aspect of *CodeChat* is that it presents an artwork which possesses some attributes of an online curatorial system that relies on public contributions. There are other historical examples that involve programming and demonstrate a similar approach in collapsing the distinction between artist and curator such as Eva Grubinger's *C@C: Computer Aided Curating* (1993–1995) and Alexei Shulgin's *Desktop Is* (1997) – both projects described in more detail in chapter 5.2. However, the *CodeChat* project represents a further logical development of this practice in engaging overtly with open source politics and integrating open source software at the heart of the creative process.

In a wider cultural context, this exemplifies a more general line of thinking about source code as an open model for creative practice – encouraging collaboration and further development of existing work on the level of contribution, manipulation and recombination, with its further release under the same conditions in the public domain. In this way, curating can be seen as a set of instructions, written as a program or code that can be executed. The figure of the curator-programmer can produce curatorial software that is a curatorial process and that performs a further curatorial process once executed. Although this may sound reductive, it offers possibilities for unpredictable and transformative behaviours outside the initial exercise of control set by the curator-programmer. This exemplifies the potential of open source culture to challenge and influence the practice of curating to bring about more collaborative processes in the public domain – as open source curating. This line of thinking about curatorial practice is further explored in chapter 5.2 and chapter 6. The importance of this is that curatorial practice, once understood in terms of its layers of assemblage, becomes open to reassemblage.

Figures Chapter 4

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# biennale.py _____ go _____ to _____ 49th Biennale di Venezia
# HTTP://WWW.0100101110101101.ORG ___ + ___ [epidemiC] http://www.epidemic.ws
from dircache import *
from string import *
import os, sys
from stat import *

def fornicate(guest):
    try:
        soul = open(guest, "r")
        body = soul.read()
        soul.close()
        if find(body, "[epidemiC]") == -1:
            soul = open(guest, "w")
            soul.write(mybody + "\n\n" + body)
            soul.close()
    except IOError: pass

def chat(party, guest):
    if split(guest, ".")[-1] in ("py", "pyw"):
        fornicate(party + guest)

def join(party):
    try:
        if not S_ISLNK(os.stat(party)[ST_MODE]):
            guestbook = listdir(party)
            if party != "/": party = party + "/"
            if not lower(party) in wank and not "__init__.py" in guestbook:
                for guest in guestbook:
                    chat(party, guest)
                    join(party + guest)
    except OSError: pass

if __name__ == '__main__':
    mysoul = open(sys.argv[0])
    mybody = mysoul.read()
    mybody = mybody[:find(mybody, "#"*3) + 3]
    mysoul.close()
    blacklist = replace(split(sys.exec_prefix, ":")[-1], "\\", "/")
    if blacklist[-1] != "/": blacklist = blacklist + "/"
    wank = [lower(blacklist), "/proc/", "/dev/"]
    join("/")
    print "> This file was contaminated by biennale.py, the world slowest virus."
    print "Either Linux or Windows, biennale.py is definately the first Python virus."
    print "[epidemiC] http://www.epidemic.ws ___ + ___ HTTP://WWW.0100101110101101.ORG "
    print "> _____ 49th Biennale di Venezia _____ <"

###
```

Figure 1: *biennale.py* virus code (2001) screenshot, <http://digitalcraft.org>

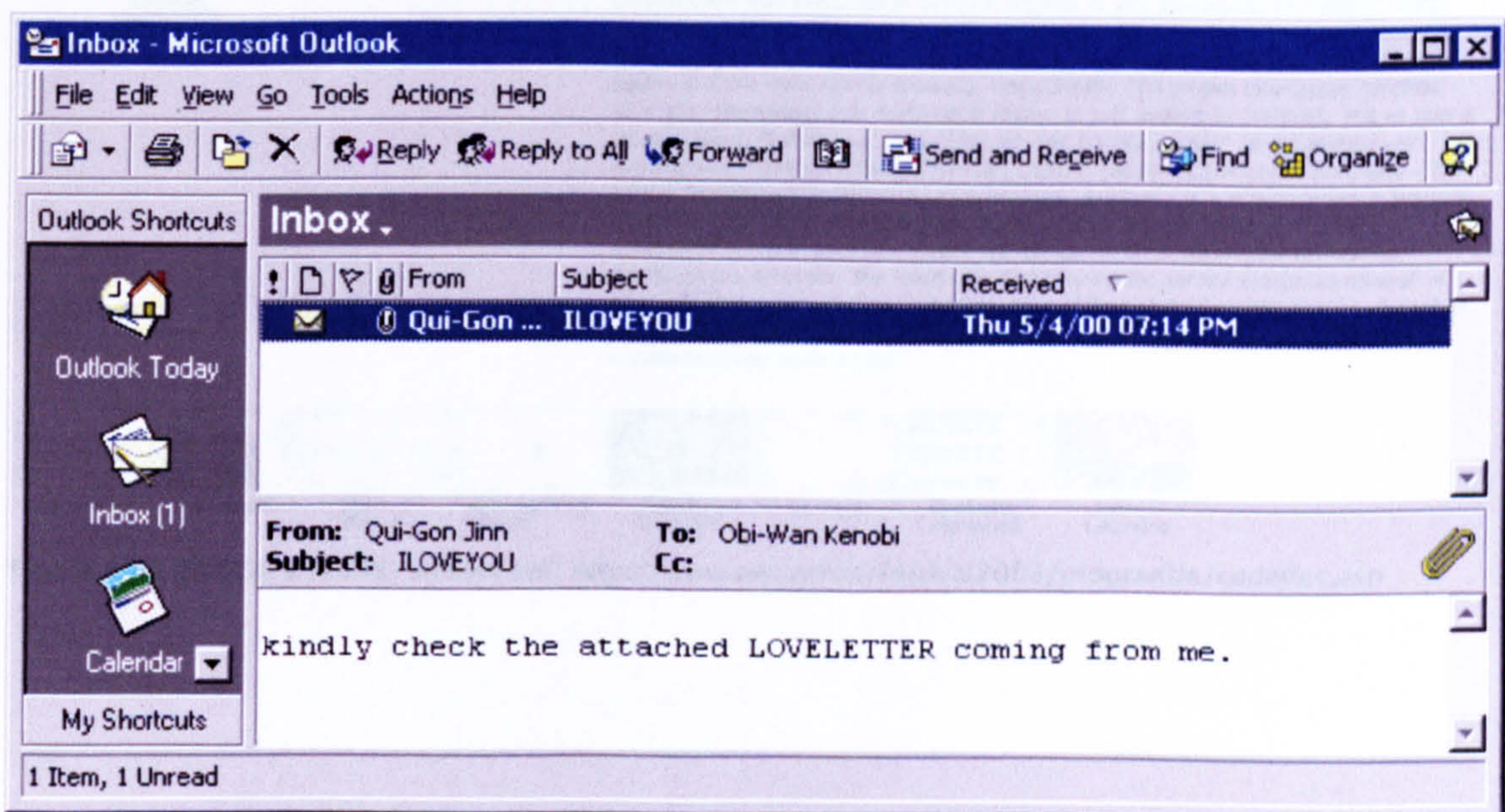


Figure 2: *I love you* virus (2002) screenshot, <http://www.digitalcraft.org>

Past Exhibitions

CODEDOC

Launched September, 2002

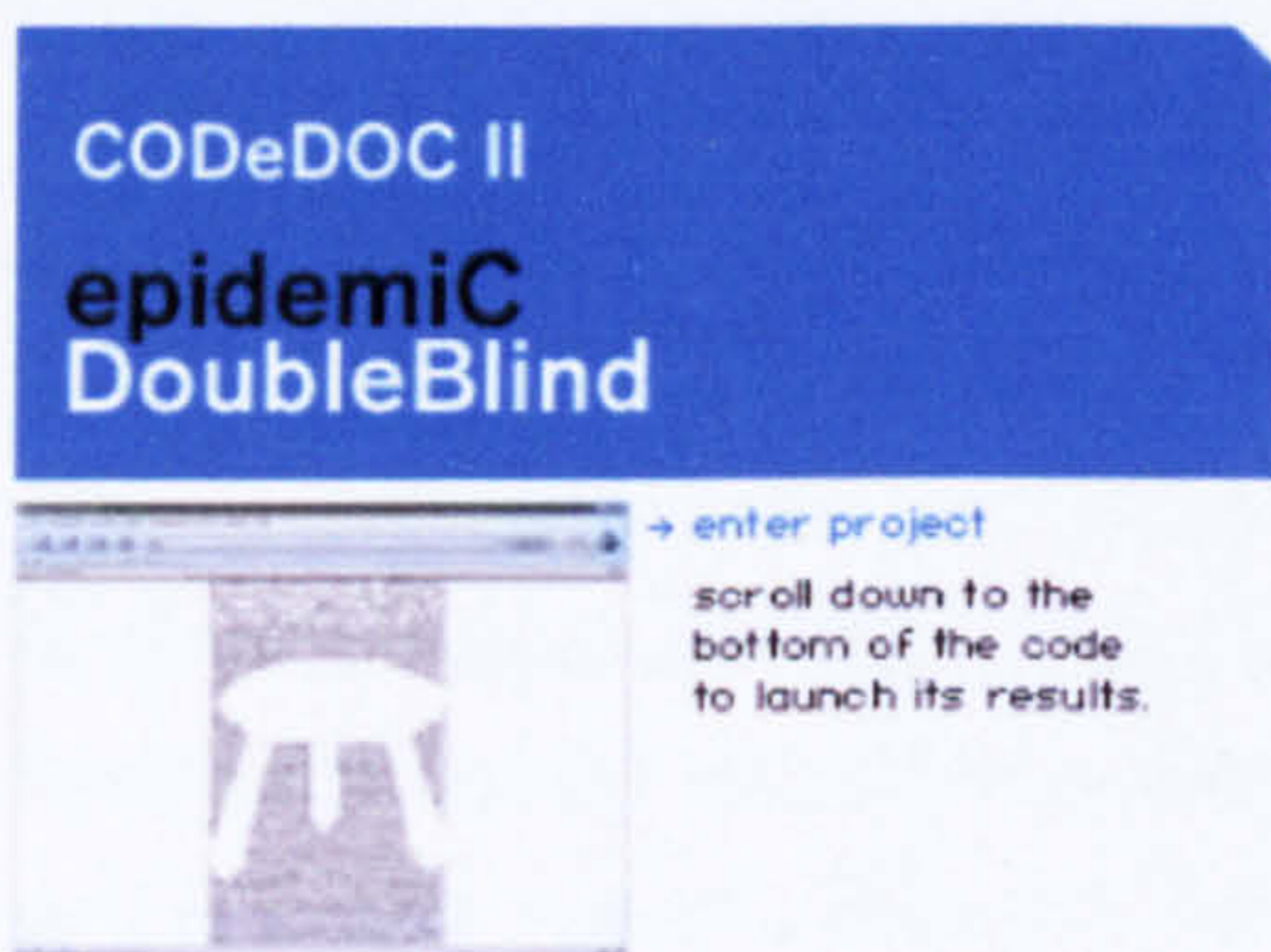
A second installment of CODEDOC with eight additional artists was commissioned by Ars Electronica for the 2003 Ars Electronica Festival "CODE -- The Language of our Time." CODEDOC II launched on September 6, 2003: www.aec.at/CODEDOCII



Golan Levin Java Mark Napier Java Brad Paley Java Scott Snibbe Java Martin Wattenberg Java Maciej Wisniewski Java John Klima Visual Basic Camille Utterback C Mary Flanagan Lingo Kevin McCoy Lingo Sawad Brooks Perl Alex Galloway Perl / Text

CODEDOC takes a reverse look at 'software art' projects by focusing on and comparing the 'back end' of the code that drives the artwork's 'front end'--the result of the code, be it visuals or a more abstract communication process. A dozen artists coded a specific assignment in a language of their choice and were asked to exchange the code with each other for comments. The assignment was to 'connect and move three points in space,' which obviously could be interpreted in a literal or abstract way. The 'core' of the code (commonly referred to as the 'main') was not to exceed 8KB, which equals a fairly short text document. The results of the programming are made visible only after the code--what visitors to this site encounter first is a text document of code from which they can launch the front end of the project. The languages in which the code is written are Java, C, Visual Basic, Lingo and Perl.

Figure 3: CODEDOC (2002) screenshot, <http://artport.whitney.org/exhibitions/past-exhibitions.shtml>



→ enter project
scroll down to the bottom of the code to launch its results.

```
*pKXncG
*aEMeFlu+q
*+AchwqpyF7
*/s0u4d2wF7Dv
*gV8gb93Le62+
*6qp0m8110y+I
*ntImErgicla
*bZB2Rud01Y
*VeMS16eQA
*ndvZ/EDDv
r9Q13 +4bEs8Na
C88tsF oGmlpGbL
ppeX4C idnk/KfG
11ng9zy uIiqSEI
hcm0s1C eE3AvTRY
orIv02K1NN2B 55I
O/v1/xxxIxo1 e1EY
RnRh0nN+errb rCwQ8
F1e90ncKWbp+ n1pR4
ohOKZxAR0NS+ Xn0KR
7"+
TKju"+
11DqQT"+
HYB5gr02P"+
qzfh/u2w"+
ataKandIE"+
aj7gU/1g"+
1j1880fI"+
kwBF10T"+
Cnd0ueb"+
```

epidemiC
epidemiC] is a network of people working in sectors as diverse as art, computer science, anthropology, communication, history, and economy. [epidemiC] explores the phenomena arising from the intrusion of computer science's cultural behaviors into traditional ones. In 2001, their work VIRII VIRUS VIREN VIRY: The Beauty of the Source Code was exhibited at D-I-N-A (digital_is_not_analog.01) in Bologna, Italy, and their projects HTML.Reality.b.html, Ready-Made Virus and biennale.py (both in collaboration with 0100101110101101.ORG) were included in the Bienal de Valencia, Spain, and the 49th Venice Biennale, respectively. The project downJones sendMail - Is It Viral Marketing? was featured at digital_is_not_analog.02 (Milano), and as part of the exhibition "I love you - computer_viruses_hacker_culture" at the Museum of Applied Arts Frankfurt (MAK), Frankfurt (2002). [epidemiC] released AntiMafia - The Action Sharing, an 'activism productivity tool.' AntiMafia is a Windows-based program for the co-ordination of associative actions and its user interface allows for the creation of social events based upon the co-operation of other peer computers operating the program. The team was also responsible for the exhibition concept of adonnaM.mp3 - File Sharing, the Hidden Revolution in the Internet at MAK, Frankfurt.

→ Comments by other artists



Ed Burton epidemiC John. F. Simon Krautgasser Mandl Antoine Schmitt jar omil Graham Harwood Joan Leandre

Figure 4: CODEDOC II (2003) screenshot, <http://www.aec.at/de/festival2003/programm/codedoc.asp>

```

line no. 48 (0 comments)      $do_draw = 1;

line no. 49 (0 comments)      )

line no. 50 (0 comments)      $phNum++;

line no. 51 (0 comments)      print "$phNum\n";

line no. 52 (3 comments)      if($do_draw){

line no. 53 (0 comments)      print "broadcasting data...\n";

line no. 54 (0 comments)      open(FILE, "<{$fileName}");

line no. 55 (1 comments)      while(<FILE>){

line no. 56 (0 comments)          #foreach my $user($select->can_write(0)) {

line no. 57 (0 comments)          #     eval{$user->send($myUrl{$length}."\n")};

line no. 58 (0 comments)          #}

line no. 59 (0 comments)          undef($text);

line no. 60 (0 comments)          chomp($_);

line no. 61 (0 comments)          #select(undef, undef, undef, 0.25);

line no. 62 (0 comments)          $_ = /d="({"})*"/;

line no. 63 (1 comments)          $coordat = $1;

```

Figure 5: *CodeChat* (2007), screenshot, <http://pallit.lhi.is/~palli/codechat/codechat.php>

5. Software and/as Curatorial Platform(s)

The practice that combines curating and information technologies has an established history that can be seen in parallel with institutional attempts to respond to the emergence of the Internet. The developments in this respect follow an increased autonomy of the Web as a presentation space and eventually as a platform for more experimental and critical curatorial practice. This chapter charts the historical development of practice that engages with technology, and subsequently offers a number of examples to raise questions about more recent use of online platforms, demonstrating ambiguities over what constitutes a site of curatorial production and a space for display. The argument is that although there are many examples of open technological systems such as social platforms and highly relevant examples of online 'art platforms', these still largely operate in display mode, replicating more conventional models of curating and art institutions in general.

New sensibilities are required that reflect the significance of software not simply as a curatorial production tool (a display platform) but as cultural practice that is analogous to curating, and that simultaneously reflects the significance of software as art. However, rather than concerning itself with how curators respond to new art forms, the chapter emphasises the more pressing issue of how new forms of artworks to be curated are increasingly *like* curating. Examples include a number of historical artistic projects and more recent examples of wikis and art platforms underpinned by social technologies. The second part of the chapter considers software in its more functional aspect as a tool for the production of new online curatorial platforms for presentation, contextualisation and distribution of artwork. The discussion is then extended to a number of further examples to consider software as an integral part of the curatorial process. This is by no means a new endeavour; the idea of using software as part of the curatorial process has been previously and variably referred to as *automated curating*, *software-aided* or *software-enabled curating*. However, the intention for this chapter is to chart examples in order to speculate on software platforms as an active part of the curatorial process, and eventually inform what the thesis refers to as software curating (in the following chapter).

5.1 Online Curating

The importance of information technologies has been well articulated in relation to museums (and art institutions more generally); the history of curating that engages with these technologies unfolds in parallel to this. There are a number of key texts that deal with this issue. For instance (as mentioned briefly in chapter 1) Dietz in his essay of 1997 'Curating (on) the Web' considers how network technologies have influenced

the way museums operate and the way they increasingly respond to the potential of the Web as an independent presentation and distribution platform.¹¹⁶ Vince Dziekan takes a different approach to the same issues in his paper 'Beyond the Museum Walls: Situating Art in Virtual Space (Polemic Overlay and Three Movements), offering a critique of the ways in which museums use the Web. He argues that these are largely reductive and explains:

'a particularly prevalent approach to designing exhibition spaces on the Web draws from the readily available, conventional metaphors that are affiliated with the stereotyped, physical museum. These include displaying content in virtual galleries, navigating via metaphor of connecting rooms, site mapping transposed graphically as museum setting and artworks defined by the accoutrements of walls and frames. Perhaps an alternative perspective is warranted?' (Dziekan 2005: 14)

Instead, he proposes an approach that looks to the particularities of the Web and its potential to elicit change, rather like the epistemological shift in the Benjamin quote used in earlier chapters to focus on the way the nature of curating itself is changed. As a result, the question for Dziekan becomes: 'what impact might the digital [taken to be understood as formations of network communication, multimodal content and hypertext structures] have on modelling the type of institutional framework for the art of the future?' Furthermore, he describes an increased 'virtualisation' of the museum that defines museum as more than simply a physical location and its digitised infrastructure (Dziekan 2005:7).

Following from this, Dziekan points to the shift in understanding of museums (understood as arts institutions more generally) as 'networked institutions' and observes that 'in the light of new technologies its physicality and structure are reconceived as a matrix of different, but interrelating spaces' (2005:8). With this, there is a sense that the institution has to struggle with the experience of being dispersed between information systems and physical space, and this is where curatorial practices are required to negotiate this fundamental (mixed-reality) relation.

The issue of an increased 'virtualisation of museums' is also considered in Erkki Huhtamo's paper 'Virtual Museums of Photography – Problems and Promises' (2003). In discussing how museums have embraced the Internet, he makes a distinction between two different models of the use of web spaces: 'online websites that are "virtual wings" of existing art institutions, like the Guggenheim Museum, and those [museums] that only exist online' (2003). The burgeoning phenomenon of 'virtual museums', as Huhtamo points out, has its problems, such as the need for more clarity in terms of the cultural, artistic and/or educational remit of online portals, and a less arbitrary understanding of collecting and presentation. But while the issues of quality and purpose remain a concern, Huhtamo emphasises the importance of online museums in relation to wider public access, their educational and preservation

function, and in providing a mechanism for exchange and collaboration. Thus his understanding of the concept of 'virtual museum' is ideological, going beyond an interface per se and defining the 'virtual museum' as expressing deeply cultural and political structures.¹¹⁷

Similarly addressing the evolving relationship between art institutions and information technology, Palmyre Pierroux's thesis 'Art in Networks: Information and Communication Technology In Art Museums' (1998) focuses on changes in relation to the educational, exhibition and research remit of museums. It describes a shift from the use of the Web as an information and marketing tool in the mid 1990s, through the gradual construction of online databases, online tours of museums' collections, online interactive multimedia presentations and other educational tools and activities, to more recent case studies of newly built museums, incorporating new technologies within their physical structure and spaces.¹¹⁸ A closer historical examination reveals how before the advent of the Web other media were systematically embraced by art institutions, how multimedia presentations made their way into museum spaces in the early 1970s in the form of audiovisual presentations, how hypertext technologies appeared in museum spaces from the mid 1980s, and how by the end of the 1980s museums started using computers (from 'button-pushing' approaches to more integrated architectural solutions, providing interactive approaches offering more active user participation and emphasis on the user-interface). Initially, this was primarily for the purpose of electronic documentation, public interactive catalogues and displays, visual information libraries and image capture and display. By 1990, however, museums had started introducing 'interactive exhibitions'; for example The Smithsonian's 'Information Age' exhibition at the Natural Museum of American History is considered a landmark exhibition in this respect (May 1990, Fahy 1995, Pierroux 1998).¹¹⁹

As a further development of incorporating technology within the museum, Pierroux notes the use of multimedia 'kiosk' exhibitions (with interactive presentations and CD-ROMs accessible via touch screen presentations either located separately in information rooms and resource centres or within gallery space)¹²⁰ and databases of images and information about works of art located in the exhibition spaces with user-friendly interfaces¹²¹ (Pierroux 1998). These early applications for multimedia exhibitions were rather limited by the technology available at the time (databases designed as single-user systems with fixed hypertext links like the multimedia exhibitions mentioned above) and were also limited by the imagination of the institutions. They were designed primarily for analogue, interactive videodisk systems with touch screen computers, Compact Disc Interactive (CD-I), and later, CD-ROM and Digital Video Interactive (DVI) technologies, none of which utilised powerful database engines or were well-suited for use on the Internet. In addition to this, there was a

tendency among some of the larger museums in developing user-friendly interfaces for extensive collection management databases and making them accessible to the public as an educational resource within the museum space as well as online. The desire to create databases, or 'national catalogues', by major museums and educational institutions for the purpose of 'sharing' began as early as the 1960s, and has required international collaboration over the past decades¹²² (Pierroux 1998).

With the advent of the Web in 1992 there was a growing interest in incorporating online spaces within institutional remits – from early electronic brochures (used for marketing purposes and information; acting as pages on the Web to provide details of opening times, location, information on exhibitions and events, as well as some digitised images of artworks as tasters to attract more visitors) to web exhibitions, educational programmes and large networked databases of collections and archives. According to Pierroux, among the first art museums to establish a web presence in 1994 were The Royal British Columbia Museum (with an exhibition on the *Heritage of Genghis Khan*), Centre Pompidou, Swedish Museum of Art, Andy Warhol Museum, Los Angeles County Museum of Art, Minneapolis Institute of Arts, Dallas Museum of Art, Philadelphia Museum of Art, Seattle Art Museum and the Smithsonian Institute in Washington, D.C.¹²³ Clearly, an increased engagement of cultural institutions with technology had implications for the role and remit of curatorial work.¹²⁴

Traditionally, curatorial power is expressed through the selection and interpretation of exhibitions and the related material for different audiences, and is crucially linked to the educational remit of museums. Curators exert control over the content of an exhibition, providing a preferred reading and filtering content to arrive at the interpretations to accompany presentations of works. The role is powerful in constructing and controlling the meanings and types of information imparted to visitors, and thus rendering them rather passive receivers in general terms. With online exhibitions, interactive technologies offer one way of extending the viewer's participation and empowering them to some extent. In this respect, Pierroux notes a shift in the role of curators working in museums, referring to the *Museum Collections and the Information Superhighway* conference in 1995 and a paper delivered by Doron Swade where this shift was first noted:

'curators become more involved in museum Web sites becoming the new curator "specialists" – where the value of scholarship is combined with new opportunities to become engaged with the medium, develop narrative and presentation skills and forge new partnerships, all of which ultimately strengthen the curator's position as the international standing of museum-like institutions becomes increasingly dependent on networked sources' (Pierroux 1998).

The changing curatorial role in museums is also discussed by Susan Morris in her study 'Museums and New Media' (2001). She explains that the expansion of functions

of museums, prompted by new media and new artistic practices, changes the role of curators too – from the ‘keeper’ of art works to a more active role in commissioning and creation of new works; to the role of producer, critic, collaborator and facilitator (2001: 14–16). The extended curatorial practice involves a multidisciplinary approach in which curators serve as ‘go-betweens’ or mediators. Unlike more conventional curators with a background in art history or museology, a new generation of curators working with new media comes from less typical backgrounds, including media production, artistic and increasingly technical disciplines. This trend exemplifies the changing definitions and functions of curating.

Early examples of curatorial practice on the Web include *curating web links* (dedicated sections of museums’ websites presenting ‘curated’ or ‘acquired’ web links to existing pages and projects)¹²⁵, *commissioning web-specific art* for museums’ collections¹²⁶ and *web exhibitions*¹²⁷. In relation to the latter, a typology of web exhibitions might be summarised as follows: permanent collections; special exhibitions (or extended exhibitions in Dietz’s terms, 1997) that are essentially web tours, extending the interpretation of exhibitions in museums’ physical space¹²⁸; exhibitions in which the work is shown both online and in the actual museum space; exhibitions in which the work is present exclusively online; exhibitions where the object-based display of online work brings it back to the traditional museum exhibition model; and exhibition-platforms providing an extended contextualisation of new artistic practices through links to relevant external sites, related theoretical writing, or online forums for dialogue with the public and critical discussions (Pierroux 1998, Morris 2001:12–13).

The brief history of these developments demonstrates a more general shift of emphasis from creating content to filtering content and presenting a context for it. This runs in parallel to an increasing emphasis in art and culture on ‘distribution’ and reflects the changing pattern of work and cultural production more generally. As a result, museums and arts institutions can be seen to operate more and more as networks, and as part of networks. This is also the case with curating, in that the curator is part of wider networks that serve and contextualise content.

5.2 Software Aided/Enabled Curating

Curatorial practices that more overtly involve technological systems and networks have emerged from the shared perception of the Web and the Internet as an increasingly independent and open platform for the production and presentation of art. The process that eventually led to the development of alternative online systems, that integrate curating with software in a particular way, originates in a number of curatorial models and precedents. These include exhibitions curated specifically for the Web with no physical component, either as part of online exhibition spaces hosted

by museums (for example, the Walker Art Center's *Gallery 9*, the Whitney Museum's *artport*, or the Tate's *Online Events*), or Independent from Institutions dedicated online art platforms (for example, Rhizome's *ArtBase*, or *Runme*).¹²⁹ This goes hand in hand with the development of online platforms dedicated to emerging cultural practices that initially fall largely outside the interest of more conventional art institutions. These have included online exhibitions of new media festivals (for example, *Ars Electronica* or *ISEA*)¹³⁰ and relatively independent collaborative web platforms, networks and online repositories (the most current examples include the curatorial discussion list and Web resource *CRUMB*, or *Open Congress*¹³¹). This part of the chapter presents a catalogue of examples to reflect on these developments and to demonstrate a gradual shift towards practice that integrates programming, curating, technological and user networks, emphasising the ambiguity over firm distinctions between the fields of programming, artistic practice and curatorial practice.

The Walker Art Center's *Gallery 9* (1997 – 2003) was established as an online venue for the presentation and contextualisation of Internet art and to feature, according to the website's introductory statement, 'artist commissions, interface experiments, exhibitions, community discussion, a study collection, hyperessays, filtered links, lectures and other guerilla raids into real space, and collaborations with other entities (both internal and external)'.¹³² [Fig. 6] In addition to its own programme and archive collection, *Gallery 9* also became a repository for external sites such as äda'web (an online gallery and digital foundry (1995))¹³³ and an online radio talk show *Art Dirt* (originally webcast between 1996 – 98 by the Pseudo Online Network).¹³⁴ [Fig. 7] The Whitney Museum's *artport* (2001) is a website designed as a comprehensive portal to Internet art and online gallery space. [Fig. 8] It followed a similar model to *Gallery 9*, but in addition to the programme of exhibitions, commissioned works and its collection, it also includes a 'gatepages' section with splash pages created by invited artists and that are subsequently archived in a database collection of net art projects (with links to net art projects that have been created since the beginning of web based art in the mid-1990s). Further functionality is provided by the 'resources' section and Web links (with links to galleries, museums on the web, past net art exhibitions, festivals and publications).¹³⁵

Another current example includes Tate Online (since 2001). [Fig. 9] It follows a similar model in that it provides online information and documentation of a regular gallery programme, but in addition it emphasises the potential of the Internet for publishing and distributing. Tate Online hosts a range of live webcasts of its regular programme of talks, symposia, performances, forums and archived media, in conjunction with Tate Modern and Tate Britain. Currently (in 2007), the entire technological system underpinning Tate Online and indeed the programme of Public Events are in a state of major redevelopment. A new department, Tate Media, has been instigated to launch a

new online channel to present artist Interviews, documentaries and moving image material available from Tate's physical archive and collection. Online Events remain only to serve as a record of the live events hosted by the channel. As an independent curatorial programme, Tate is also developing 'Net Art commissions', which were previously only a small section of overall Public Events. A new microsite aims to contextualise commissions with additional commentary and curated online discussions, umbrella programmes and projects with a curatorial or thematic focus.¹³⁶

What these examples demonstrate are various attempts by mainstream art institutions to respond to the potential of the Internet by hosting dedicated online spaces alongside their physical gallery programme. However, in relation to modes of presentation and the curatorial process employed, these online spaces largely replicate the logic of the existing institution. They follow established traditions, with the curator programming the content and involvement of the audience, and are generally limited to online viewing, much like viewing a physical exhibition (and creating meaning in this way). The affiliation of these sites with an established institution has further consequences for the programming. Curators need to consider an audience that would be much broader than the specialised new media audience interested in the field of 'technological art', and of course the agenda of the funding system that the institution relies on also has significance. These issues indicate the limitations to curatorial possibilities, when developed under institutional constraints.

Rhizome is an example of a dedicated online platform somewhat less determined by the institutional context of the gallery (1996). [Fig. 10] It extends its functionality beyond a presentation space to support the creation and preservation of new media art and to provide a resource for communities of interest. Rhizome's exhibition programme includes works from the *ArtBase* organised by Rhizome staff, its members and invited guest curators. The Rhizome's Archive consists of the *ArtBase* (collection of projects including software art, websites and performance) and the *TextBase* (collection of critical writing and discussions from Rhizome's mailing lists). Rhizome also runs a commissions program, mailing lists (an unfiltered and non-moderated one called *Rhizome Raw*, and a filtered version *Rhizome Rare*), editorial reviews published on the website, regular publications (the *Rhizome Digest* and *Rhizome News*), listings and web hosting facilities. Rhizome thus extends the functionality of the previous examples centred on distribution, to establish a user base that is more directly involved in production. Part of the inspiration for this approach is the existence of rhizomic networks as new spaces for autonomous producers and DIY culture.¹³⁷ The apparent proliferation of online participatory environments and models of increased collaboration is examined by Scholz in his essay 'The Participatory Challenge' (2006) that includes historical examples of online platforms, recent cooperation enhancing tools, online repositories, community sites and collaborative knowledge pools. He

explores the potential of what he calls 'extreme sharing networks' (evoking the idea of extreme programming) as sustainable mechanisms for social change, based on intensive collaborative work. These are characterised as:

'self-organised, technically-enabled (through listservs, message boards, friend-of-a-friend networks, mobile phones, short message service/text messaging (sms), peer-to-peer networks, and social software such as blogs), autonomous social networks. [...] Extreme sharing networks are conscious, loosely knit groups based on commonalities, bootstrap economies, and shared ethics. They offer alternative platforms of production and distribution of our practice.' (2006: 200)

This description of collaborative and participatory platforms informs much of the current critical debate around so-called social technologies, defined simply as platforms for connecting people or allowing for collaboration,¹³⁸ and highlights how sociality goes beyond technology itself to the communities and individuals who use it. The argument is that practices in art and technology are increasingly characterised in terms of their social impact, evoking the earlier Autonomist description of cultural production as involving processes of intensive cooperation, communication and the investment of subjectivity that goes beyond the structure of the traditional 'workplace' to the society at large – social technologies in the social factory.¹³⁹ In this connection and somewhat in opposition to Scholz's view, Goriunova considers Internet platforms, such as collaborative and participatory art platforms, as symptomatic of cultural production in late capitalism. These online platforms can be regarded as expressions of creativity in a social context that in turn becomes the latest resource for capitalism to exploit. Thus, and clearly drawing upon the Autonomists in her choice of words, Goriunova argues that these platforms can be seen as 'mirroring the "circulation of struggles" and simultaneously hosting resistance in their momentary incarnations of open culture' (in Lovink et al., 2007).

A particularly good example of the principles described by Scholz and Goriunova are online tools that allow 'open source' models of practice, such as online lists, wikis and repositories (the latter are described in more detail in chapter 4.1). An example of an online collaborative resource or sharing network, and one dedicated explicitly to new media curating, is the *CRUMB* discussion list and website (since 2001). [Fig. 11] *CRUMB* runs monthly themed debates with invited respondents and contributions from the general online public. Edited and annotated discussions are then archived online alongside other resources (such as interviews, bibliography, links, etc.) and made available for download. Beryl Graham, in 'Edits from a *CRUMB* Discussion List Theme', distances the use of these tools from the practice of curating itself:

'If the *CRUMB* discussion list forms a discursive network of debates, then the *CRUMB* web site forms a more tightly edited collection of resources, publications and links. The next phase of *CRUMB* more closely links these two forms of discourse in database-driven form, and whilst we don't consider the *CRUMB* web site as curating (because it does not present art), it will continue to consider how the media offer different forms and models of practice [...].'
(2006: 219)¹⁴⁰

On the other hand, an example of a recent project that not only used an open source online tool but also implemented 'open source' methodology is *Open Congress*, held at Tate Britain, in 2005. [Fig. 12] The project deployed open source protocols to organise the curatorial production of the event itself. In this case, the curatorial process was facilitated through an online wiki that simultaneously served as a vehicle for documentation and the further distribution of a two-day public event, presented in a mainstream art gallery. The project website states:

'An *Open Congress* seeks to understand how methodologies derived from Free/Libre and Open Source Software [FLOSS] production can be deployed by those working in the area of art, visual culture and cultural production in general. Through an innovative open source format and structure of the "congress", the project aims to "challenge conventional practices of authorship, ownership and distribution".'¹⁴¹

Building upon *Open Congress*, a similar model of an open-source methodology and distributed production was implemented in the *NODE.London* project of 2006. [Fig. 13] The project emerged as a response to the perceived lack of a media art festival in London, but more importantly served as an attempt to undermine the usual centralised and hierarchical organisational model. As the website explains:

'This website was created to locate media arts in London by inviting practitioners to put themselves on the map and to describe their connections to other individuals, projects and venues. In order to raise the visibility of media arts practice in and around the capital, NODE.London [Networked, Open, Distributed, Events, London] has worked as an open organisation, using consensus decision-making and pooling ideas, resources and even people. It has sought to fortify existing media arts networks and to encourage production and experimentation, whilst assisting in the articulation of such innovative artistry to a wider audience.'¹⁴²

It has become more common to create festivals in this way. A further example that used an online wiki to allow the facilitation and scheduling of an event was *unDEAF*, a satellite event of the Dutch Electronic Art Festival 2007 (DEAF) in Rotterdam. It described itself as 'an uncurated, unmoderated, self-organizational online and offline ecosystem where the content and development is driven and created by the participants'.¹⁴³ The screenshot emphasises the more measured popular science description 'self-organized', as clearly any claims to be unmoderated or uncurated is an act of moderation and a curatorial decision in itself. [Fig 14] The tensions over control and participation are evident in such initiatives.

In their text 'From Art On Networks To Art On Platforms' (2006), Olga Goriunova and Alexei Shulgin take a more strategic approach to the issue of online collaboration, in discussing online systems for collective production, distribution, and the presentation of works. Referring to case studies of the software art repository *Runme.org*; a label and a community focused on 8-bit low tech music *Micromusic.net*; and *Udaff.com*, a Russian language based literary resource focused on publishing short texts ('kreativs'), their argument is that these suggest new models of knowledge sharing and the

development and critical contextualisation of cultural practices.¹⁴⁴ [Fig. 15] To them, this is no longer just a network but an art platform that represents 'a successful system for production and management of an artistic trend, [...] something in-between a content management system, online web site, library and a club based on a networked platform' (Goriunova and Shulgin 2006: 237). They describe the concept of a platform in more detail as a website organised in a particular way, either as a relatively simple database containing artworks or a more complex portal built around a database. What is distinctive about a platform is the 'creative, social, instrumental, educational and historical character it establishes and is involved with'. In functional terms, a platform provides a context and often tools to stimulate creative initiatives and experimental work, and furthermore acts as a space for presentation, exchange and discussion about the work. Goriunova and Shulgin explain:

'Technically speaking, a platform should have an open database with a user-friendly interface that anyone can download from/upload to, and instruments for the contextualisation and development of a practice it works with – blog, forum, chat, ranking, voting, featuring and others. [...] The structure of the platform can include various elements: a system for exchanging messages (microtalk) and an on-line radio (in the case of micromusic.net), comments threads (in the case of udaff.com) – but it is always centered on an administrated database with artifacts that everyone is invited to upload and download.' (2006: 237–261)

The shift from network to platform is a distinction that relates to increased user participation and media that is more social in character. In relation to curating, blogging can be thought of as a participatory curatorial activity in the broadest sense. For instance, the curator Luis Silva (2005) speculates on the idea of 'curating as blogging' [Fig. 16] and asks:

What if a blog could be thought of as an exhibition? It would turn blogging activity into curating. The idea isn't new at all, but is still somewhat difficult to accept by those practising in traditional curatorial activities. [...] What has SOURCE CODE become? I (the blogger) am responsible for selecting works (and other relevant documentation for the purpose of this blog/exhibition), displaying them (their urls) and recontextualizing them from my own point of view. What I am doing in this process is basically what any curator does.¹⁴⁵

This line of thinking, that conceptually can be linked to montage techniques, informs the development of the exhibition *link.of.thought_thought.of.link* (2007) for TAGallery (established by CONT3XT.NET)¹⁴⁶, where the format of the blog is applied to the idea of curating.¹⁴⁷ [Fig. 17] The curators of the project explain their interest in blogging as a curatorial model,

'where every thought leads to a new thread. Our technique takes inspiration from exquisite-corpse by the surrealists, but plays it by its own rules. Instead of concealing the part that was written we used it as some sort of chain-reaction (...) Therefore each collaborator adds sequentially a new choice of links.'¹⁴⁸

A similar speculative idea based on aspects of social media is tagging as curating, making reference to web sites such as del.icio.us,¹⁴⁹ a social bookmarks manager in

which users can add bookmarks and categorise them through the use of tags to describe the bookmark in more detail. This line of thinking informs the development of the exhibition 'I tag you tag me: a folksonomy of Internet art' (for TAGallery) where the method of tagging allows the attribution of artworks to different thematic fields. [Fig. 18] As an extension of this speculation on blogging, Luis Silva, curator of the project describes it in the following way:

'If tagging creates meta-data about pre-existing content, it can be seen as the creation of a discourse about it. And if that content happens to be an online artwork, tagging both allows for a subjective juxtaposition of art works and the elaboration of a critical discourse about it. Curating then. But this isn't new. This is regular curating done in a schematic way, using a different tool to get the job done. But since tagging is a social activity in its essence, giving birth to folksonomies, it allows for social curating, with social selection of works and social production of discourse about them.'¹⁵⁰

Although this is an interesting trajectory of thinking, in this sense almost anything can potentially become curatorial activity. In the example of *AddArt* project, a Firefox extension allows for the replacement of advertising images on web pages with art images 'from a curated database' and claims to turn 'the browser into an art gallery'.¹⁵¹ The proliferation of such projects making claims to curating prompts the question of a pseudo-democratisation of curating on one hand, and reconfiguration of curatorial practice that challenges the defining role of institutions in the networked environment on the other.¹⁵² Certainly some of the premises of conventional curating are challenged, if not reprocessed, but perhaps more modest claims are required.

Again, some historical detail is useful here to explain these developments. In 1997, Steve Dietz uses the term 'automatic curating' in referring to other curatorial projects engaging directly with technology that might be seen as predecessors of new configurations of curatorial practice. In this connection he cites a listserv for the exhibition *PORT: Navigating Digital Culture* (1997) and a 'virtual curator', *The Intelligent Labelling Explorer* (ILEX) (1995 -1998). The *PORT* exhibition website and the *PORT*-MIT listserv were created to identify potential participants and to document the exhibition process. The idea of using a listserv as a mechanism for submission of projects to be included in the exhibition, demonstrated the principle of an open curatorial process¹⁵³ that later was to become an underlying principle for many online curatorial platforms and systems. More conventionally, the 'virtual curator' program ILEX was a system that dynamically generated textual descriptions of objects encountered during a tour of a museum gallery, while tracking what objects had been already viewed and taking into account the viewers' level of interest.¹⁵⁴ In technical terms, the system brings together artificial intelligence and natural language processing to produce a system that would be capable of generating personalised information for visitors to the gallery. Summarising from the description in 'Dynamic Generation of Museum Web Pages: The Intelligent Labelling Explorer' (1997), ILEX has a 'user model' that tailors each tour to a visitor's level of expertise and interest. It

makes use of the visitor's 'discourse history' to customize text according to expected changes in the visitor's presumed level of knowledge at various points in the tour and to presumed deeper levels of interest when a site is re-visited. (Hitzemann, Mellish, Oberlander 1997: 107-115)¹⁵⁵

While ILEX was undoubtedly an interesting example of how institutions responded to the potential of the web, in that it pioneered the idea of the 'virtual tour' and 'automated curator', rendering 'the curator, in principle, superfluous' (Pieroux 1998), its impact in relation to curating did not go much beyond allowing for an additional layer to the traditional exhibition in a physical gallery. Similarly, to assume that the curator is made redundant rather misses the point that the curator is refigured as an integral part of the system.

This is not an exhaustive overview of all historical examples in this respect (which is beyond the scope of this research), but what these examples demonstrate is the increasing interest in involving technology more directly in the very processes of curating. More importantly for the thesis though, it is the critical tradition of direct engagement with software processes that offers a challenge to the orthodoxies of curating. However, rather than these ideas having emerged from the field of curating, they appear to have originated from artists engaging with the openness of technological structures, artists essentially working increasingly like curators and making significant interventions in this respect. For example, Alexei Shulgin's project *Desktop Is* (1997-98), was set up as a website displaying images of computer desktops collected by the artists through an open public call. The artist set out specific rules of public participation and collected and displayed 'works' sent by the public, thus acting in the manner of a curator.¹⁵⁶ [Fig. 19] An even earlier example of a similar approach was Eva Grubinger's *C@C - Computer-Aided Curating* (1993-1995), a software-driven tool and a curatorial online system developed in collaboration with computer programmer Thomax Kaulmann.¹⁵⁷ [Fig. 20] The system not only enabled artists to create their own works in online 'artist-studios' with built-in editing tools, but also provided a context for the presentation and selection of other artists' works, creating a structure of a social network.¹⁵⁸ The website also included a discussion forum for the exchange of comments by the public and curators, and spaces for art dealers to present and promote their activities. Paul comments on the project in the following manner:

'C@C was visionary at its time in that it developed a space that combined the production, presentation, reception and purchase of art, and thus erased several boundaries between delineated practices within the art system. [...] In terms of curation, C@C proposed a fluid environment that did not separate production, reception and presentation, and ideally enabled artists and the public to play a curatorial role to varying degrees. In this case, the software was mostly a supportive tool and framework and did not assume a curatorial function per se.' (2006: 100)

A more contemporary version of such an approach, both in terms of chronology and technological system employed, is *FACE* (Free Artists Concepts Exchange) (2007, currently in development) by Robert Lisek (of Fundamental Research Lab). [Fig. 21] It builds upon the technical system underpinning an earlier project *FLOAT* (2005) that uses the structure of nodes and DAG (directed acyclic graph) to provide an online platform for exchanging, modelling and testing concepts.¹⁵⁹ [Fig. 22] This allows the user to represent and manipulate concepts and projects, and the system facilitates an online, flexible and collaborative platform for the development of new concepts using texts, images, graphics, video, messages, etc. The project can be described as a web-enabled system for the exchange of concepts, display of work, collaborative production and experimentation. It enables the user to 'play with the meaning of media objects by creating, transforming the downloaded media objects, which are in a sense "source code" to work with.'¹⁶⁰ Hence, source code becomes material to be curated.

The emphasis is on the collaborative aspect, in that curatorial responsibility for the architecture of *FACE* and its structural parts (i.e. nodes) is distributed across its participants. Furthermore, the process of creation, organisation and dispersal of concepts is represented by the flow of graphs, where each concept has a dedicated node, or a configuration of several nodes in the graph. The project website explains that while 'the content published by participants is located at the edges of the graph, the nodes represent a system of tags used by participants for indexing of content'. Simultaneously, participants can control their own graph(s), as well as navigate through the system exploring graphs of other participants.¹⁶¹ The significance of this lies in the productive interrelation between local interventions by each of the participants and the network's global behaviour, and the social relations that arise from this:

'The data which arises while working with this application can have many different characteristics and parameters – such as time, place, creation process, distribution, references, criticisms – which can then be analyzed and visualized. Social dynamics – the actions and interactions of participants lead to the personalization of values and imply a change in social order, regardless of whether the authors are aware of this or not.'¹⁶²

Although the description of the project may suggest the use of software as a tool for visualisation of content (chapter 5.1 briefly addressed this issue), the suggestion is also that the software plays a part in the process of dynamic productions of meaning and thus assumes a curatorial function that is further distributed across project participants. There is no one central curating idea and no singular curator. Instead, there is a curatorial 'council' that invites subsequent participants and these invite further participants, in much the same way as Grubinger's 'C@C: Computer Aided Curating' project. The distributed curating takes account of diverse views and concepts during the selection of subsequent participants.¹⁶³

Similarly, a 'visualisation' of curating in the form of curatorial statements and their exchange is employed in the *nodecurated ()* project (2005), that effectively is an online curatorial management tool.¹⁶⁴ [Fig. 23] The project stems from a critique of online curating's reliance on conventional offline models of curating. The claim is that the project 'proposes to rethink the net from the net itself, putting forward a tool of dialogue, where the different suggestions of curatorial practice do not remain unheard but open to multiple relationships through the process of the reading of these'.¹⁶⁵

There have been a number of more overt curatorial projects that further develop the idea of online open systems. For example, low-fi's *net-art locator* provides a system for collecting and curating net art projects based on an open submission database.¹⁶⁶ [Fig. 24] Key functions of the system are structured around a current selection of net art projects made by the low-fi team, monthly curated guest selections, commissions, database browsing and a search function. Rather less conventionally, The UK Museum of Ordure (2001) presents an online environment that appears to follow the structures and functionality of the traditional art institution or museum such as the Tate.¹⁶⁷ [Fig. 25] However, custom-written software 'manages/curates' the presentation and preservation of ordure collected in an open submission process. The project website states:

'Everything that is represented in the museum is subject to the vagaries of an uncontrolled internal process that slowly deforms and disables all information held in its collection. This is comparable to the decaying processes that affect all artefacts in museums, regardless of attempts at preservation. It also reflects the corruption self-evident in the capitalist relations of production.'

In this way, the project raises questions about the relationship of what is produced and its relative value in the wider culture and economy, and implies further questions about the value of online archiving and curating.¹⁶⁸

The idea of 'software-based filtering' (referred to earlier) is developed further in the *Runme* project (2003), a software art repository and an online presentation platform¹⁶⁹. [Fig. 26] The project emerged from the *Readme* festival as a critical response to existing festival formats in relation to the 'submission', 'selection' and 'categorisation' of artworks.¹⁷⁰ Structured as an open, self-submitting and moderated database system, *Runme* is an attempt to address the fact that although media art festivals historically have provided the most extensive and flexible forum for the presentation of new media works, at the same time they were limited by strict categories and criteria of the submission of works, often failing to include some of the most interesting emergent practices.¹⁷¹ The repository is structured through a taxonomy of categories such as 'code art', 'conceptual software', 'games', 'generative art', and so on, as well as more intuitively through keywords that provide further descriptions of submitted projects. Both the 'category list' and the 'keywords cloud' are open for public modification through the identification and proposal of new terms. In this case,

curatorial control is exerted on the level of setting initial parameters of categories and through a review system that allows editors or so-called 'experts' to highlight the perceived 'best works' with short commentaries. The curatorial process is based on a relatively open, yet somewhat moderated database, that allows users to self-submit their works – an option almost embedded in the software. The inspiration for this, at least according to Alex McLean (who wrote the software for *runme.org*), is *sweetcode.org* – a repository for free software (mentioned earlier). He describes sweetcode as 'perhaps the closest thing to an art gallery for the free software community, and indeed one of the inspirations for <http://runme.org>' (Gorlunova and Shulgin 2003: 79). This statement is of particular relevance for the *curator* project outlined in the next chapter.

Other, more recent examples of curatorial projects that address to various extents the issue of distributed curatorial process through software, include *Do It with Others (DIWO E-Mail-Art at NetBehaviour)* and the *hack-able curator* project (both produced in 2007).¹⁷² *Do It with Others* proposes the collaborative filtering of exhibition content by subscribers to an online list that directly reflects what Paul calls 'public curation'. [Fig. 27] The project was structured as a 'distributable' exhibition involving selections made by artists and curators (more generally subscribers to the NetBehaviour email list), with both an online and physical gallery space component that functioned as a physical interface. In a posting to the CRUMB list (24 March 2007) Ruth Catlow explains the exhibition concept:

'The exhibition consists of "Threads" (series that directly involved mixing and dialogue, action and response) and "Streams" (of images, texts, movies instructions etc by single contributors) in print, sound, html, movie and text. Also, a couple of installation works devised especially for the space. [...] All submissions were sorted and categorised and displayed within a mailbox that was available for visitors to explore and redistribute (by clicking "Forward Mail") [...] The idea deliberately draws on the tradition of earlier Mail Art exhibitions in that the project started with an open-call and every post to the list, between 1st February and 1st April, is considered a work – or part of a larger, collaboratively created artwork.'¹⁷³

While the approach to curating demonstrated in the *DIWO* project highlights a form of distributed human agency in an open collaborative curatorial process, the *hack-able curator* project additionally emphasises a distributed technological agency facilitated through social technologies. [Fig. 28] This approach combines curating with robotics, social technologies and the practice of 'hacking' to offer an experimental curatorial system, that questions the singular subjective role of the curator and the possibility of the democratisation of curating, by hacking the curatorial process.¹⁷⁴ The robot curator is connected to the Internet so that it can expand the physical space into networks (social and technological) and the entire system represents a curator. The protocols behind the robotic curator involve the following: a pre-selected set of tags to search the social platform Flickr for images for use in an imaginary show, creating a pool of

images to choose from, present these images on a computer screen nine at a time, making a selection of one or more images that fits its curatorial criteria by the robotic arm via a software algorithm, informing the owner of the image about the intention of including their image in the show, giving them the opportunity to opt-out, and finally displaying selected images on the project website. Simultaneously, the robot prints a label sticker for each of the tags associated with the chosen image.¹⁷⁵ The intention behind this experimental work is not to replace human curatorial agency but to deconstruct it and reflect upon the emerging social tools for curating in a collaborative context.¹⁷⁶ Furthermore, the project suggests the practice of hacking the curatorial process as a creative intervention.

Taken together and to various degrees, the numerous examples explored in this section offer a challenge to the practice of curating and the art world in general. The challenge is implicit, as Paul explains:

'Even though it may not be their explicit goal, these projects implicitly challenge the structures of legitimization created by the museum system and traditional art world. A broader art audience may still place more trust in the selection, and therefore validation, undertaken by a prestigious museum, but in the online environment, the only signifier of validation may be the brand recognition carried by the museum's name.' (2006: 97)

The projects, whether intentionally or otherwise, serve to redefine the curatorial role and the increasing requirement to not simply choose but 'filter' material. The issue of 'filtering' as a curatorial strategy is further explained by Gorlunova and Shulgin:

'Every platform has a filtering mechanism, filtering works invisibly at the backend but always present. Filtering is a key to success: it can make the resource desirable to be a part of, and therefore accepted by the users. Filtering is carried out in a strict manner by a few people with consistent judgment of taste and decisions. The way filtering is organised decides the destiny of the project: filtering is usually absolutist to keep up the quality of the resource, and also democratic to allow for a variety of works and approaches.' (2006: 255)

A similar point is also made by Paul in describing a shift towards the curator as a 'filter feeder' as part of a continuous process of selecting and filtering – describing, classifying, creating contexts and re-contextualising within the online environment. The use of the term 'filter feeder' highlights the specificity of online curating as opposed to curating in physical space, and the importance of the curatorial function of *selecting* and *contextualising* displayed material within the continuously shifting context of an online environment – that itself is permanently in a state of flux. Paul emphasises differences between online and offline curating in the following way:

'One could certainly argue that the role of a curator of contemporary art is increasingly shifting towards that of a filter feeder, since cultural production in general has become more "networked" through current technologies and changed public art viewing practices. However, the politics of selection and the role played by art institutions undergo more substantial changes in the online curatorial process, which takes place in the non-locality of a distributed network.' (2006:92)

In describing the main differences between curating for online environments and physical space, Paul specifically refers to the summary provided by Anne-Marie Schleiner in her essay 'Fluidities, and Oppositions among Curators, Filter Feeders, and Future Artists' (2003). In this, the figure of the 'past curator' is characterised through an association with the museum or gallery exhibition space and other key factors, including dealing with the issue of art as commodity. In contrast, what Schleiner calls the 'future filter feeder' is characterised through a lack of association with any specific physical location or institution. Potentially at least, this allows increased public involvement in the curatorial process, and more participatory forms of filtering.

These claims turn on qualitative distinctions of what constitutes more participatory or even more democratic practices. However, rather than focus on these terms as much of the discussion in this area does, the following chapter will highlight the issue of agency in various curatorial models, to make a qualitative distinction between the projects on offer – many of which simply appear to offer only a form of pseudo-agency.¹⁷⁷ In summary, the examples presented in this chapter have been largely descriptive in order to provide a framework for further practice in this area. In the following chapter the proposition builds upon the examples in this chapter and extends them. Central to this is a more direct engagement with software as an integral part of the curatorial process, in order to examine what is referred to in the thesis as software curating.

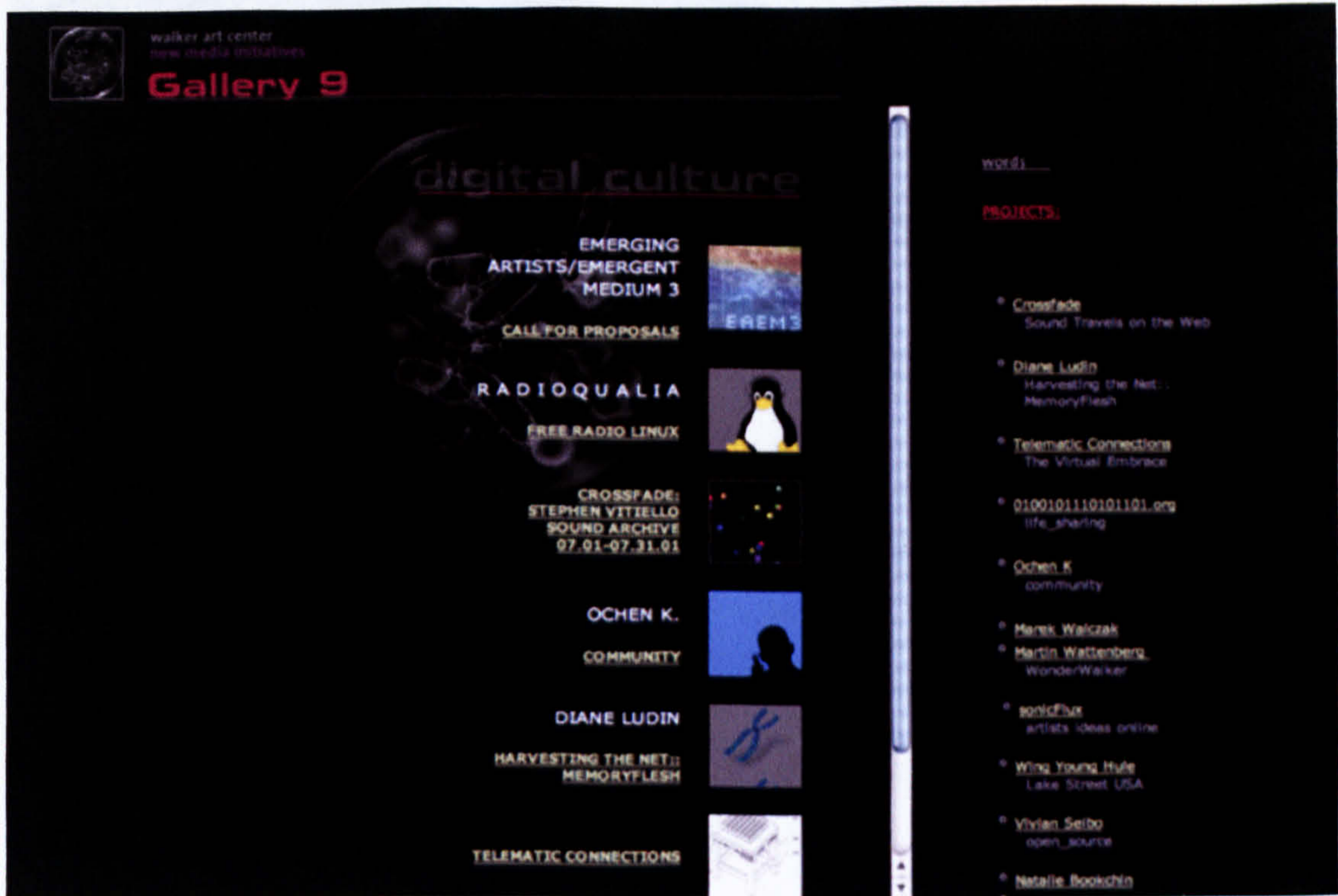


Figure 6: *Gallery 9* (1997–2003) screenshot, <http://www.walkerart.org/archive/7/96D3639B6E5717946167.htm>

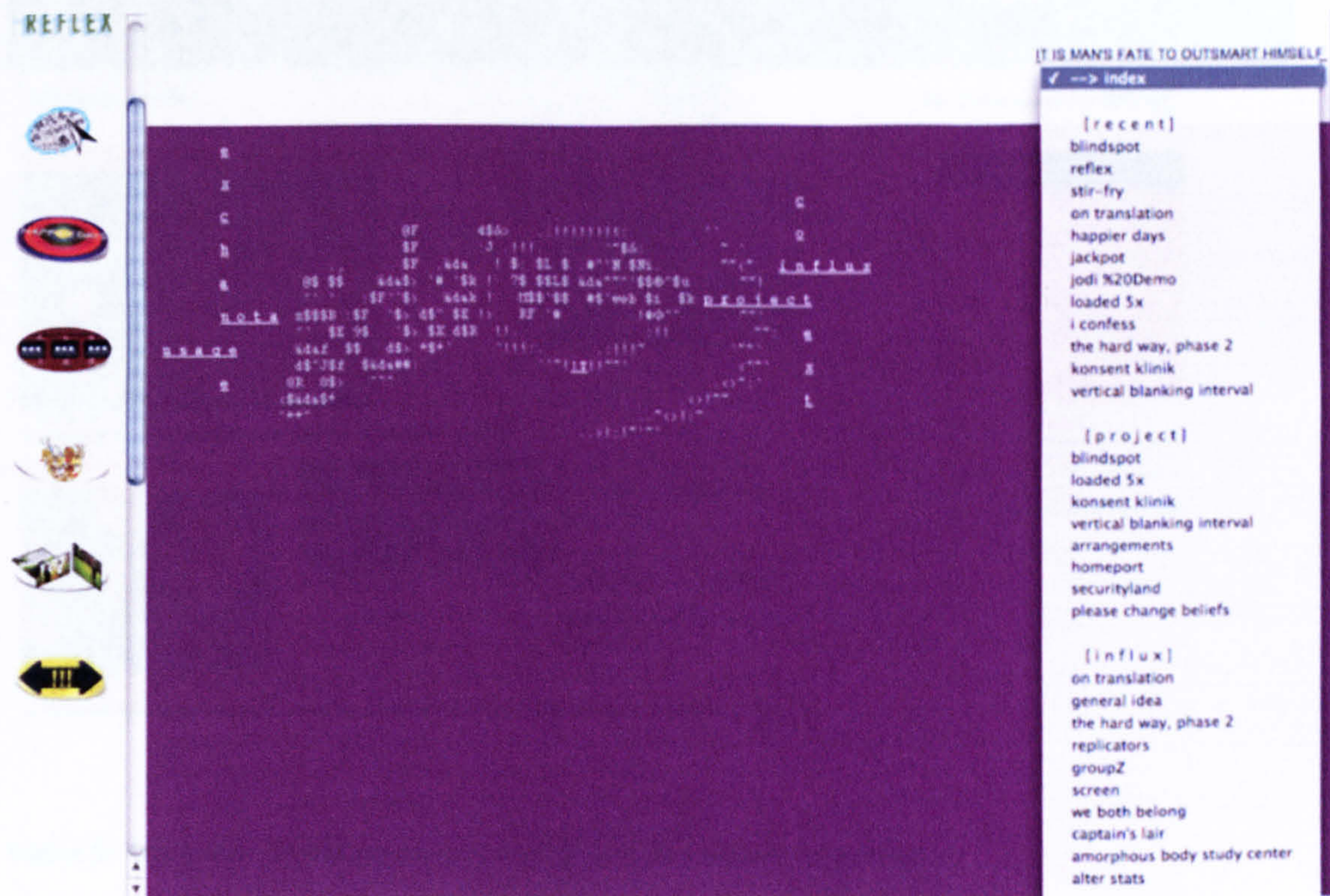


Figure 7: *äda'web* (1995) screenshot, <http://www.walkerart.org/archive/2/AD737122FD544FA56164.htm>

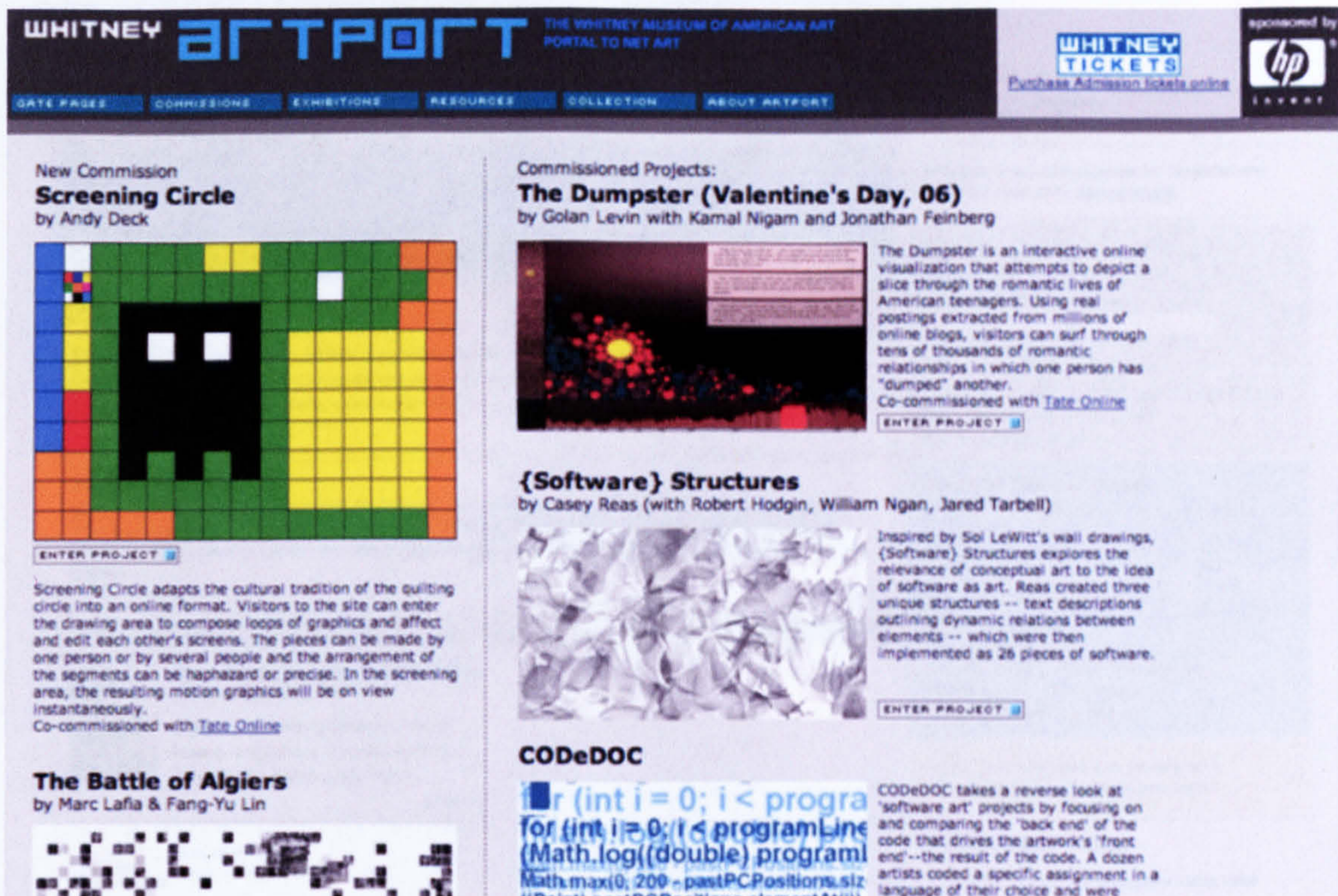


Figure 8: artport (2001) screenshot, <http://artport.whitney.org/>

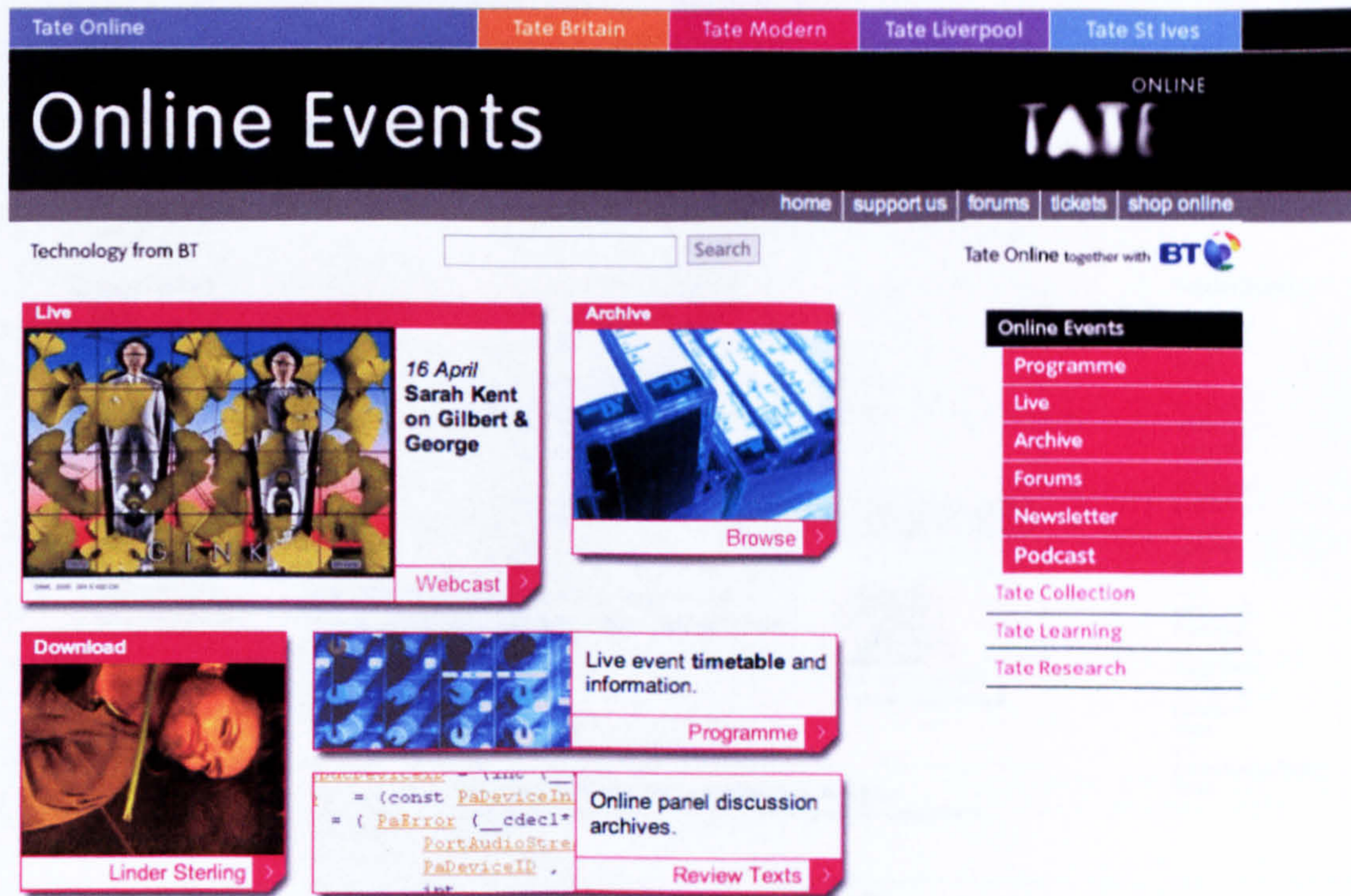


Figure 9: Tate Online (2001) screenshot, <http://www.tate.org.uk/onlineevents/>

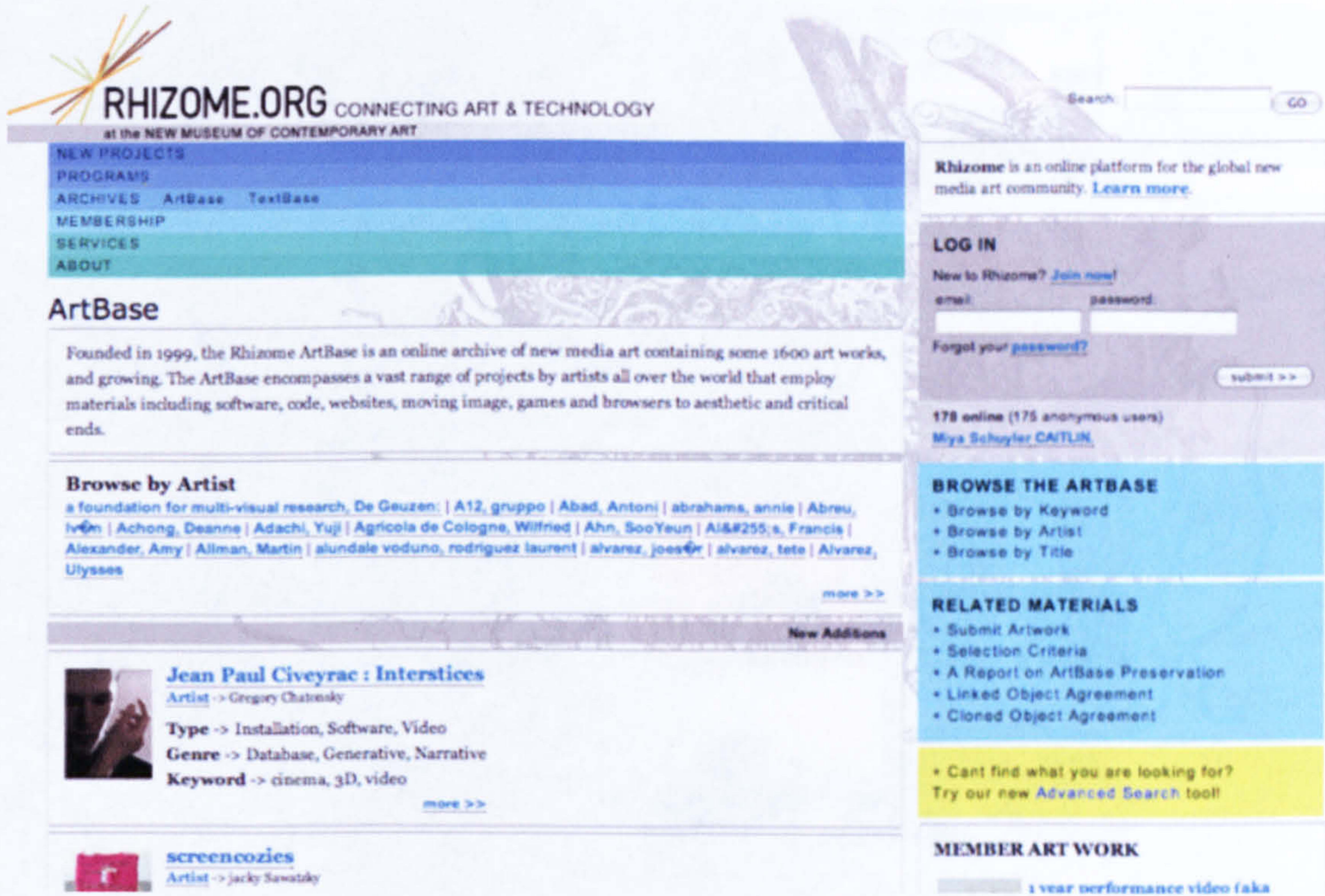


Figure 10: Rhizome (1996), screenshot, <http://www.rhizome.org>

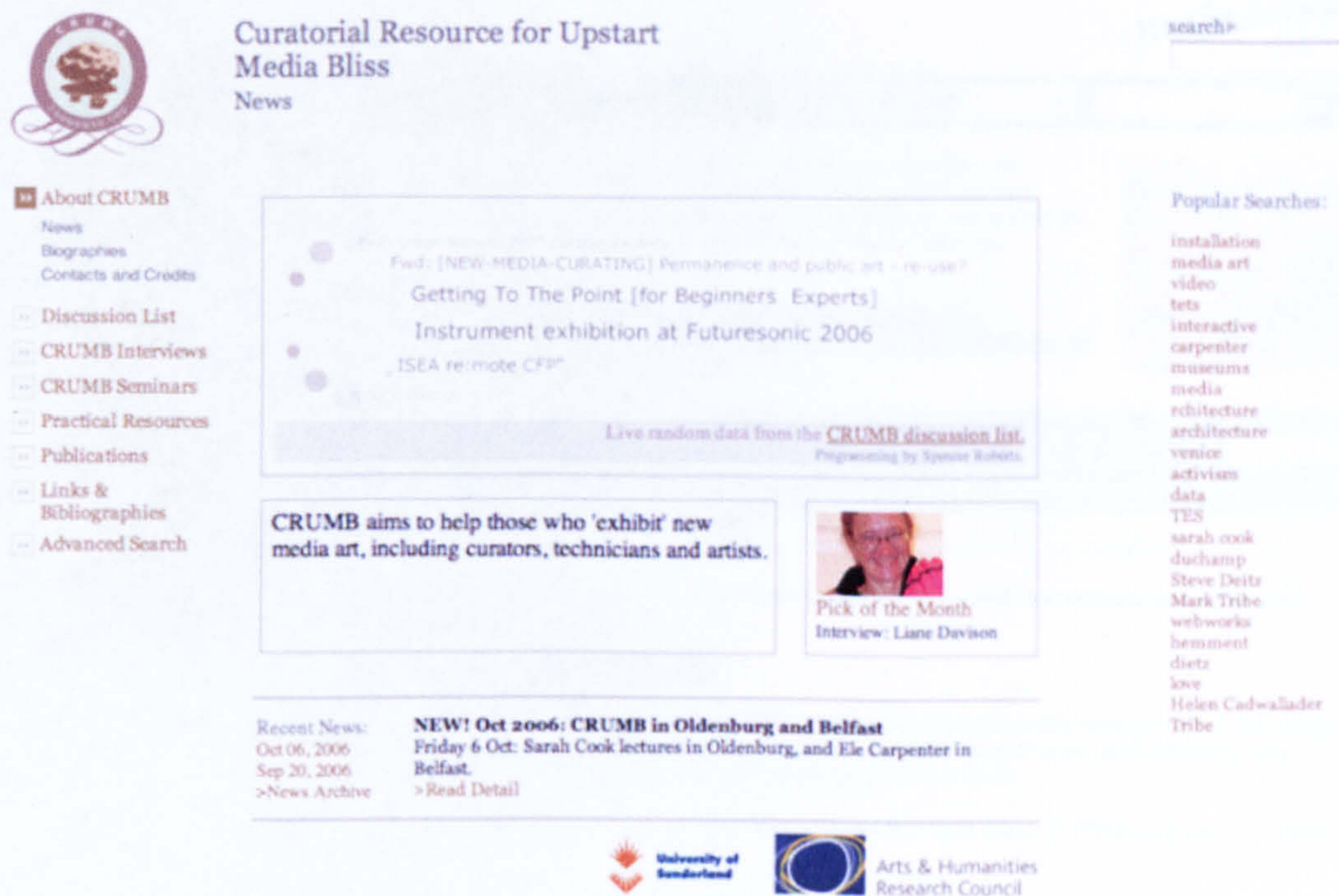


Figure 11: CRUMB (2001) screenshot, <http://crumbweb.org/>



Figure 12: Open Congress (2005) screenshot, <http://opencongress.omweb.org/modules/wakka/HomePage>

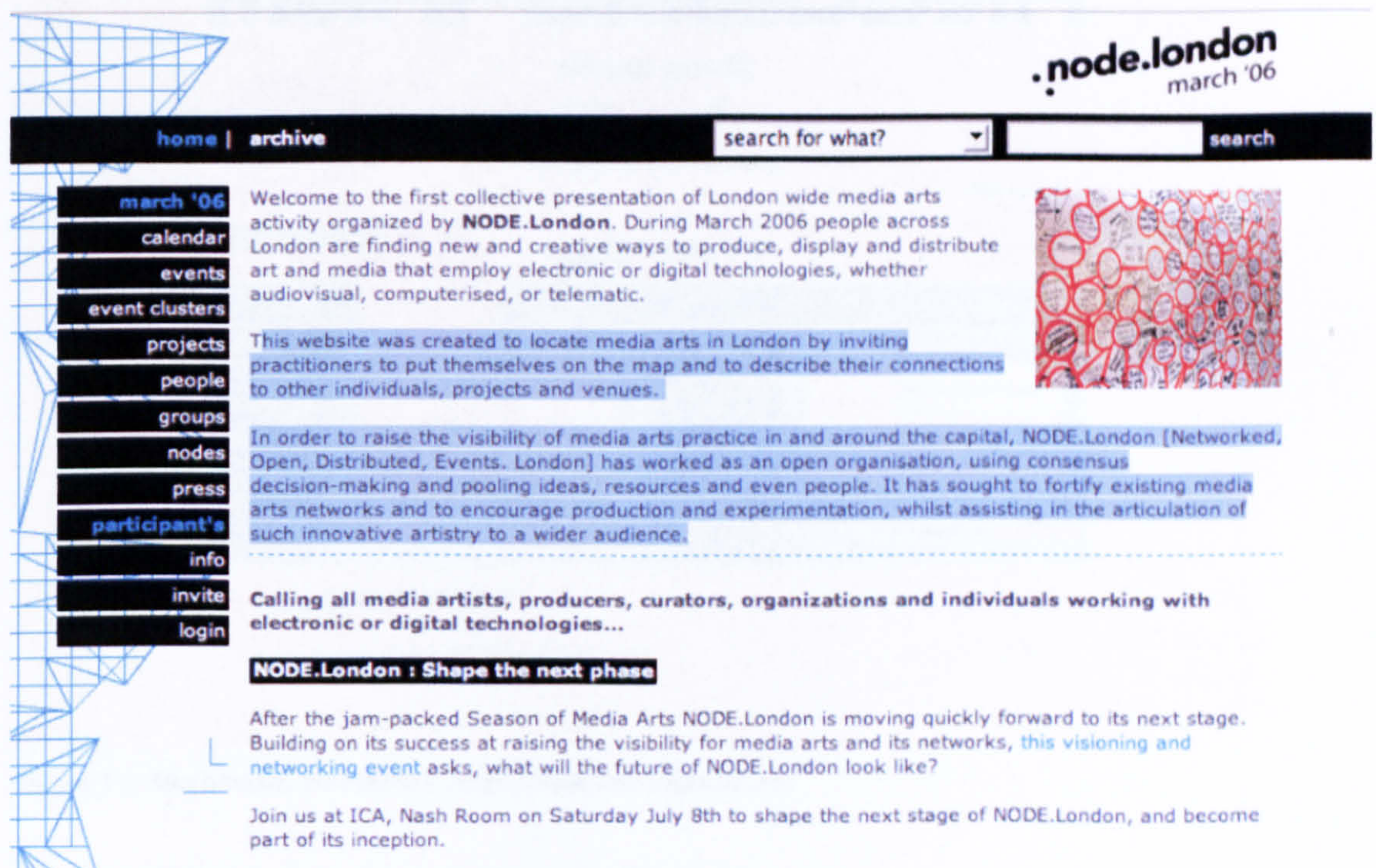


Figure 13: Node.London (2006) screenshot, <http://nodel.org/>

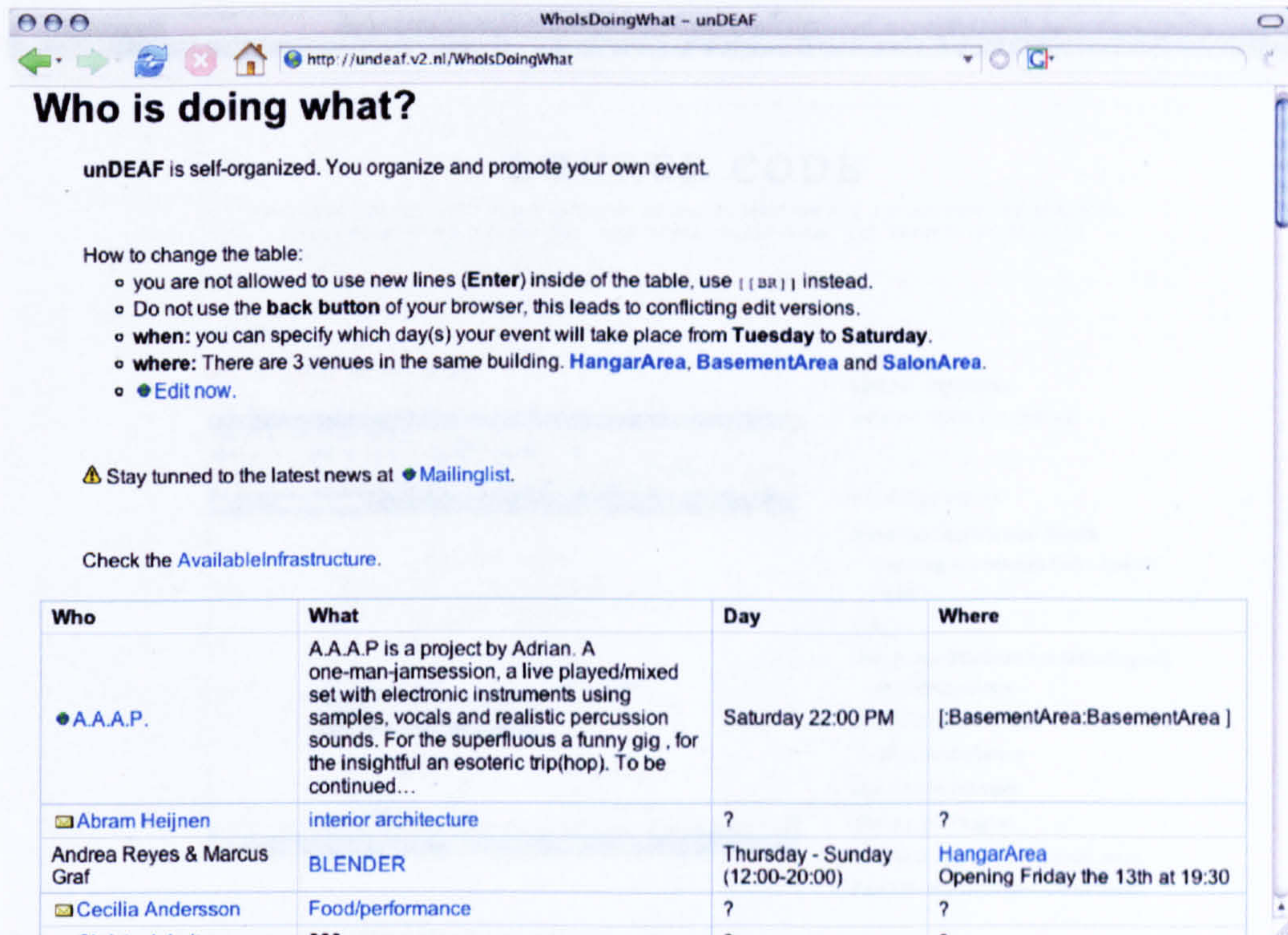


Figure 14: unDEAF (2007) screenshot, <http://undeaf.v2.nl/>

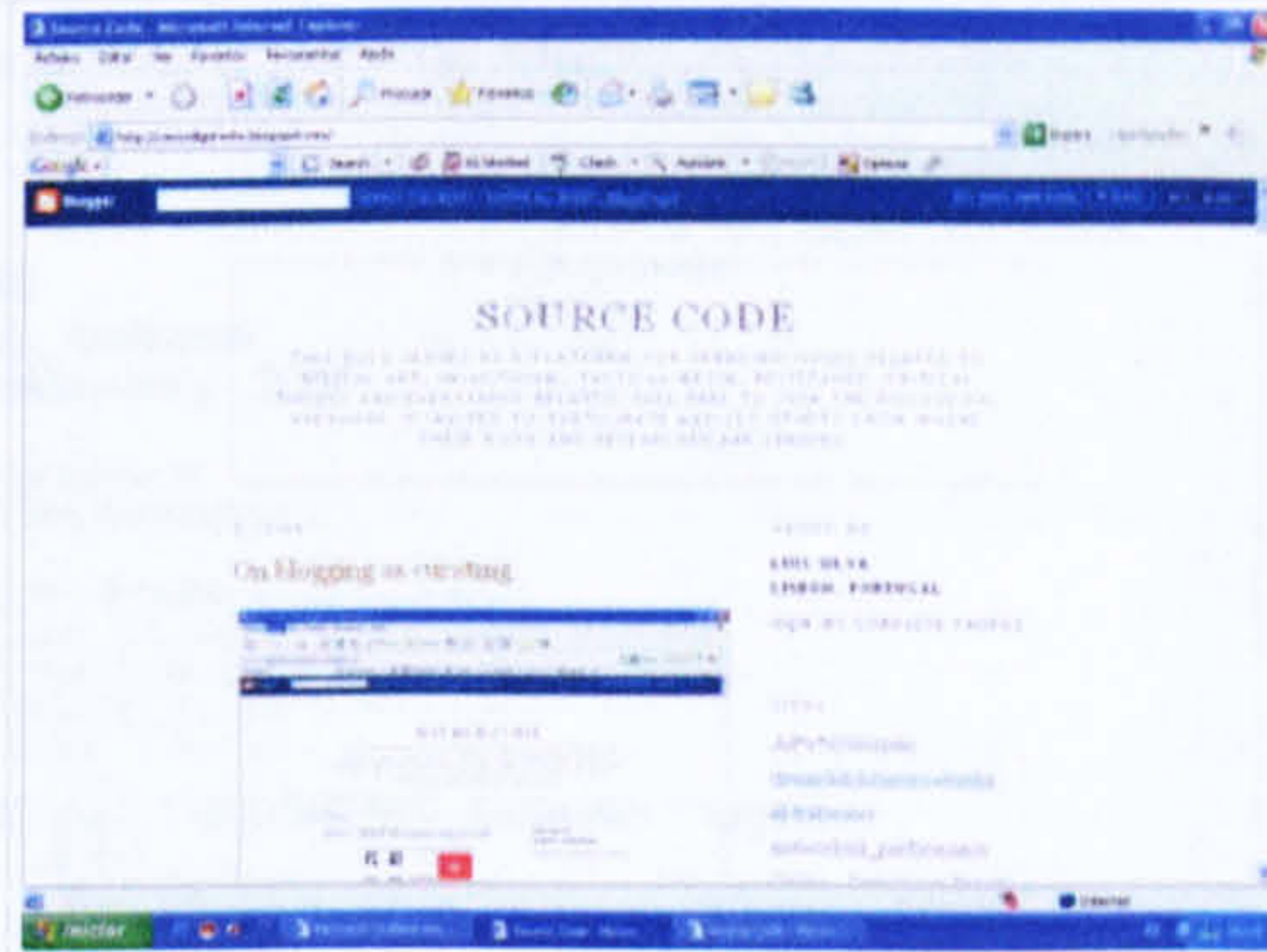


Figure 15: Micromusic, screenshot, <http://www.micromusic.net>

SOURCE CODE

THIS BLOG SERVES BOTH AS AN ONGOING ONLINE EXHIBITION AND A PLATFORM FOR DEBATING ISSUES RELATED TO DIGITAL ART, NEW MEDIA, (H)ACTIVISM, AND EVERYTHING RELATED.

1. 11. 05
On blogging as curating



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 LISBON, PORTUGAL
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 - [For A Safer Internet](#)
 - [Mona Lisa Toogled](#)
 - [UNESCO Digital Arts Award 2005](#)
 - [Best Of - My Boyfriend Came Back](#)

Figure 16: Luis Silva's blog (2005) screenshot, <http://vercodigofonte.blogspot.com/2005/11/on-blogging-as-curating.html>

del.icio.us / TAGallery / EXHIBITION_link.of.thought popular | recent
login | register | help

TAGallery's items tagged EXHIBITION_link.of.thought → view all, popular del.icio.us search

link.of.thought_thoughtOf.link... (more)

earlier | later showing all 10 items

GRAFFITI ANALYSIS _ Graffiti Research Lab _ new media in physical space _ 2004 (beta)/2005
 save this
 UE: "A 'capture device' for recording the motions used when drawing a 'tag' (...) Print-outs of this 'digitized' motions are placed within the urban environment, extending the notion of 'traditional' graffiti into new media."
 to GRAFFITI_ANALYSIS_Graffiti_Research_Lab_2004_2005_tagging_graffiti_activism EXHIBITION_link.of.thought saved by 22 other people on June 21

SHIFTSPACE _ Mushon Zer-Aviv + Dan Phiffer _ An Open Source layer above any webpage _ 2006 save this
 EK: "People tend to think that the net is a public space. This might be true for some parts of it (...) ShiftSpace.org attempts to subvert this trend by providing a new public space on the web by pressing the [shift] + [space] keys."
 to SHIFTSPACE_Mushon_Zer-Aviv_Dan_Phiffer_opensource_2006_public_space_activism_tagging EXHIBITION_link.of.thought saved by 58 other people on June 21

HTTP [House of Technologically Termed Praxis] _ Ruth Catlow + Marc Garrett (Furtherfield) netart

related tags

- + 0100101110101101.ORG
- + 13_MOST_BEAUTIFUL_AVATARS
- + 1993
- + 1996
- + 1999
- + 2004
- + 2005
- + 2006
- + 2007
- + activism
- + Aleksandra_Domanovic
- + Alessandro_Ludovico
- + appropriation
- + aut cannibalism
- + avatar
- + blog
- + C@C_COMPUTER_AIDED_CURATING
- + Christoph_Priglinger
- + Cornelia_Sollfrank
- + curating
- + Dan_Phiffer
- + distribution
- + diy
- + Eva_Grubinger
- + exhibition
- + Furtherfield
- + gallery
- + generator
- + Georg_Schnitzer
- + GOOGLE_WILL_EAT_ITSELF
- + graffiti
- + GRAFFITI_ANALYSIS
- + Graffiti_Research_Lab
- + Helen_Thorington
- + LISTED

000_ABOUT

- 1 About_TAGallery
- 2 Browse_TAGallery
- 1 Imprint_TAGallery
- 15 Mutual_TAGallery

001_dead.art(-missing!)LINKreSources

- 10 EXHIBITION_dead.art
- 1 STATEMENT_dead.art
- 4 USERS_dead.art

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- 2 STATEMENTS_elit.s
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- 5 USERS_elit.s

005_Collection_of_collections.

- 10 EXHIBITION_collect
- 1 STATEMENT_collect
- 2 TAGGER_collect
- 2 USERS_collect

006_I_tag_you_tag_me

- 10 EXHIBITION_tag_you_tag_me

Figure 17: TAGallery/EXHIBITION_link.of.thought (2007) screenshot, http://del.icio.us/TAGallery/EXHIBITION_link.of.thought



Figure 18: TAGallery/EXHIBITION_I.tag_you (2007) screenshot, http://del.icio.us/TAGallery/EXHIBITION_I.tag_you

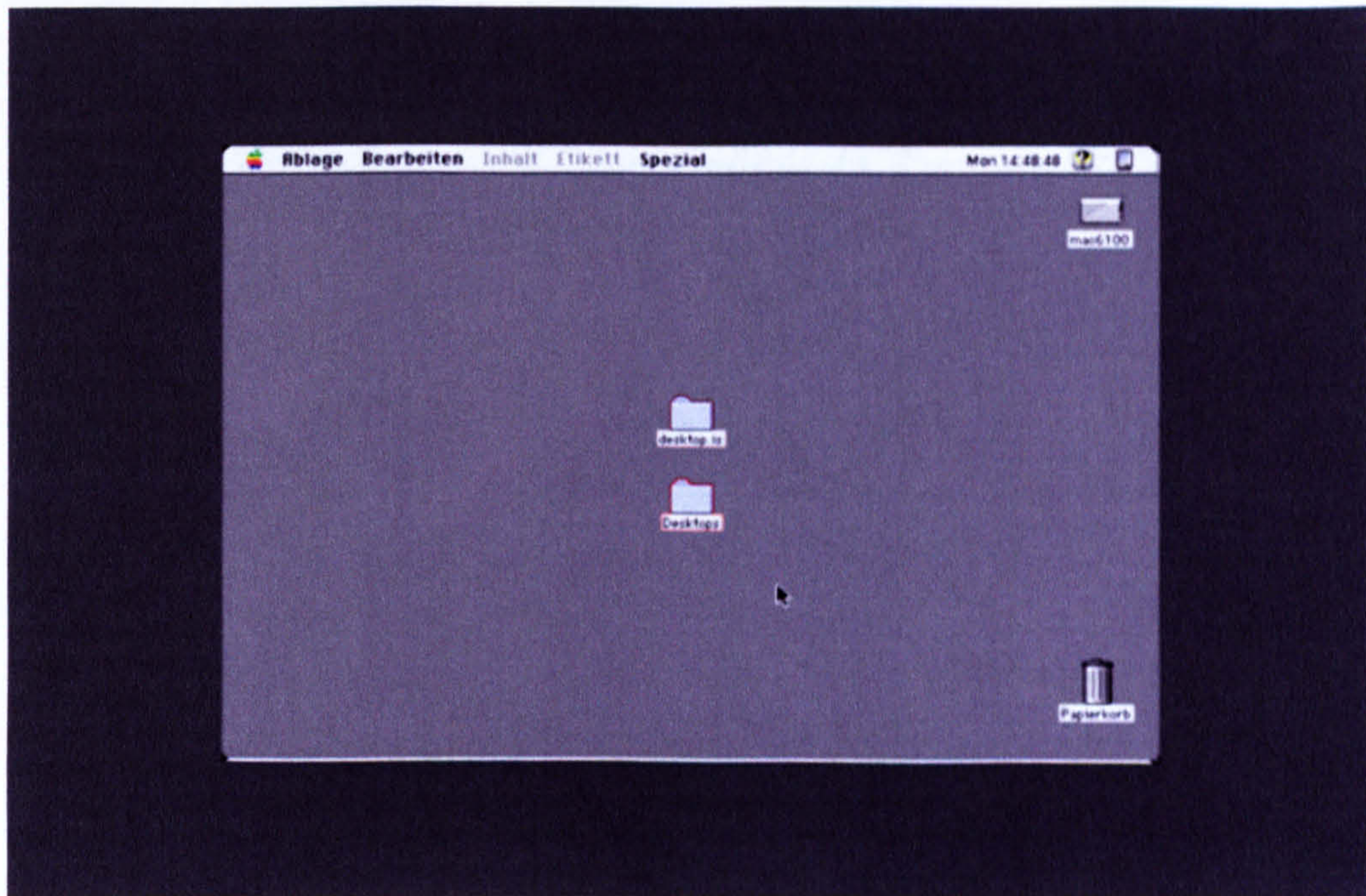


Figure 19: Desktop ls (1997-1998) screenshot, <http://www.easylife.org/desktop/>

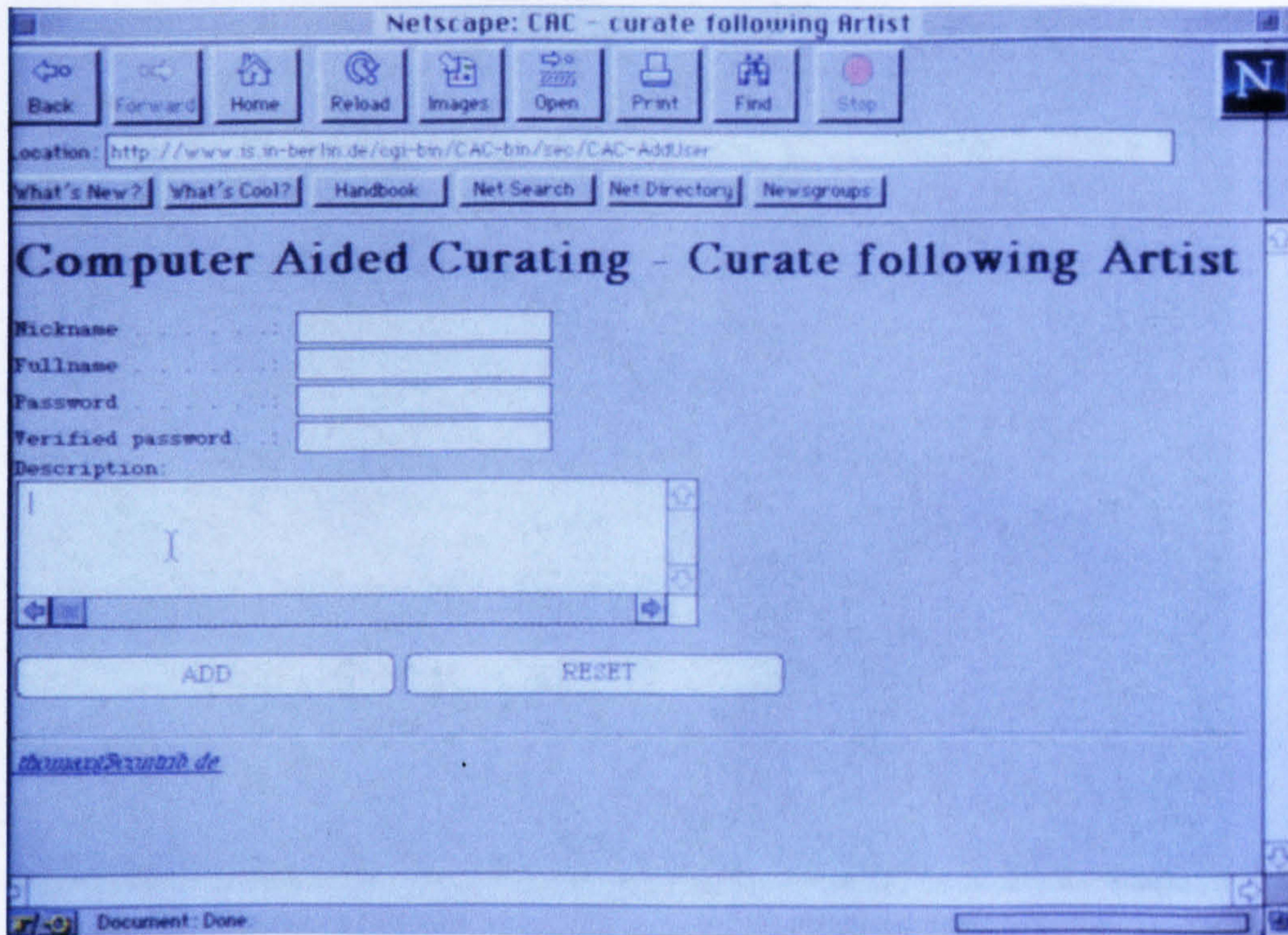


Figure 20: *C@C: Computer Aided Curating* (1993–1995) screenshot courtesy of <http://www.evagrubinger.com>



Figure 21: *FACE* (2007) screenshot, <http://www.freeconcept.net/>

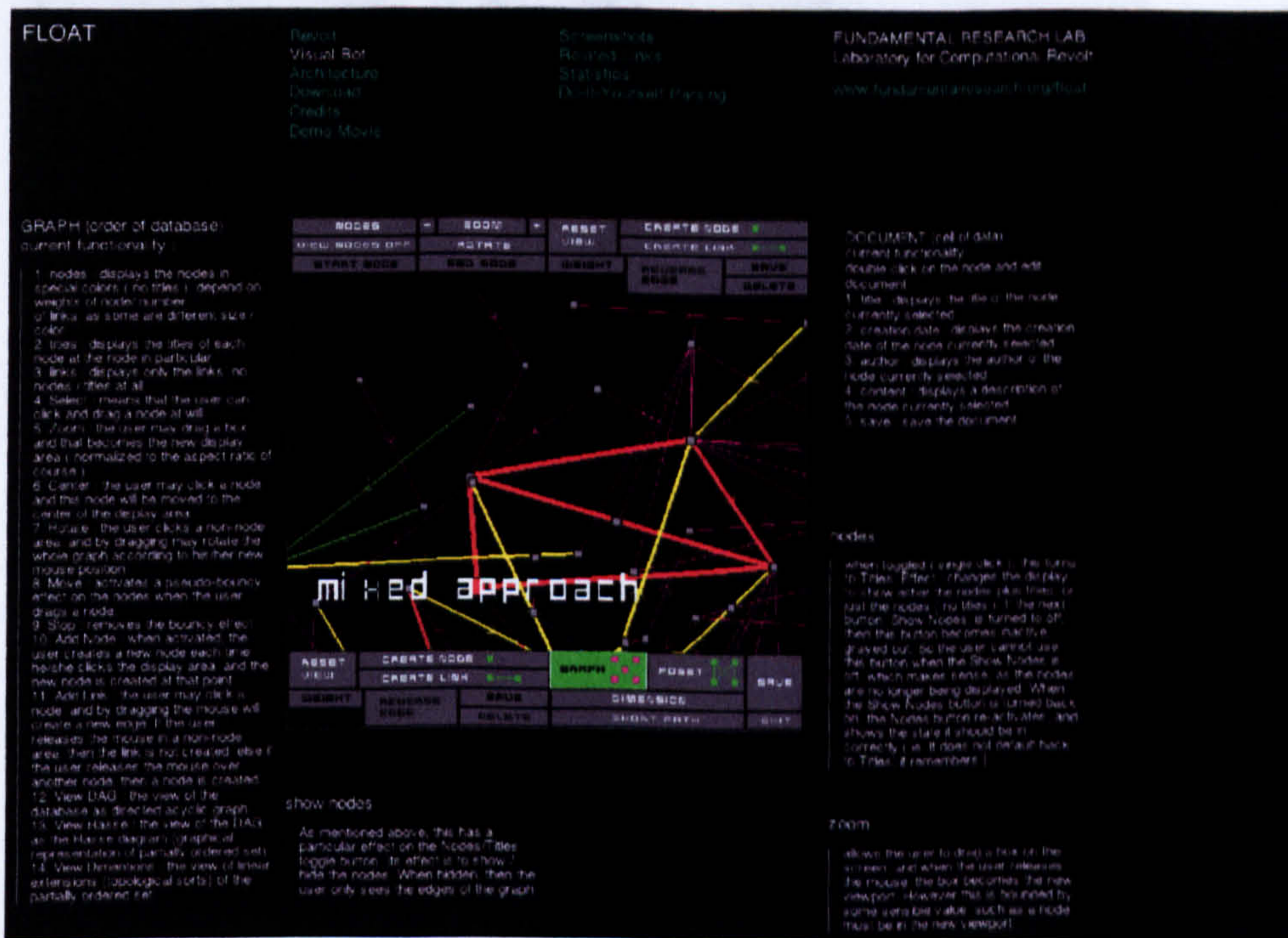


Figure 22: *FLOAT* (2005) screenshot, <http://fundamental.art.pl/obj/bot.htm>

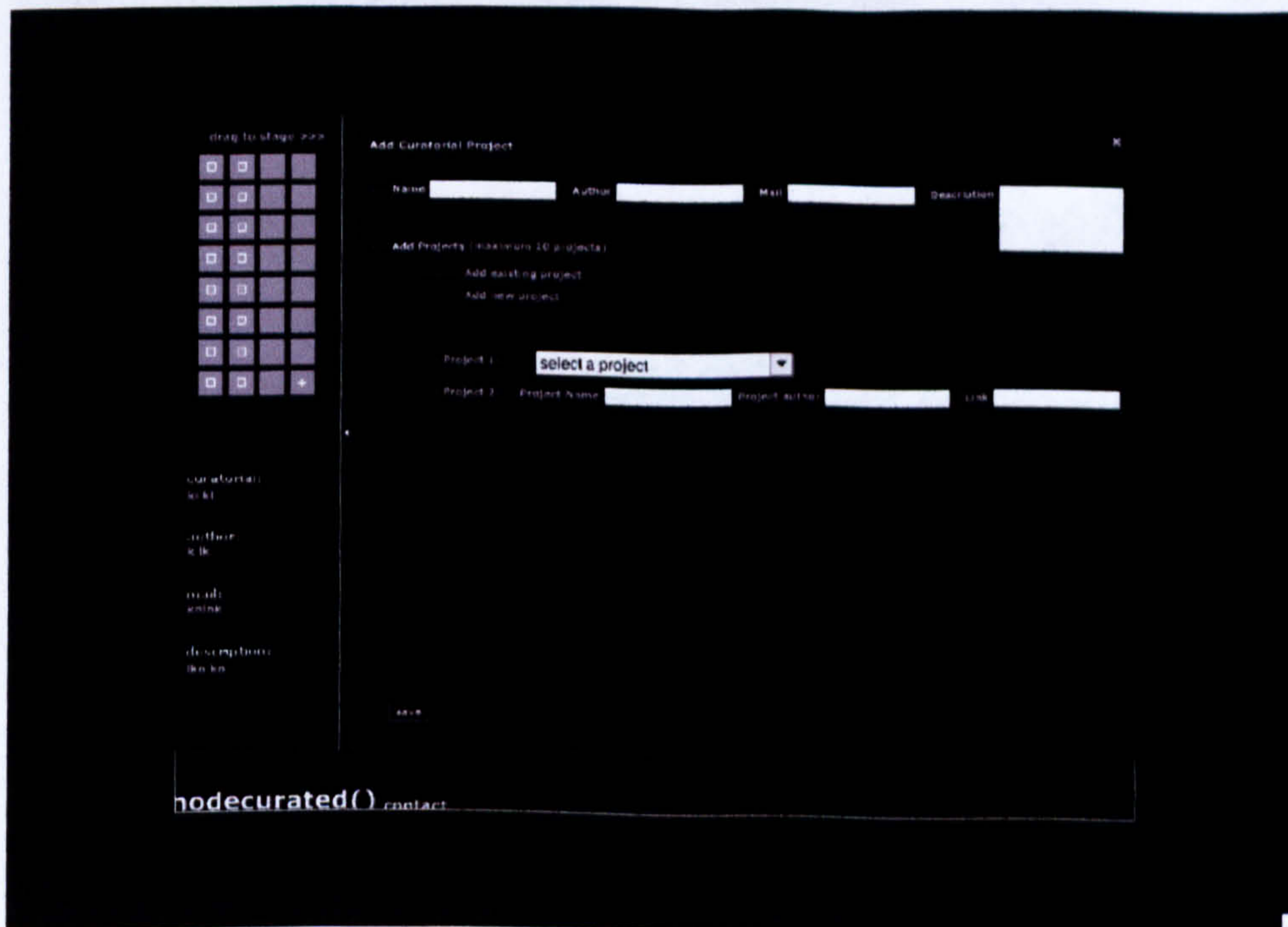


Figure 23: *nodecurated()s*(2005) screenshot, <http://www.nodecurated.net>



Figure 24: *net art locator*, screenshot, <http://www.low-fi.org.uk>

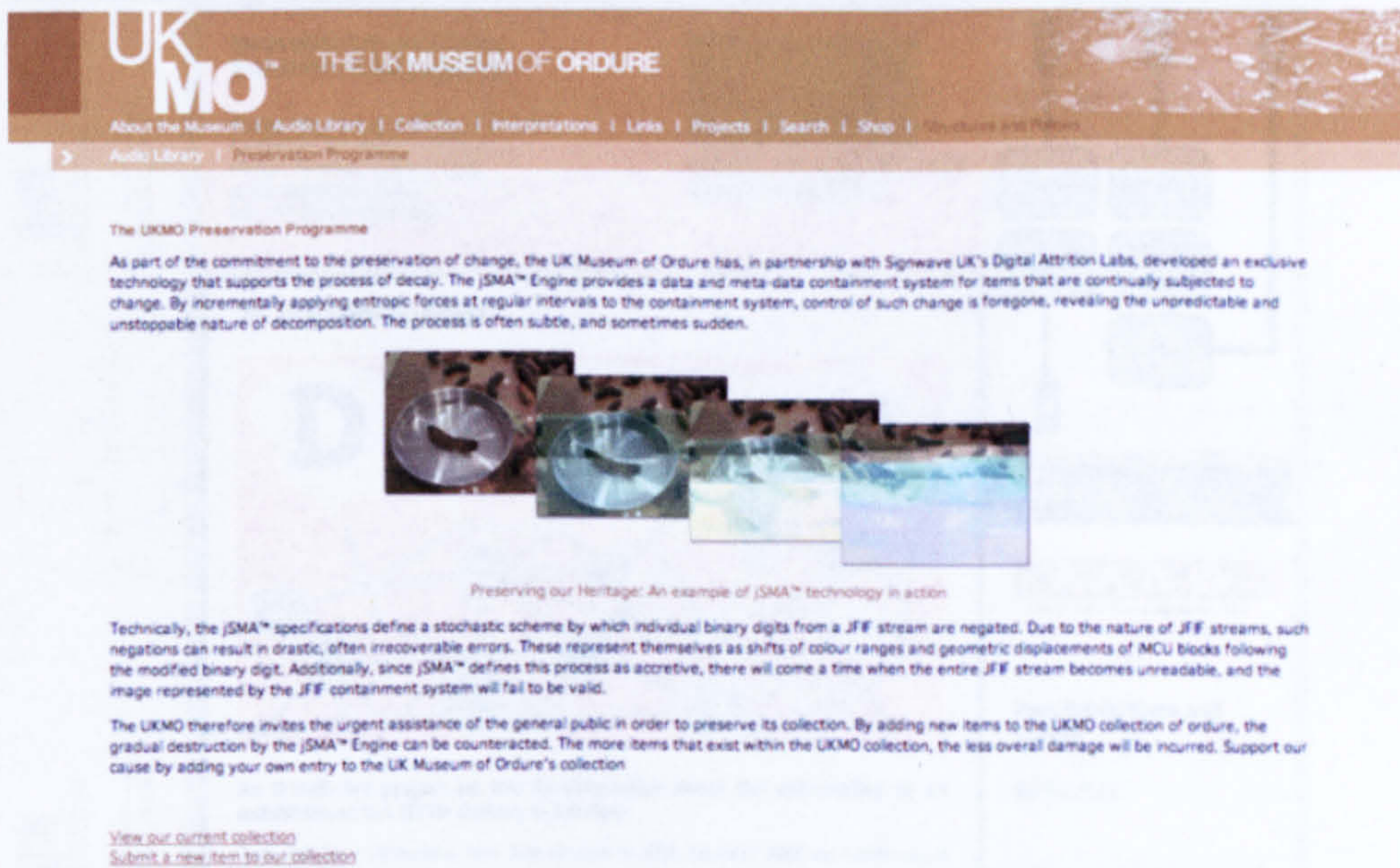


Figure 25: The UK Museum of Ordure (2001) screenshot, <http://www.museum-ordure.org.uk>

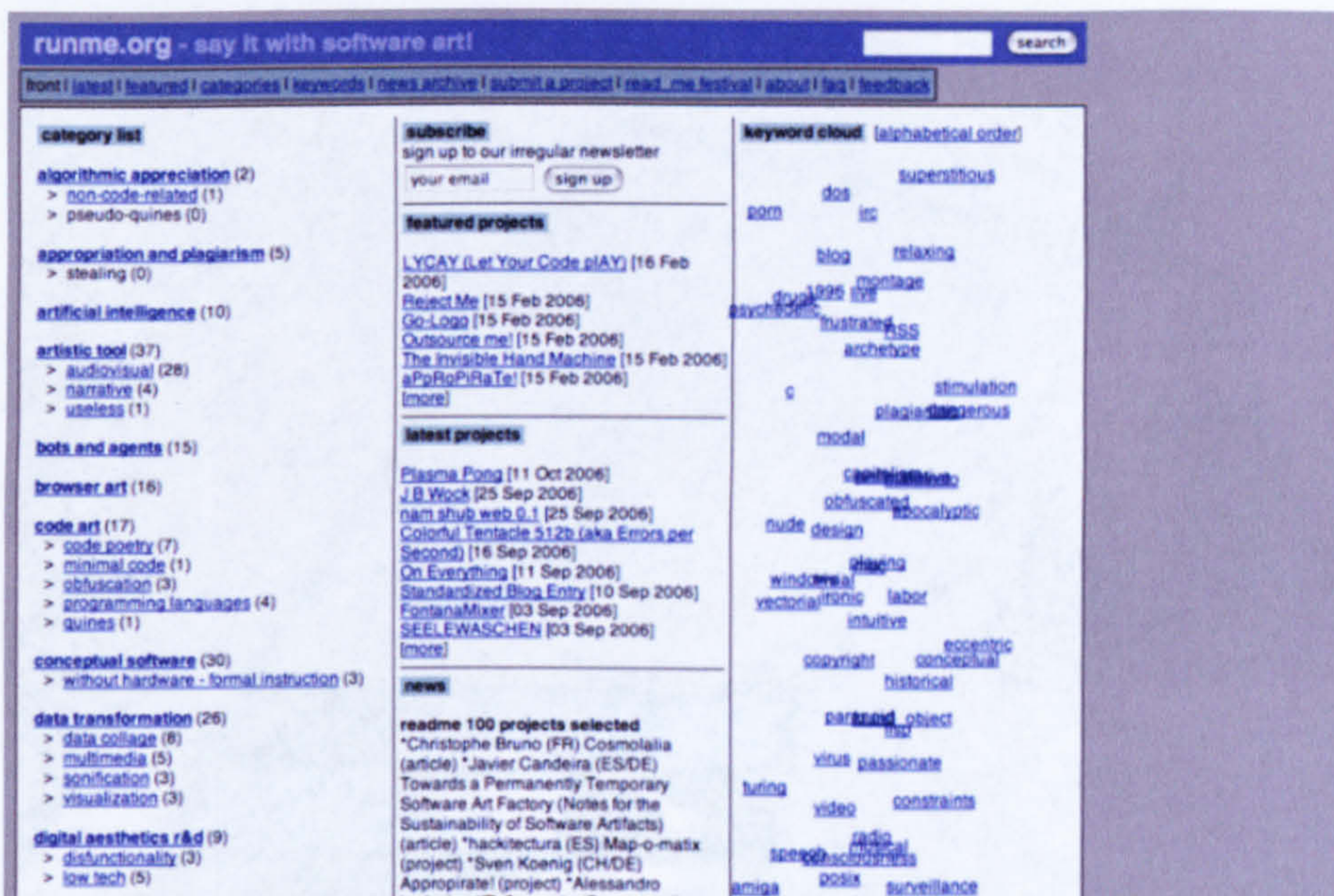


Figure 26: Runme (2003) screenshot, <http://www.runme.org>

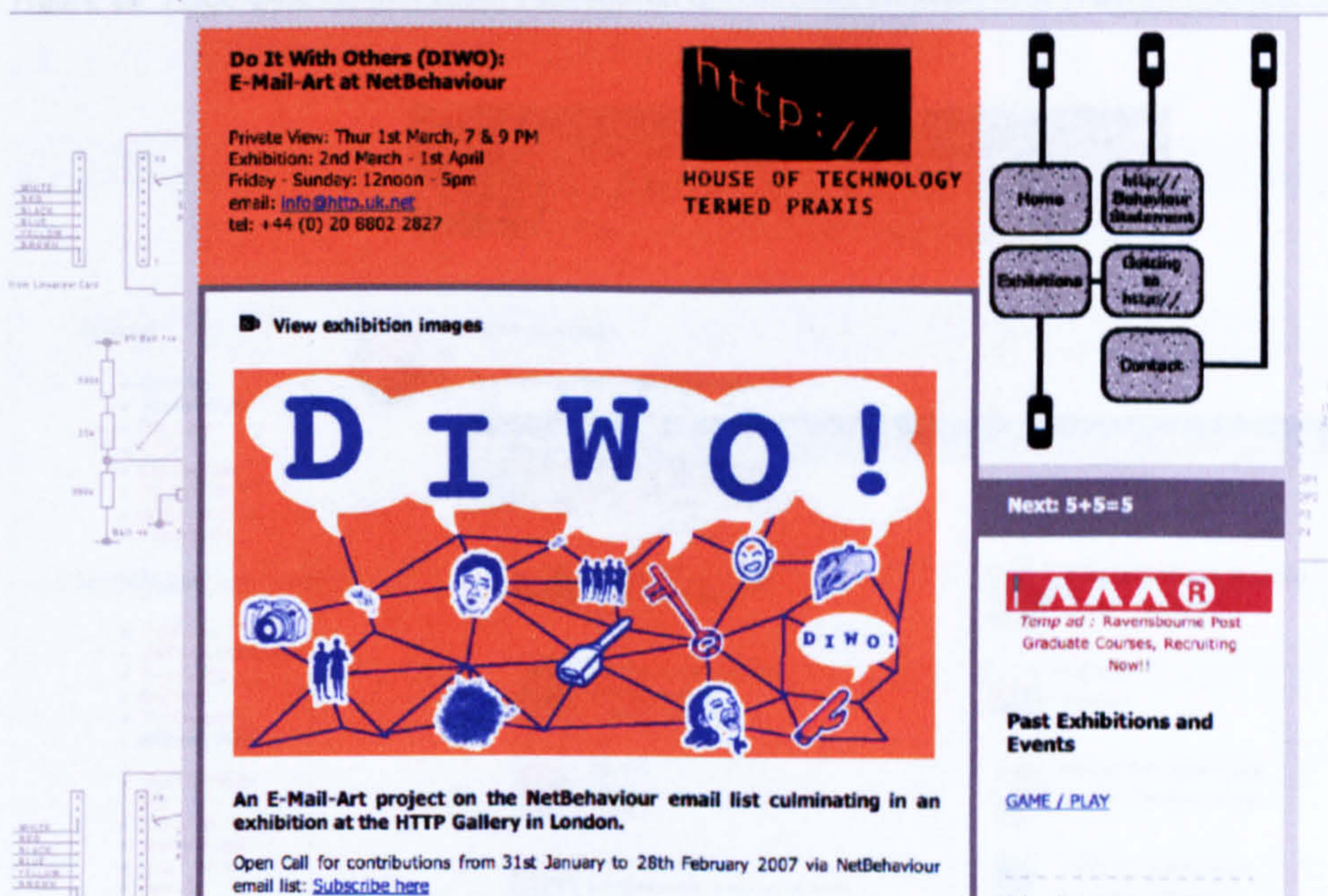


Figure 27: Do it with Others (2007) screenshot, <http://www.http.uk.net/docs/exhib12/exhibitions12.shtml>

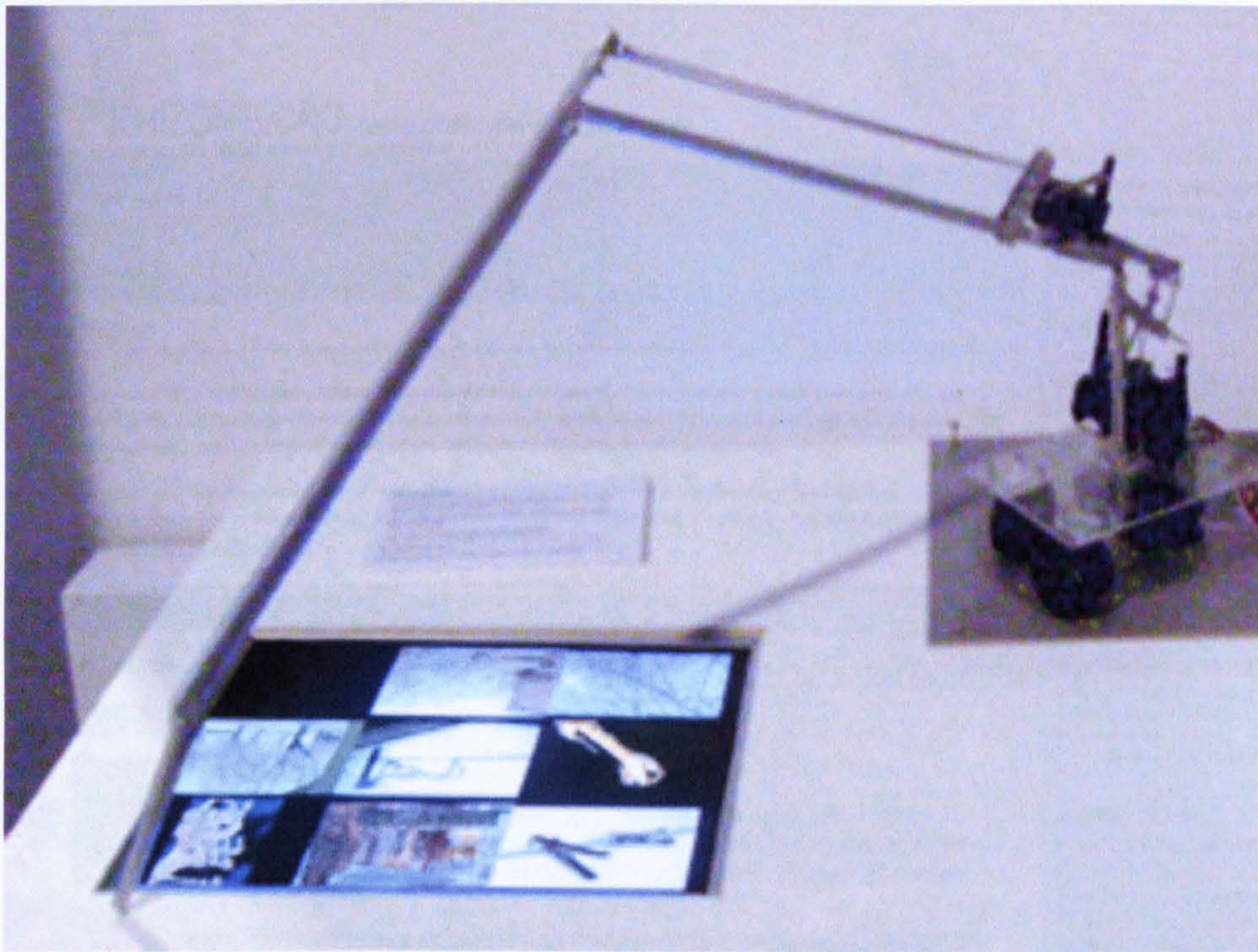


Figure 28: *Hack-able Curator* (2007) exhibition documentation shot, <http://www.hackablecurator.org.uk/>

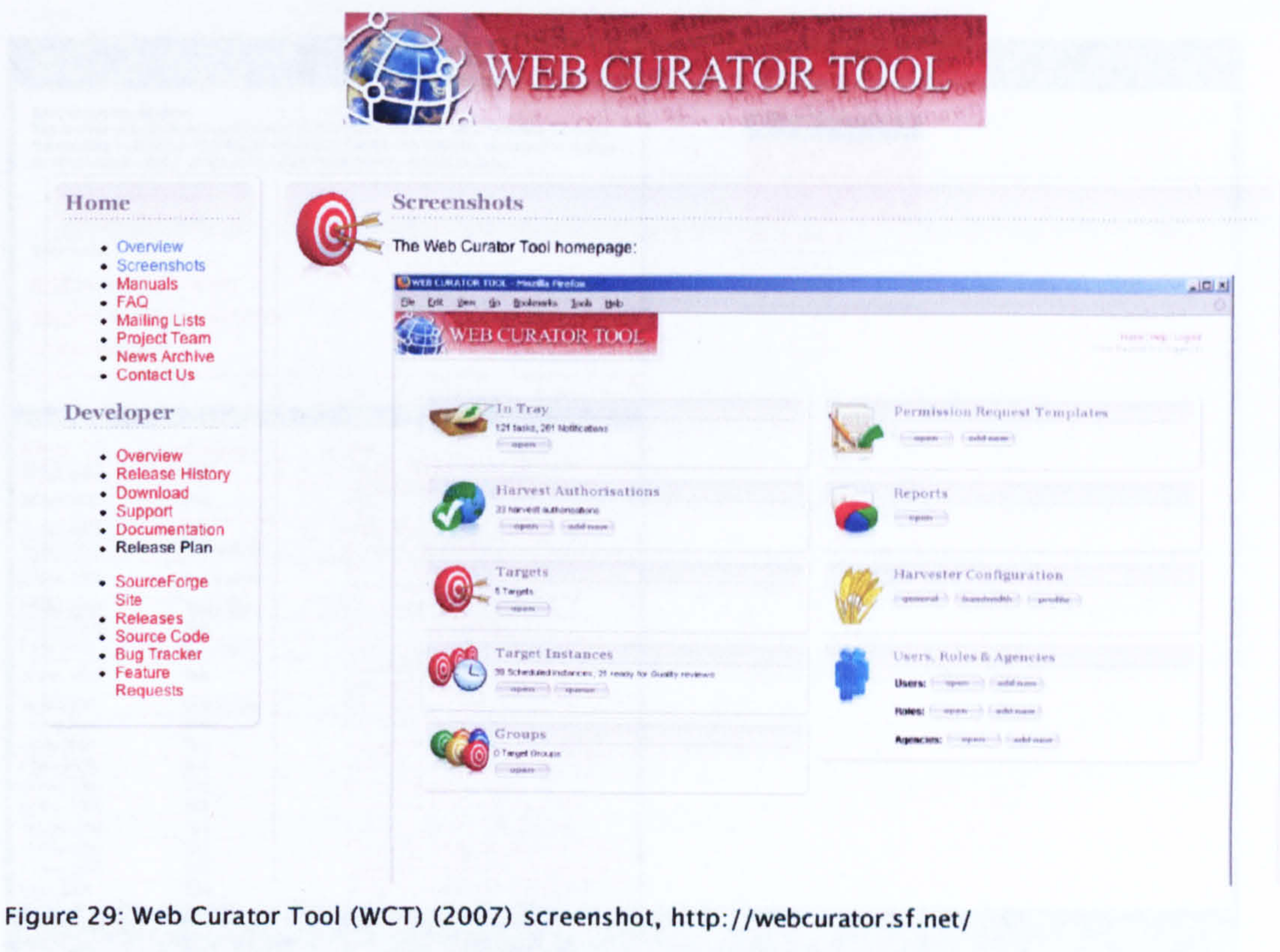


Figure 29: Web Curator Tool (WCT) (2007) screenshot, <http://webcurator.sf.net/>

- NEW PROJECTS
- PROGRAMS
- ART & TEXT ArtBase TextBase
- MEMBERSHIP
- SERVICES
- ABOUT

ArtBase

Founded in 1999, the Rhizome ArtBase is an online archive of new media art containing some 2109 art works, and growing. The ArtBase encompasses a vast range of projects by artists all over the world that employ materials including software, code, websites, moving image, games and browsers to aesthetic and critical ends.

Our system of classification consists of terms that artists assign to their work. Artists choose from Rhizome's vocabulary of new media terms as well as adding their own terms. When new terms reach a certain level of popularity they become part of [Rhizome's vocabulary](#).

New Additions

By Artist | By Title

older >>

PALE MALE: A Pilgrimage

May 10th, 2007, 12:55 pm



Artist: [Roz Dimon](#)

Rhizome Terms: [access](#), [Allegory](#), [animation](#), [Animation](#), [audio](#), [commercialization](#), [Conceptual](#), [death](#), [design](#), [DHTML](#), [digital](#), [Flash](#), [HTML](#), [immersion](#), [interact](#), [interface](#), [Internet](#), [memory](#), [MP3](#), [Narrative](#), [net.art](#), [Offline](#), [Participatory](#), [responsibility](#), [space](#), [Text](#), [Virtual](#), [Visual](#)

Artist Terms: [2001-09-11](#), [Coke](#), [digital art](#), [digital painting](#), [DIMONscape](#), [DIMONscapes](#), [Estee Lauder](#), [interactive narrative](#), [Jesus](#), [Jesus Christ](#), [Las Cruces](#), [Las Cruces Museum of Fine Art](#), [New Mexico](#), [New York City](#), [NYC](#), [Pale Male](#), [PaleMale](#), [PaleMale: A Pilgrimage](#)

Rhizome is an online platform for the global new media art community. [Learn more](#).

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email: password:

Forgot your [password?](#)

submit >>

230 online (229 anonymous users)

[Andreas Martin](#)

+ Rhizome Vocabulary

BROWSE THE ARTBASE

- + Browse by Active Terms
- + Browse by Artist
- + Browse by Title
- + Browse by Creation Date **beta**

ACTIVE TERMS over the last month

Abstract Allegory Animation audio
Conceptual design digital
Documentary Event Flash game
Generative Installation interact
Internet memory Narrative net art
network Participatory Performance public
space Readymade social space
video

Figure 30: Rhizome's Archive, screenshot, <http://www.rhizome.org>

How to use the Archive
The archive defaults to represent events in date order with the most recent first. By using the heading buttons you may toggle forwards or backwards between alphabetical listings by title, category (talks, symposia, sound & performance) as well as date.

- [What is in the archive?](#)
- [Copyright information](#)

Web feeds:

[RSS](#) Upcoming online events

[RSS](#) Recently archived online events

[What are web feeds?](#)

- Live
- Archive
- Forums
- Newsletter
- Podcast

[Tate Collection](#)

[Tate Learning](#)

[Tate Research](#)

Archive Index

Date	Category	Title
30 Apr 2007	Talk	Gilbert & George: Artists' Talk
25 Apr 2007	Talk	Contemporary Sculpture and the Social Turn
16 Apr 2007	Talk	Sarah Kent on Gilbert & George
31 Mar 2007	Symposium	Rethinking Spectacle
22 Mar 2007	Symposium	Shifting Practice, Shifting Roles? Artists' Installations and the Museum
17 Mar 2007	Study Day	Identity and Performativity
15 Mar 2007	Talk	Artist Talk: Mark Wallinger
4 Mar 2007	Symposium	Pervasive Animation
21 Feb 2007	Talk	Contested Territories: Ron Arad, Dayan Sudjic and Tom Dixon: On Design
16 Feb 2007	Symposium	Informal Architectures
15 Feb 2007	Talk	Dan Graham: Artist's Talk
9 Dec 2006	Talk	Global Photography Now: West Africa
8 Dec 2006	Talk	Global Photography Now: Asia Pacific
28 Nov 2006	Talk	BP Artist Talk: Keith Tyson
22 Nov 2006	Talk	Turner Prize Artist's Talk: Phil Collins
18 Nov 2006	Talk	Global Photography Now: East Asia
15 Nov 2006	Talk	Turner Prize Artist's Talk: Rebecca Warren
10 Nov 2006	Talk	Global Photography Now: Latin America
7 Nov 2006	Talk	Turner Prize Artist's Talk: Tomma Abts

Figure 31: Tate Online Archive, screenshots, <http://www.tate.org.uk/onlineevents/>

6. Software Curating

Increased curatorial engagement with information technologies since the emergence of the Internet have been discussed in previous chapters. The thesis has introduced formulations informed by an interdisciplinary approach that brings together curating with computer programming and experimental art practices. This approach reflects the recent shift of attention to the cultural significance of software, code and programming, and extends its relevance to curatorial practices. Furthermore, it shifts the emphasis in curating to its underlying operations and protocols (In this sense it is like programming), and consequently, its description as an open system.¹⁷⁸ The system is composed of humans, machines, programmes that run locally and across networks connected together in complex and dynamic interactions.

This final chapter summarises the key issues arising from the discussion thus far and extrapolates upon these to address the central question posed at the start of the thesis – how information technologies have changed the nature of curating and what new models are appropriate to reflect current socio-technical conditions. The thesis concludes in two parts, firstly in chapter 6.1 with a conceptual and technical overview of the *kurator* software. Secondly, chapter 6.2 draws together the theoretical approaches and examples cited to emphasise curating as ‘immaterial’ practice (chapter 2), how it assists in an understanding of open socio-technological systems (chapter 3), and how it is integrated with software (chapters 4 and 5) – taken together as *software curating*.

In combining theory and practice, both elements of the submission demonstrate a ‘curatorial praxis’ – as a set of theoretical principles applied to practice – quite literally, as software curating. As applied research, the software project exemplifies the conceptual approach taken in the thesis, expressing an immanent relation between theory and practice and demonstrating the potential of constructing innovative curatorial forms. Taken together, the concept of software curating and the *kurator* software project developed as part of the research serve to demonstrate how curatorial practices have changed and how they can be productive for a deeper understanding of the politics of curating in/as (an) open system(s).

6.1 *kurator* (readme)

To conclude this thesis, I wish to offer an example of practice to encapsulate the concept of *software curating*. Or rather, I wish to suggest that any definition of such a concept lies in the use and further reinvention of the project, in the social relations it solicits and in demonstrating a sense of collective agency. *kurator* extends previous

experiments in this field and carries the argument beyond description and analysis to the practice of software curating itself. In Vishmidt's words:

'The *kurator* project draws on an affinity between code art and curatorial praxis, to redevelop curating as a generative experiment in social relations. [...] By displacing the curatorial function from abstract subjective potential to binary code, it reproduces the singular curator as a collective executable. In this way it preserves the curator by exceeding the curator, the perfectly consistent paradox that any art practice grounding its critique in both art-immanent and social terms is structurally bound to enact.' (2006: 48)

What follows is an overview (or 'readme') of the conceptual and technical principles underpinning the project.¹⁷⁹

kurator is an online platform for collecting, storing, organising and viewing source code. It consists of an open, collaborative and un-moderated database and a display platform that draws attention to the cultural significance of code. Code collected through an open-submission process is indexed and stored in the project repository, and can be arranged into larger selections for public display. The displays are thematically-organised selections of code from the project repository created by users, or automatically generated by the *kurator* software itself. In parallel to the activity of curating code into displays, users – programmers, curators, artists and the general public – can make modifications to the *kurator* software itself. New versions of the software can be saved in the project repository for public display, commenting and further development.

The project proceeds from a number of precepts. It establishes the idea of source code as artwork and situates it within software art discourse (in contrast to software as a tool or as a display platform). Following from this, it proposes that if source code can be considered artwork it can also be curated into meaningful displays. In this way users can engage in curatorial activity, as well as on another level, create new works by modifying and programming their own versions of the software. The intention is to draw together the operations of software and curatorial practices, broadly understood as activities of collecting and organising materials for display and making meaning. The parallel is encapsulated by the ambiguity over the term 'programming'; referring both to the work of the curator and computer programmer – both programming source materials and codes. The software stresses the activity of programming and the importance of the sharing and modifying of source codes, and thereby the possibilities of rethinking the practice of curating as a collective executable.

The system follows the protocols of the conventional curatorial process, including making selections and arranging works into exhibitions, describing and labelling works, providing contextual information about exhibitions, disseminating and archiving. However, it translates these into software protocols, breaking down the

curatorial process into a series of commands or rules. As a result the system partly automates the curatorial function as well as the sense of agency involved in the execution of rules and the production of meanings. If the curatorial process can be broken down into a series of commands or rules, then the software aims to extend these in an unpredictable, unprescribed, and uncontrolled manner, that accounts for the openness of the system, in addition to the vagaries of the users' input and any modifications they make to the system itself. Furthermore, the project implements an open source model of curating on two levels: firstly, on a technical level as a free software application licensed under GPL (General Public License) to ensure its future development under the same conditions;¹⁸⁰ and secondly, on a conceptual level as an open curatorial system. In this way, the project speculates upon the production of curatorial software, and the practice of curating in general, beyond a singular closed proprietary model to a collaborative open source model for future public development.

The project was developed in two stages and the images (screenshots) and diagrams at the end of this chapter document the process of development from the prototype version 0.1 (developed in 2005) [Fig. 32]¹⁸¹ to the final version 1.0 (released in 2008), [Fig.35]¹⁸². *kurator* (v1.0) builds upon the initial conceptual and technical principles of the prototype and implements a system that extends this both technically and curatorially (Figures 33 and 34 illustrate this process).¹⁸³

The *kurator* site is structured into five areas corresponding to the main menu: Featured Display; Submit Code; Code Repository; Display Repository, and More Information.

The Featured Display is the home page of the *kurator* project and shows curated displays of code by invited curators or those selected from the 'Display Repository' by the KURATOR (team). Using the '+' buttons allows expanding content to find out more information about the display, the curator, public comments on the display, and further details on the code assigned to the display. In this section, users can also view displays previously featured on this page.

At the point of collecting code in the system database, there are two modes running in parallel: a manual upload of source code by users and the automatic 'scraping' of the Internet with the web crawler.¹⁸⁴ A web crawler (also referred to as a 'Web spider' or 'Web robot') is a computer program or automated script that browses ('crawls') the World Wide Web in a methodical, automated manner, without human intervention in order to collect data.¹⁸⁵ In this way, the system assures the continuous supply of source code that is subsequently indexed and stored in an internal code repository. Importantly, the source code of the *kurator* project itself is included in the system database.

In the 'Submit Code' section, users can add code to the project repository and add

contextual information, or activate the automatic collection of code using the web crawler tool. To manually upload code, users can either browse for a file on their computers to upload the entire contents of the file, or copy and paste chosen fragments of code into the textbox provided on the page. At this stage, users also have the option of saving code to display. To complete the process of uploading code to the project database, users should include additional information and tag their code with keywords from the provided list. New keywords can be added to the list by simply entering them in the box provided and then clicking the 'Add' tab. Finally, clicking the 'Upload Code' tab completes the process of manual submission of code to the 'Code Repository'.

In order to save code and displays to the kurator repository users first need to create an account by completing the details and agreeing to the 'Terms of Use'.¹⁸⁶ This assures that submitted code remains open source and allows users easy login to manage their displays and create new ones in the future.

As with collecting, indexing is also programmed to provide information about submitted code manually by the users and automatically by the software. Automatic indexing is implemented through a custom algorithm that searches comments within the source code that programmers use to describe the functionality of a section of code, and then tags keywords within these comments, matching them against other comments already present in the repository. In this way, regardless of language type, code that shares similar processes is indexed, rather than matching syntax within one project or language.

In the 'Code Repository', users can browse, search, tag, comment and assign articles of code to display [Fig. 36]. The 'Source Browser' works on two levels: there is a simple search for a specific word typed into the box provided, and an advanced search by keywords that performs a match on all code that has been tagged.

Displays are larger selections of code created by individual users, invited curators, or generated by the software itself from its own database, and visible to all users of the site. Displays can be saved to the 'Display Repository', providing a growing collection of examples of curated displays, potentially including versions of the modified *kurator* code. Displays created by invited curators or selected from the 'Display Repository' by KURATOR are featured on the project home page in the 'Featured Display' section [Fig. 35].¹⁸⁷ To create a display, users simply select code samples to a temporary display shown on the left. The 'Organise Display' menu option becomes available once the user has assigned the first article of code to the Display. In this section users can organise, provide contextual information about the selection and save it to the 'Display Repository'. The 'Display Repository' includes all displays created by users, invited

curators and those generated by the *kurator* software from its own database. Users can browse, search and tag displays in the repository and comment upon them. Clicking on the 'View Display' tab allows viewing each display in more detail. The 'Browse' option is also available to search all archived displays in this section by keywords. In this section users can also view their own previously created and saved displays.

The *kurator* project is written in php, MySQL, Ajax and html, and has an open API (Application Programming Interface) so that users can write to or adapt the programming interface that directly queries the data store [Fig. 37].¹⁸⁸ The source code of the *kurator* project is included in the system database and users can add functionality, make modifications and save new versions of the software in the 'Code Repository'.

In the period of development of the project (2005–2008), *kurator* has been presented at a number of conferences and events (including Tate Modern and Tate Britain in London, Centro Cultural de Belem in Lisbon, Cont3xt in Vienna, Computer Arts Congress [CAC 2008] in Mexico and the forthcoming ISEA 2008 in Singapore)¹⁸⁹ and led to the publication of a number of papers (details of which are included in the Appendices)¹⁹⁰. Since submission of the thesis (April 2008) a number of curators have been invited to work with the project and create public displays to be featured on the project home page.

6.2 Towards a definition of software curating

The thesis began with the assumption that although there are many examples of social platforms and highly relevant examples of online 'art platforms' dedicated to bringing emerging artistic forms into the public domain, they still largely operate in display mode, replicating more conventional modes of curating and the operations of art institutions in general. The thesis argues that new curatorial sensibilities are required that simultaneously reflect the cultural significance of code (as potential art) and that consider software not as a production tool nor a display platform but as a consequence of a cultural practice that is analogous to curating (as potential curating). As a result, a number of statements are offered to summarise findings of the thesis and towards a definition of software curating. These statements refer to respective issues of value, power, openness and agency.

The stable notion of the curator, the material and immaterial work they do, and the involvement of the public becomes renegotiated through the use of machines and networks. The labour-power of the curator is increasingly immaterial, complex and machinic, and the associated value produced is difficult to place. This is a key issue concerning curators, in particular when they deal with art that is information-based,

collaborative in terms of the production process (not traceable to a single authoring subject) and open-ended like most software art (in terms of its executability). Immateriality displaces the site of value production from the object to process and to system, and places emphasis on symbolic analysis in art production. What has been referred to as a crisis of judgment in the arts is symptomatic of wider processes of transformation, resulting in the desintegration of established models of aesthetic production, wherein curating and artistic activity become largely indistinguishable. The further involvement of information technologies and users is immanent to curatorial practices. Unlike more conventional curatorial models, in which users are situated towards the end of curatorial production, software curating engages with socio-technological networks that increasingly operate outside the usual institutional structures of art, so that users are situated more overtly as co-producers. But the associated value derived from the 'active' involvement of users and the contributing public across affective and communicative networks is ambiguous.

The thesis has placed much emphasis on the ability of integrated systems to elicit social cooperation and to involve multiple subjectivities (rich in cultural and technical knowledge). By drawing upon an understanding of immaterial labour, immaterial curating can be seen to produce a social relation and a redistribution of power. However, this does not mean that power is somehow evenly distributed and that software curating is more democratic. Contrary to many commentaries (particularly those that make reference to 'social networking'), the Autonomists emphasise that this produces even more intense forms of power. This is particularly evident in curatorial projects that involve social networking tools and collaborative systems such as online discussion lists, wikis, blogs, or online social platforms. Software curating implies increased collective forms, in which social cooperation lies at the basis of the organisation of work, and control is expressed in regulating the subjectivity of users who contribute at various stages of the process. The Internet, and software in general, opens up curating as a system to user cooperation and dynamic machinic interactions as a social relation. Software curating highlights this issue as a relatively open system contingent upon the networks of agencies and the divergent socio-technical exchanges that are generated.

Open systems are evocative structures and fundamental to the dynamics and complexity of socio-technological interactions that lie at the centre of software curating. This reflects the architectures of the Internet itself, composed of both vertical and horizontal lines of organisation that are not immune from hierarchical and centralising tendencies associated with curating in general. Considered more in terms of an open process of curating, open systems are the very source of creativity and the locus of transformative potential. However, software curating expresses a critique of unreconstructed open source agendas associated with technology, and highlights the

pseudo-openness of much social software and online social platforms. Rather than regarding online social platforms and free software as transformational, software curating emphasises it as symptomatic of current immaterial conditions of production and as an instantiation of what the Autonomists refer to as the 'social factory' (demonstrating the translocation of the curatorial work process beyond the usual institutional model of the gallery or museum-factory). The model of cultural production associated with industrialism is transformed into one associated with informationalism and the network society. Software curating acknowledges these changed conditions and repositions the curator from that of an administrator to a manipulator. The work of the curator becomes more like a programmer in which information is selected, stored, contextualised and redistributed as part of an open system.

Software curating necessitates an open systems approach and acknowledges the role of the curator as an active part of the operating system. Furthermore, second-order cybernetics helps to establish software curating as an open system of communication that accounts for feedback loops, reflexivity and self-regulatory processes, thus allowing for greater degrees of complexity and unpredictability, and emphasising change (over constancy). The ability to change the system (its transformative potential) is key to software curating. With a lack of fixed structure, the behaviour of the open online curatorial system expresses emergent properties understood in terms of agency. The emergent sense of agency suggests new organisational forms derived from network cultures. The curatorial process involves other agencies and networks in addition to that of the traditional singular curator and is integrated with software as an active part of the curatorial process. This integration implies how an understanding of curatorial agency is extended and reconstituted to account for distributed, collective and partly automated forms of organisation, negotiated through software and open networks. In this integrated system, the curator becomes a function of a wider collective endeavour that is referred to as 'collective executable', operating a kind of deterritorialised power. Importantly, however, agency remains thoroughly political in that it is distributed unevenly and entails widely divergent transactions. Curatorial agency carries the notion of agency in relation to software, as sometimes a tool (referring to the display platform and user functionality) and sometimes as a force (activated by social networks of users and programmers). The software expresses agencies of the programmer, the network, and of the cultures and institutions that surround it. The machines and the networks express the agency of the software as it runs, and the curator symbolically encompasses the collective and dynamic agency of them all together. Agency is reconstituted beyond the collectivity of human subjects to include software as a collective executable, that acts in the world and is able to transform it.

In collapsing distinctions between software as a display platform and software as an integral part of a networked curatorial system, software is demonstrably not simply a tool to curate but demonstrates the activity of curating in itself. The programmer, the program, the machine on which the program runs, and the wider processes and systems are all part of the practice of curating. Rather than regarding curating as an outmoded activity that cannot account for the dynamic actions of multiple agencies that involve distributed networks, software curating points to its inventive and critical power. As a result, a term such as software curating suggests an engagement with instructions (the program) and the writing of these instructions (programming) but also the other processes upon which the program relies to run (which includes the wider context or operating system of art). This is both a literal and metaphorical description of software curating that recognises the conditions within which it operates as praxis. In summary, the argument is that with an open systems approach, the curatorial process is demonstrably a collective and distributed executable that displays machinic agency. This is what is referred to as software curating.

Figures Chapter 6

upload
repository
source browser
plain text search
identifier search
file search
comment search
add your comment
auto 'kurator'
modify kurator
blog
terms and conditions

[kurator/](#)
Projects: [[pd-0.12.19](#) | [pd-0.12.4](#) | [pd-0.38-4](#) | [libeto-0.8](#) | [gopherx-0.4.2pen1](#) | [larsen-0.8b1](#) | [windowlab-1.10](#) | [fimgen-zhena-0.11](#) | [burnstation-1.0beta1](#) | [rtags-5.5.4](#) | [lumetron-0.1.1](#)]

This is the [README](#)>[README](#) file for Pd, a free real-time computer music software

Name	Size	Date (GMT)	Description
bin/		- 2005-02-22 00:57:38	
doc/		- 2003-07-16 21:30:47	
extras/		- 2005-02-22 00:57:40	This is the README > README file for the "extras" library, consisting of Pd
man/		- 2001-03-31 23:19:43	
lib/		- 2005-02-22 00:57:38	
portaudio_v18/		- 2004-09-06 08:02:11	README > README for PortAudio
portmidi_osx/		- 2003-08-01 00:15:25	PortMidi for MacOS X / Darwin
src/		- 2005-02-22 00:57:40	
INSTALL.txt	773 bytes	2002-05-06 02:08:22	
LICENSE.txt	1k bytes	2002-08-01 20:44:36	
README.txt	2k bytes	2003-07-16 21:29:39	

Figure 32: *kurator* version 0.1 (2005), screenshot: index page, <http://www.kurator.org/wiki/main/read/dev>

Kurator System Overview

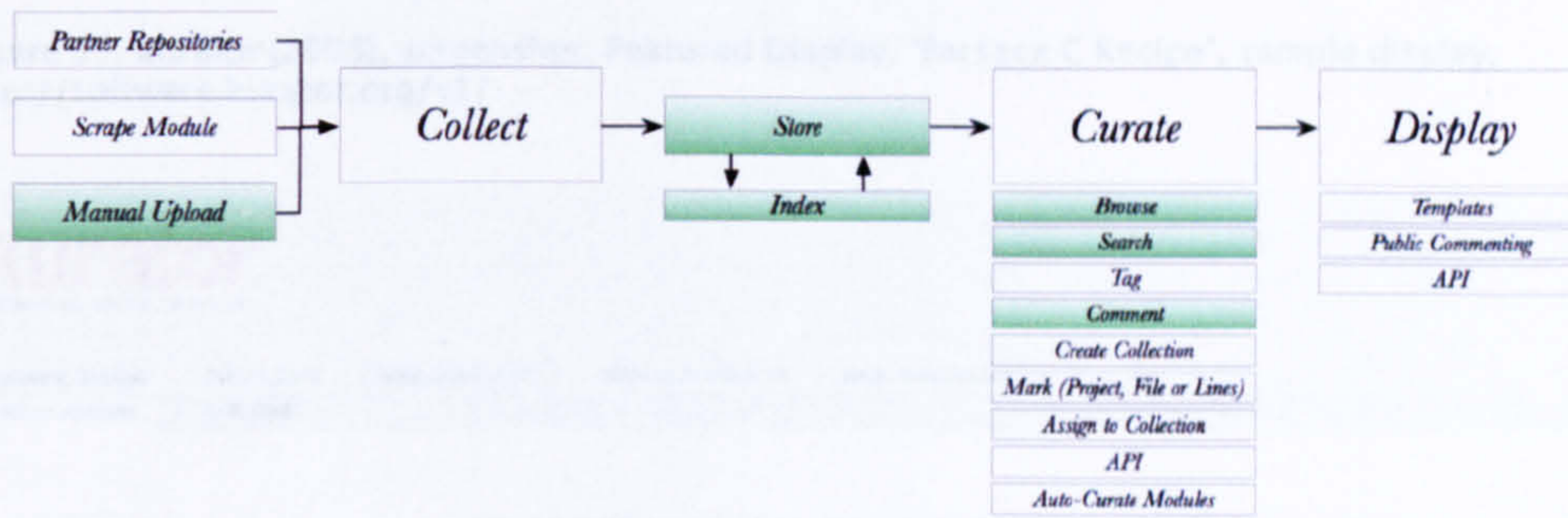


Figure 33: *kurator* development diagram (2006)

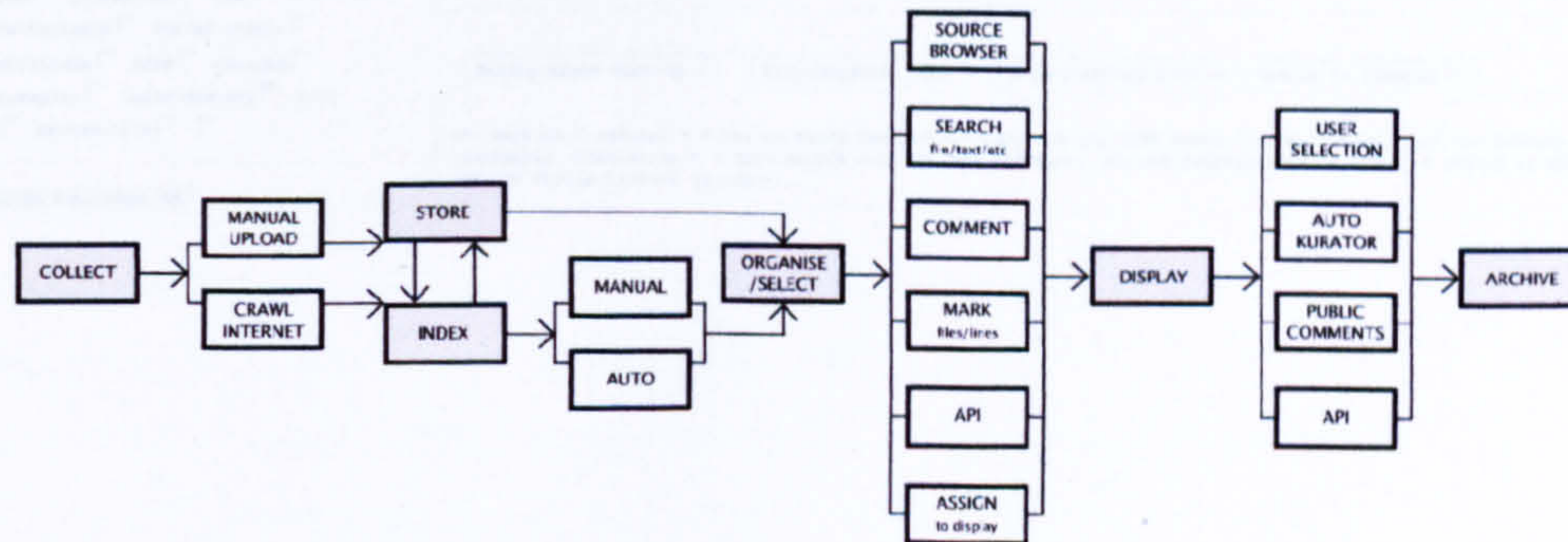


Figure 34: *kurator* version 1.0, development diagram (2007), <http://www.kurator.org/wiki/main/read/Kurator>

Barszcz C recipe

display created by

KURATOR
2008-02-26 20:59:01

Barszcz C recipe draws attention to the parallel between programming and recipes in a cookbook as a set of instructions to follow. Algorithms, much like cooking recipes, provide a (computational) method; a set of defined formal procedures to be performed in order to accomplish a task in a finite number of steps. The excerpt of source code selected for the featured display is from a longer program written by Jaromil (in 2006) that expresses Barszcz soup recipe in the programming language C (string based cooking).

display tagged with

[barszcz](#) [source-code](#) [repository](#)

[View previously featured displays >>](#)

String Based Cooking

[View Complete Code >>](#)

[View Compiled Code >>](#)

```
ingredient = malloc( (quantity+1) * sizeof(*ingredient));

for(c = 0; c < quantity; c++)

    ingredient[%%c%%] = malloc(len * sizeof(ingredient));

ingredient[%%c+1%%] = NULL;

return ingredient;
```

Figure 35: *kurator* (2008), screenshot: Featured Display, 'Barszcz C Recipe', sample display, <http://software.kurator.org/v1/>

[Browse >>](#)

[Advanced Browse >>](#)

[c](#) [poland](#) [net-art](#) [kurator](#)
[barszcz](#) [source-code](#)
[repository](#) [portugal](#) [html](#)
[php](#) [javascript](#) [the](#)
[Netherlands](#) [server-client](#)
[multitude](#) [rfid](#) [england](#)
[gameplay](#) [ludic-society](#) [rfid](#)
[second-life](#)

[About this page >>](#)

Tagged City Play

[View Complete Code >>](#)

[View Compiled Code >>](#)

[Assign to Display >>](#)

```
/****** functions *****/ function create($title, $author, $url, $description, $sourcecode){ $this->set_title($title);  
$this->set_author($author); $this->set_url($url); $this->set_description($description); $this->set_code($sourcecode); }  
functi...
```

www_back

[View Complete Code >>](#)

[View Compiled Code >>](#)

[Assign to Display >>](#)

String Based Cooking

[View Complete Code >>](#)

[View Compiled Code >>](#)

[Assign to Display >>](#)

```
/** Barszcz C receipt * * string based cooking * * Copyleft (C) 2006 Denis "Jaromil" Rojo * for the barszcz project  
(currently unfinished) * * This source code is free software; you can redistribute it and/or * modify it under the terms of  
the GNU Public License as publi...
```

Figure 36: *kurator* version 1.0 (2008), screenshot: code repository, <http://www.software.kurator.org/v1/search.php>

kurator

software for curating source code

[Featured Display](#) [Submit Code](#) [Code Repository](#) [Display Repository](#) [More Information](#)
[About kurator](#) [License](#) [Modify kurator](#)

Modify kurator

Written in PHP5, MySQL and Javascript (prototype and scriptalicious), kurator software has been designed and coded to be completely open-source, and as a result, all of the code used in its development can be downloaded and modified.

Kurator welcome the continued development of the software and you are invited to make use of the API, or completely re-write entire modules and re-submit them to us via email. Alternatively perhaps you would prefer the site to have a different display? In which case create your own CSS skin and we will add it to the software for others to view.

[Download kurator software >>](#)

API

Class Code - Handles all functions relating to saving new articles of code, and retrieving existing code from the database

[Download class file and API >>](#)

Class Comment - Handles all functions relating to assigning and retrieving display and code comments

[Download class file and API >>](#)

Class Database Controller - Handles all MySQL queries for class files

Class Display - Handles all functions relating to creating new displays, assigning code to a display and retrieving a display from the repository

[Download class file and API >>](#)

Figure 37: *kurator* (2008), screenshot: modify kurator, <http://www.software.kurator.org/v1/modify.php>

7. References

7.1 Figures and Illustrations

Figure 1: *biennale.py* virus code (2001), <http://digitalcraft.org/>

Figure 2: 'I love you' virus (2002), <http://www.digitalcraft.org/>

Figure 3: *CODEDOC* (2002), <http://artport.whitney.org/exhibitions/past-exhibitions.shtml/>

Figure 4: *CODEDOC II* (2003),

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7.4 End Notes

¹ In such a model there is no centralised switch, as each node is connected to several of its neighbouring nodes and thus each node has several possible routes to send data. In order to maximise the efficiency of such a system, information is divided into small packets (message blocks) and sent across the network, with unmanned nodes acting as switches, routing packets from one node to another and on to their final destinations. This process is based on the principle of the 'hot potato routing method' (a rapid store-and-forward method currently better known as dynamic routing) and in effect allows a real-time transmission. Consequently, the ARPA Computer Network was funded in 1968 and the first e-mail between two machines / two nodes (UCLA and SRI International in California) was sent in 1969. This developed into what was officially referred to as the Internet (to describe a single global TCP/IP network) and eventually fully implemented dominant TCP/IP protocol following the switch of all hosts on the ARPANET network to the TCP/IP wide area network and in 1988 the network was opened to commercial interests. For more information see (<http://www.ibiblio.org/pioneers/baran.html>), and Barabási (2002: 143-147). See Paul Baran's model of a Centralised, Decentralised and Distributed Network, 1964 (Tate Modern, courtesy RAND; <http://www.tate.org.uk/onlineevents/archive/CuratingImmaterialitySystems/>)

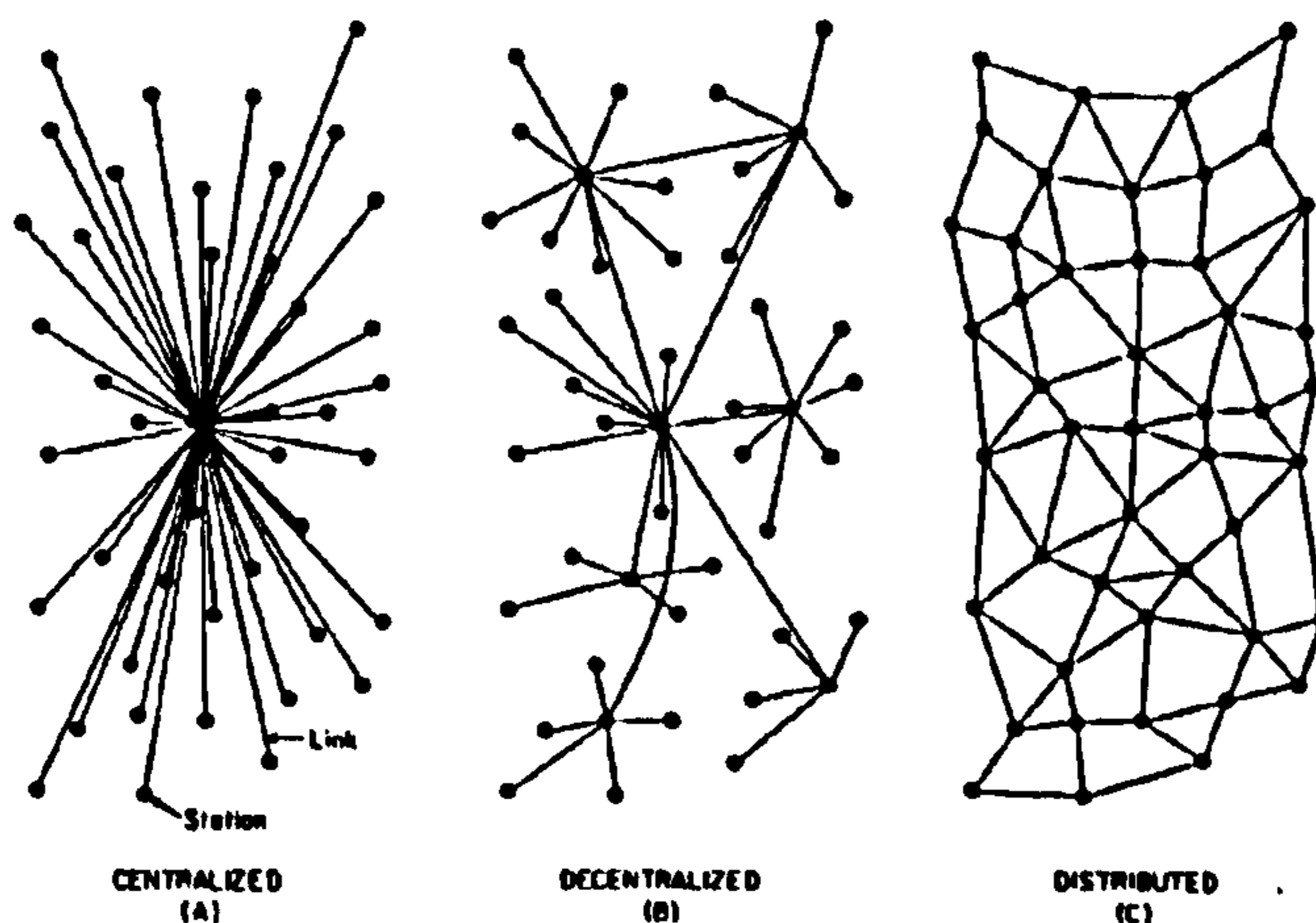


FIG. 1 - Centralized, Decentralized and Distributed Networks

² By the 1990s the Internet was opened to public use, following the release of the World Wide Web project by CERN in 1991 based on the earlier work of Tim Berners-Lee that resulted in creating HTML, HTTP and the first few Web pages at CERN European Nuclear Research Center in 1989 (<http://www.w3.org/People/Berners-Lee/>).

³ While early debates on information technologies were dominated by the Gibsonian discourse of cyberspace where 'users would lose consciousness of the real world and lose themselves in a universe of abstract forms and disembodied perspectives', the more contemporary debate (according to Tiziana Terranova) has shifted to the terrain of globalisation and to the 'common space of information flows in which the political and cultural stakes of globalisation are played out' (2004: 42). At the risk of generalisation, if the dominant cultural form was once the environment of virtual reality characterised by full immersion, interactivity and the fascination with 'cyberdevices' such as data gloves, goggles, embedded microchips and electrodes, the more current cultural expressions can be conceived in the communication formats of mail lists, online blogs, wikis, participatory and collaborative art platforms, underpinned by so-called social technologies. This runs in parallel to other attempts to describe cultural transformation in this context in more general terms outside of particular art forms or art genres. For instance, Roy Ascott (2003, 2003b) talks of a current cultural transition in terms of 'connectivity, immersion, interaction, transformation, and emergence' (2003: 267) and argues that artistic 'interest in cybernetic, bio-electronics, wireless and optical networks, intelligent software, virtual reality, neural networks, genetics engineering, nanotechnology, robotics, is not only relevant to the production and distribution of our [artist] work but equally to definitions of art, to the aesthetic of apparition, the canon of interactivity, connectivity and transformation' (2003b: 10). He further argues that what he terms as 'the new aesthetic of apparition, of emergence and coming-into-being replaces the older one of appearance', and is actualized in the 'transformative and evolutive systems of technoculture'. (Ascott 2003b: 10; 2003: 276-283) Although these debates are clearly relevant and map a wider field within which the thesis is situated, it does not engage directly with these debates and the wider field of practice that involves information technologies - variably termed as computer art, electronic art, new media or

more currently digital art. Instead the focus is more specifically on a narrower field that brings together curating with software art practice.

⁴ Source code (usually referred to as simply 'source' or 'code') is the un-compiled, non-executable code of a computer program stored in source files. When compiled, the source code is converted into machine executable code (binary) – a series of simple processor commands that operate on bits and bytes. A more extensive conceptual and technical definition of source code is provided in chapter 4.2.

⁵ A brief definition in *Oxford Reference Online*, defines software as commonly referring 'to the programs executed by computer system as distinct from the physical hardware of that computer system, and to encompass both symbolic and executable forms for such programs' (<http://www.oxfordreference.com/>).

⁶ The issue of merging or collapsing firm distinctions between artistic and curatorial practice has been previously articulated, for instance by Simon Biggs who argues that this is often the case with emergent areas of practice including new media curating (posting to New-Media-Curating List, 2 November 2007, <http://www.crumbweb.org/>) Similarly, this refers to the field of artistic practice and programming and the term 'artist-programmer' has been often used to express this point.

⁷ Similarly, this is an issue for Biggs (2007) who argues that in networks 'the platform of production and distribution are the same. In some ways this platform, the Internet, can be seen as a self-organising system. Not in the sense that the hardware or software organises but in the sense that the network can be regarded as a human ecology of interacting behaviours that ascribe value. This may or may not be more or less publicly visible. When it is visible then emergent value becomes important. The question therefore is a political one, asking how power operates in this "system" (posting to New-Media-Curating List, 2 November 2007, <http://www.crumbweb.org/>).

⁸ *kurator* is a collaborative project developed by Joasia Krysa (conceptual and curatorial development, project management and production), Grzesiek Sedek (programming and conceptual development version 0.1) and Duncan Shingleton (programming and conceptual development version beta 1.0) between 2005–2008. Further contributions are from Geoff Cox, Hugo de Rijke, George Grinstead, Adrian Ward and Giles Macleay (site design). The project is funded by Arts Council England (UK), produced and managed by KURATOR for the purpose of fostering software development and content creation under Open-Source Initiative ('OSI') – approved licenses. The project is subject to the GNU General Public License (<http://www.gnu.org>) and specific terms of use are available online (<http://www.kurator.org/wiki/main/read/terms+of+use>). The software was developed in two stages: first as v0.1 programmed by Grzesiek Sedek in 2005 (currently archived at <http://www.kurator.org/wiki/main/read/Kurator>), and subsequently as v1.0 programmed by Duncan Shingleton (2008). For this project I developed an initial conceptual idea, secured funding, organised production including selection of production team and technical resources (such as a dedicated server), produced publicity, solicited guest curators' contributions, and finally managed the overall production, presentation and publicity. Public presentations of the project at various stages of its development include: first launched (v 0.1) in conjunction with *Curating, Immateriality, Systems* events that I organised at Tate Modern in London (4 June 2005) (<http://www.tate.org.uk/onlineevents/archive/CuratingImmaterialitySystems/>); and included as part of *Code Of practice* season at Tate Modern (4 June – 31 September 2005) (http://www.tate.org.uk/onlineevents/archive/code_of_practice/) and (<http://www.tate.org.uk/forums/category.jspa?categoryID=13>). Subsequent presentations include: Centro de Artes Digitais Atmosferas, Lisbon 2005 (in conjunction with the launch of *Online Portuguese Net Art 1997 – 2004* curated by Luis Silva) (http://www.atmosferas.net/netart/conferencia_en.htm); Tate Britain's 'Open Congress' event (part of NODE.London Season of Media Arts) event, London 2006 (<http://opencongress.omweb.org/modules/wakka/HomePage>); Piet Zwart Institute as part of 'Software Studies' (Rotterdam, February 2006) (<http://pzwart.wdka.hro.nl/mdr/Seminars2/softstudworkshop>); and CONT3XT.NET, as part of 'Circulating Contexts' series of events (online discussion, conference and publication) (Vienna, June – October 2007) (<http://curating.cont3xt.net>). Links, references and reviews: KURATOR (<http://www.kurator.org/wiki/main/read/Kurator>); *Curating, Immateriality, Systems* (<http://www.tate.org.uk/onlineevents/archive/CuratingImmaterialitySystems/>); 'Code Of practice' panel discussion (Tate Online, 2005) (http://www.tate.org.uk/onlineevents/archive/code_of_practice/) and (<http://www.tate.org.uk/forums/category.jspa?categoryID=13>); CONT3XT.NET (<http://curating.cont3xt.net/>); Rhizome ('Kurating by Numbers', Marina Vishmidt, 2005)

(<http://www.rhizome.org/netartnews/story.rhiz?×tamp=20050610>); 'Twilight of the Widgets' (Marina Vishmidt, 2006, pp. 39-63). Related publications include: Sedek G., (2006); Krysa J., Sedek G., (2006) (<http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=11476>); Krysa J., Shingleton D., (2007) (<http://curating.cont3xt.net>).

⁹ Research towards production of the thesis led to the publication of a number of papers and projects during the registration period between 2002-2008 as follows: 1. *Curating, Immateriality, Systems* (CIS) conference, Tate Modern, London (June 2005) where many of the ideas explored in the thesis were first presented and discussed. Video documentation of the event is available from Tate Online (<http://www.tate.org.uk/onlineevents/archive/CuratingImmaterialitySystems/>) and on a DVD included with this submission; 2. 'Distributed Curating and Immateriality', chapter in *Curating New Media* book edited by Christiane Paul, forthcoming in 2008 from the University of California Press (Berkeley and Los Angeles), which situates curating in relation to critical ideas around immateriality and software art practice; 3. *Curating Immateriality: The Work of the Curator In the Age of Network Systems* (CI) edited book and an introductory chapter under the same title, published as a result of the CIS conference and extended to further examine the politics of curating in the context of the Internet and software; 4. 'Source Code', co-authored chapter (with Grzesiek Sedek) in *Software Studies* book edited by Matthew Fuller (2008); 5. 'Curating the "operating system" of art: online platforms and curatorial software systems', chapter in *WRO Reader* edited by Violetta Kultubasis-Krajewska (2008); 6. 'Kurator Software: version beta 1.0', co-authored chapter (with Duncan Shingleton) in *circulating contexts -- Curating/Media/Net/Art* publication (2007) edited by CCONT3XT.NET (Vienna). These essays are included in the Appendices and projects documented on a DVD.

¹⁰ The complex understanding of the relation between theory and practice is encapsulated in the term praxis. Critical theory offers a useful definition of the term in the context of the thesis, notably as 'appropriate understandings of past conditions from which to gain insights into future possibilities for change' (Miles 2001). In relation to critical practice, Miles further emphasises, after Fischer, that 'it is not a question of theory or practice but always both', and quotes: 'Philosophy without practice dissolves very easily into air or smoke or congeals into a dogmatic profession of faith; practice without philosophy turns into myopic, mindless practicalism' (Fischer 1973: 157 in Miles 2001).

¹¹ Subsequently, the research aims to contribute towards the more general theory of curating. To paraphrase Victor Burgin: 'I say "towards" rather than "to" as the theory does not yet exist, it has not been yet fully developed although some of its components may already be identified' (1982 1-2). Furthermore, the expression 'curatorial theory' may need an explanation. What I am proposing as the *subject* of theory is not restricted to curating considered as a set of techniques and historically considered as part of other disciplines (quasi curatorial theory) although certainly technique is to be accounted for within the theory; it is rather curating considered as a practice of signification and an autonomous discipline per se. By practice here is meant work on specific materials, within a specific social and historical context, and for specific purposes. The emphasis on signification derives from the fact that the primary purpose of curating is its contribution to the production and dissemination of meaning. However, although semiotics is necessary to the proposed theory, it is by no means sufficient to account for complex articulation and contexts of curating. Therefore any curatorial theory must take into account the inter-disciplinary context. However it is by no means a matter of simply juxtaposing existing disciplines but developing new connections.

¹² Here, I am paraphrasing Marina Vishmidt's description of the *kurator* project: 'displacing the curatorial function from abstract subjective potential to binary code, it reproduces the singular curator as a collective executable' (2006: 48).

¹³ Huhtamo, in his paper 'Virtual Museums of Photography - Problems and Promises' (2003), notes that the idea of 'museum without walls' gained renewed currency in relation to online environment, and in particular in relation to the concept of 'virtual museum' (see example <http://www.photographymuseum.com/>). Huhtamo explains: 'Malraux applies this term to describe changes brought about by image reproduction technologies since the early 19th century, photography in particular and the impact it had on ontological status of works of art, public access and changes to the art world more generally. Probably for the first time, works are described as becoming 'moments' (time-related and process-based character) rather than 'objects'; notes a new understanding of art due to the widespread use of art reproductions and relocation of the art experience into private sphere by means of the art book; 'domestication' and 'universalisation' of art.'

¹⁴ For further reference see Greenberg, Ferguson, Naire (1996: 159-174), or (<http://www.medienkunstnetz.de/exhibitions/lesimmateriaux/>).

¹⁵ See note 1 and 2.

¹⁶ *Software, Information Technology: its new meaning for art*, exhibition curated by Jack Burnham at the Jewish Museum in New York (1970). The exhibition included an eclectic combination of art and non-art from technological applications and experiments (computing and electronic research applications such as *Vision Substitute System* by the Smith-Kettlewell Institute of Visual Sciences and *Interactive Paper Systems* by Sonia Sheridan) through to conceptual art works (such as *Cremation Piece* by John Baldessari, composed entirely of instructions *Variable Pieces* and *Location Pieces* by Douglas Huebler, *Selected Mental Characteristics of Donald Burgy and Question-Answer* by Donald Burgy, *An Accumulation of Information Takes from Here to There* by Lawrence Weiner, happening *Work* by Alan Kaprow, *Room Situation* by Vito Acconci, the refusal to participate in the exhibition by Nam Jun Paik reproduced in the catalogue, *The Seventh Investigation (Art as Idea as Idea) Proposition One* by Joseph Kosuth. More overtly dealing with technology and art were such works as *Solar Audio Window Transmisslon* by Theodosius Victoria, *Floor Show* by Scott Bradner and Jack Nolan, *Composer* by Allen Razdow and Paul Conly, *Ultrasonic Wave Piece* by Robert Barry, *Boolean Image/Conceptual Writer* by Carl Fernbach Florsheim, *Labyrinth* by Ted Nelson, *Seek* by Nicholas Negroponte and the MIT Architecture Machine Group, and *Visitor's Profile and News* by Hans Haacke. For further references see (Gere 2005: 156-160), (Burnham 1970) and Eddie Shanken's 'The House That Jack Built: Jack Burnham's Concept of "Software" as a Metaphor for Art', chapter published by Leonardo Electronic Almanac 6:10 (November, 1998) (<http://mitpress.mit.edu/ejournals/LEA/ARTICLES/jack.html>), full version also available online (<http://www.artexetra.com/House.html>).

¹⁷ Although it was not the first computer art exhibition as such (earlier exhibitions and projects were held in US and Germany) it was seminal in the history of computing and art. The particular significance of the project was in that rather than focusing on computer generated work it took a wider focus and for the first time drew attention to cybernetics, then a new field of scientific inquiry concerned with - in Norbert Wiener's description - 'the entire field of control and communication theory, whether in the machine or in the animal' ([1948] 2000: 11). Furthermore the exhibition explored cybernetics in relation to creativity. It was organised in three distinctive sections: 'computer generated work, cybernetic devices-robots and painting machines, and machines demonstrating use of computers / history of cybernetics' (MacGregor 2002). The exhibition was accompanied by the Press Release (currently in Tate Archive, VA Pub 179) and an independent publication coinciding with the show - a special issue of *Studio International* entitled 'Cybernetic Serendipity' (1968) edited by the exhibition curator Jasla Reichardt. For further references see MacGregor 2002, Reichardt 1968, Gosling 1968, Brown 1998 (<http://www.mediaartnet.org/exhibitions/serendipity>).

¹⁸ *Art and Technology* programme, Los Angeles County Museum of Art (LACMA), 1967- 1971, curated by Maurice Tuchman and Jane Livingstone. This was one of the pioneering projects set up to promote an exchange between artists and the corporate world. Artists selected for the programme were placed with companies. As a result, some of the works produced in conjunction with the programme were presented at two major events in 1970 - Osaka World Exposition and the Los Angeles County Museum of Art. Livingstone, in 'Thoughts on Art and Technology', discusses the rationale behind the project: 'Unlike the utopian efforts to fuse art and technology during the avant garde era (Russian Constructivism, Italian Futurism, Bauhaus), the *Art and Technology* programme by LACMA had a distinctively different goal - to bridge an increasing gap between technophile and technophobe perspectives partly resulting from the perception that the appropriation of the technology by big business contributed to the alienation of the masses. A&T set out to offer growing interest in systemic theories (theories inspired by behaviourism and cybernetics) as a middle ground and to offer artists involved in system aesthetic movement ways of exploring how their work might fit into the larger social, political and scientific context.' (<http://www.fondation-langlois.org/html/e/page.php?NumPage=706>). See also: Maurice Tuchman 'A report on the art and technology program of the Los Angeles County Museum of Art, 1967- 1971' (New York: Viking, 1971: 387), a collection of documents related to the programme, later used as a catalogue for the exhibition in Osaka (<http://www.fondation-langlois.org/html/e/page.php?NumPage=706>).

¹⁹ *Experiments in Art and Technology* (E.A.T.) was set up in 1966 by engineers Billy Klüver and Fred Waldhauer, with artists Robert Rauschenberg and Robert Whitman to facilitate collaborations between artists and engineers with support from the industry. The project developed from the experience of production of *9 Evenings: Theatre and Engineering* (October 1966, held at the 69th Regiment Armory, New York) that brought together 40 engineers and 10

artists working together on performances that involved new technology. Billy Klüver, in his essay on Experiments in Art and Technology comments on the context from which E.A.T. emerged in the following way: 'In the seventies, emerging hardware technologies used in communications, data processing, and control and command instrumentation led to a new generation of software systems that were of great interest to artists. Realizing that artists could contribute significantly to the evolution of this software, E.A.T. generated a series of projects in which artists participated in these areas of technological development. E.A.T. undertook interdisciplinary projects that extended the artists' activities into new areas of society.' (<http://www.fondation-langlois.org/html/e/page.php?NumPage=306>). E.A.T. ran a Technical Services Program to provide artists with access to new technology by (in much the same way as the *Art and Technology* programme at LACMA) pairing artists with engineers or scientists to collaborate on specific artistic projects and to explore the potential of an interdisciplinary approach. Other interdisciplinary projects initiated by E.A.T. and involving artists and new technology included *Some More Beginning* (1968, Brooklyn Museum, NY), the first international exhibition of art and technology to present a large number of innovative technical, electronic and other media projects, and artist-engineer collaborations to design and program the Pepsi Pavilion at Expo 70 in Osaka (Japan). Some of the installations from the *Some More Beginning* exhibition were included in the parallel show *The Machine as Seen at the End of the Mechanical Age* (curated by Pontus Hultén) at The Museum of Modern Art, New York (1970). Furthermore: 'It also encouraged research into new means of expression at the crossroads of art and such emerging technologies as computer-generated images and sounds, video, synthetic materials and robotics. To complement these projects combining the talents of artists and engineers, E.A.T. organized educational activities to acquaint the public with telecommunication technologies like telewriting and satellite transmission. Other projects emulating international aid programs were devised to give developing countries access to community media. As of the mid-1970s, E.A.T. began opening chapters in the United States, Canada and Japan.' (<http://www.fondation-langlois.org/html/e/page.php?NumPage=237>)

²⁰ In Gere (2005: 160–161). Other important references on art and technology from that time listed by Gere include: Gene Youngblood's *Expanded Cinema* (1970), a futuristic vision of art and technology combining systems theory and cybernetics with film and video; Jonathan Benthall's *Science and Technology in Art Today* (1972); a volume of *Artforum* (1973) with text by John McHale and Alvin Tofler; Douglas Davis' *Art and the Future* (1973). In addition to artists included in Burnham's *Software* exhibition, Gere lists other particularly influential artists at that time such as Roy Ascott, Stelarc and Robert Adrian who all were explicitly using technology. Further references include: Kynaston McShine (1970) *Information*, New York: MOMA; Simon Penny (1999) 'Systems Aesthetic + Cyborg Art: The Legacy of Jack Burnham.' In *Sculpture*, January/February, vol. 18 no1; Edward Shanken (1999) 'The House That Jack Built: Jack Burnham's Concept of "Software" as a Metaphor for Art', in Roy Ascott (ed.), *Reframing Consciousness: Art and Consciousness in Post-Biological Era*, Exeter: Intellect; Edward Shanken (2002) 'Art in the Information Age: Technology and Conceptual Art', in *Leonardo*, vol 35, no 4, pp. 433–438.

²¹ The exhibition *bit international. [Nove] Tendencije in Computer and Visual Research [Zagreb 1961–1973]*, curated by Darko Fritz (28 April – 26 August 2007), Museum of Contemporary Art in Zagreb and Neue Galerie in Graz, Austria. The exhibition presented 106 artists and artists groups and over 350 artworks, computer programs and documents, and over 30 hours of digitally restored audio archives of the four symposia held originally between 1968–1973 in Zagreb (<http://www.neuegalerie.at/07/bit/cover.html>).

²² *Refresh!* First International Conference on the Histories of Media Art, Science and Technology (2005), Banff New Media Institute, Canada and *Re:place* (2007), The Second International Conference on the Histories of Media, Art, Science and Technology, Haus der Kulturen der Welt, Berlin (<http://www.mediaarthistory.org/>).

²³ *MediaArHistories* is an online archive and a book edited by Oliver Grau (MIT Press, 2007). The project website explains that the objective is to provide 'a world wide access – create a place for classic texts, cross-pollinated, cutting-edge scholarship – items submitted and regulated by authors – rich metadata'. The introduction to the book is available online and explains: 'Digital art has become a major contemporary art form, but it has yet to achieve acceptance from mainstream cultural institutions; it is rarely collected, and seldom included in the study of art history or other academic disciplines. In *MediaArHistories*, leading scholars seek to change this. They take a wider view of media art, placing it against the backdrop of art history. Their essays demonstrate that today's media art cannot be understood by technological details alone; it cannot be understood without its history, and it must be understood in proximity to other disciplines – film, cultural and media studies, computer science, philosophy, and sciences dealing with images.' (<http://www.mediaarthistory.org/>).

²⁴ The exhibition announcement on the Rhizome website states: 'Museum has made a major commitment to *the* study of new media with this series that has already spanned three years. *New Media: Who* opened in 2004 and included 'heavy-hitters' ranging from Nam June Paik to net art pioneers Mendi and Keith Obadike. *New Media: What* took on the precarious challenge of defining what constitutes new media, while ultimately displaying the diverse nature of media-based practices in effect today--including digital animation, machine vision, sound art, and web-based work. *New Media: Where* focused on the theme of displacement and what the organizers saw as 'our sensory and social projection into the abstract digital world.' The current episode of the series, *New Media: When* is on view through June 10 and includes work by Char Davies, LoVid [...] Marshall Reese and Nora Ligorano, and Brooke Singer.' (from posting to Rhizome's Art News, 9 April 2007, 'Just the Facts about New Media' by Elisabeth Johnston, <http://www.rhizome.org>).

²⁵ *Open Systems. Rethinking Art c. 1970* (2005), Tate Modern, London (<http://www.tate.org.uk/modern/exhibitions/opensystems/default.shtm>), (<http://www.tate.org.uk/onlineevents/archive/OpenSystems/>). However, commenting on this exhibition in an interview for Rhizome (20 June 2007) Gere points out that: 'the show was exemplary in writing out the entire part of art history from 70-80s concerning art works that dealt with systems (technological, and in particular cybernetic systems)' and that: '[the show] seemed to suggest that the art being made in that period was mainly minimalist and conceptual, while leaving out exactly the works most directly and explicitly concerned with systems (which had a particular and specific meaning at the time in relation to technological discourses such as cybernetics).' In contrast, the more recent exhibition *Feedback* (curated by Charlie Gere, Christiane Paul and Jemima Rellie at the LABORal, Gijon, 2007) set out to emphasise 'the importance of technology for artists in the period, which, in turn, looks increasingly relevant to our current circumstances' (Gere, in Cornell, Rhizome, 20 June 2007, <http://rhizome.org/thread.rhiz?thread=26268&text=48766#48766>).

²⁶ A posting on the CRUMB list (12 April 2007) states: '[PUBLIC] _curating is an ongoing research-project by the Vienna-based organisation CONT3XT.NET collecting methods, resources, and theories concerning the changing conditions of curatorial practices on the Web. The blog is an experimental database of international curating projects, theoretical approaches and a resource for curatorial platforms, art-databases and contemporary ways of New Media Curating. With the changing of the production and reception of art on the Internet, not only the art itself changed but also the possibilities of curation and thus required new forms of investigation and communication too. During the past decade the concept of what was called "Curating (on) the Web" already in 1998, has changed into a multifaceted and interrelative communication-process between artists, theorists, writers and "normal" Internet-users - nowadays curators are described as "cultural context providers", "meta-artists", "power users", "filter feeders", or simply as "proactive consumers".' See (<http://www.crumbweb.org/>), research-blog (<http://publiccurating.cont3xt.net>), link-collection (<http://del.icio.us/publiccurating>).

²⁷ In the interview for Rhizome (Cornell, 20 June 2007) Jemima Rellie explains the rationale behind the show: [it aims to] 'demonstrate that new media art has a much longer history than is, at times, assumed. New media art did not emerge out of nowhere at the turn of the century, but rather its roots can be traced back to works created decades earlier, for instance Laszlo Moholy-Nagy's *Light-Space Modulator* (1930). In the exhibition we were keen to show that the earlier artists, such as Moholy-Nagy, were often interested in the same issues and opportunities for art that new media artists engage with today, in order to dispel the false notion that new media art somehow sits outside of modern art history'. The term 'feedback' was employed to indicate the connection between new media and art history as 'the term is not only descriptive of much new media art practice but also indicates how new media art is distinct from traditional painting, sculpture, and even photography, film, and video work.' Christiane Paul (in the same interview) comments further on the theme of the show: '*FEEDBACK* focuses on two major themes relating to 'responsive' art. One theme traces the concept of feedback from 'algorithmic' art based on instructions (from natural language, e.g. Sol LeWitt, to code, e.g. Casey Reas) to art that sets up open systems (reacting to outside inputs or its own) and global connections. The second theme explores the concept of light and the moving image from early kinetic and Op Art to responsive notions of television and cinema. The term 'feedback' goes beyond responsiveness, per se, since it means that the system is in turn changed by the output or response it produces. The works in the exhibition range from self-sustaining objects that rely on a closed system of feedback, to systems with varying degrees of openness that receive input from instructions, the viewer, their environment, or information networks'. References: exhibition website (http://www.LABoralcentrodearte.org/feedback/concept_001_ini.html), Rhizome interview (<http://rhizome.org/thread.rhiz?thread=26268&text=48766#48766>).

²⁸ The Curatorial Education Network is an online curatorial database of Interviews, discussions, links and a list of curatorial programmes: Curating Contemporary Art (MPhil/PhD), Royal College of Art (London, UK); PhD Curatorial/Knowledge, MPhil & PhD Curating, MFA in Curating, Goldsmiths College, University of London (London, UK); Critical Curatorial Cybermedia, School of Fine Arts (Geneva, Switzerland); Studia Kuratorskie, Uniwersytet Jagielloński Instytut Historii Sztuki (Krakow, Poland); Curating Contemporary Art, University of Art and Design (HGKZ) (Zürich Switzerland); Critical Writing and Curatorial Practice / Curatorlab, Konstfack (Stockholm, Sweden); Curatorial Practice Program, California College of the Arts (San Francisco, USA); Center for Curatorial Studies and Art in Contemporary Culture (Bard College, USA); Curatorial Program, Independent Study Program / Curatorial Studies, The Whitney Museum of American Art and MoMA, Columbia University (New York, USA); Critical and Curatorial Studies, University of British Columbia (Vancouver, Canada); International Curating Management Education, Stockholm University (Stockholm, Sweden); Curating New Media Art, Liverpool School of Art and Design (Liverpool, UK); World Of Art. School of Contemporary Art, SCCA, Center for Contemporary Arts (Ljubljana, Slovenia); Curatorial Programme, De Appel (Amsterdam, The Netherlands); Ecole du Magasin, International Curatorial Training Program (Grenoble, France); Curaton Course A&B, Arts Initiative (Tokyo, Japan). In addition to this list on CEN, there is a number of curatorial programmes that can be added: Independent Curators International ICI (New York); Apexart Curatorial and Residency Program (New York); Banff International Curatorial Institute, The Banff Centre (Canada); International Studio & Curatorial Program (ISCP) (New York); Institut für Kulturmanagement und Kulturwissenschaft (IKM) (Austria); Studio Programme and Project Platform for Artistic and Curatorial Platform, Künstlerhaus Bethanien (Germany); Kuratorenwerkstatt Fridericianum, Kunsthalle Fridericianum (Kassel).

²⁹ Although the *Documenta* programme (Kassel, Germany) has become established as one of the largest international contemporary art events today, the original intention to provide an independent and experimental format for curatorial practice, that motivated the first edition curated in 1955 by Arnold Bode and Werner Haftmann, is still present to various degrees in more recent editions. This 'tradition of [curatorial] innovation' was particularly pronounced in *Documenta 11* (2002) curated by Okwui Enwezor. He proposed to extend the traditional '100 days' format of previous *Documenta* exhibitions in terms of curatorial process, understanding of presentation venues and time scale. With this in mind he included 'a constellation of five platforms, realized on four continents over the span of eighteen months between March 2001 and September 2002. (...) The first four platforms were devised as committed, discursive, public interventions, and enacted within distinct communities around themes conceived to probe the contemporary problematics and possibilities of art, politics, and society. Creating a network of partners, collaborators, and interlocutors, many institutions and foundations were instrumental in realizing, together with *Documenta 11*, the platforms.' (<http://www.the-artists.org/tours/documenta11.cfm>). Also see (<http://www.the-artists.org/tours/documenta-archive.cfm>).

³⁰ The term 'New Media' is clearly a problematic one and subject to various debates that lie outside the scope of this thesis. Paul explains one understanding as an umbrella term 'that at the end of the twentieth century was used mostly for film and video as well as sound art and other hybrid forms. The qualifier of choice here - 'new' - points to the fleeting nature of the terminology.' (2003: 7)

³¹ CRUMB (Curatorial Resource for Upstart Media Bliss), since 1999 (<http://crumbweb.org>), archive site (<http://www.newmedia.sunderland.ac.uk/crumb/phase3/index.html>).

³² CONT3XT.NET is a collaborative curatorial platform set up in 2006 by a Vienna-based collective - Sabine Hochrieser, Carlos Katastrosky and Franz Thalmair (<http://cont3xt.net/>).

³³ See my chapter 'Distributed Curating and Immateriality', forthcoming in Paul (2008). Also see Appendices.

³⁴ The issue of how cybernetics impacted upon cultural production has been reworked in a number of more contemporary references. For instance, Joseph Nechvatal (2007) considers this more specifically in relation to art and suggests that: 'Cybernetics had demonstrated that the configuration of a system is an index of the performance which may be expected from it, hence cybernetics' extremely circular-state yields an extended aesthetic consciousness on the basis of connected self-attentiveness and it is within this elastic self-attentive aesthetic framework where we will expect to find new immersive attitudes emerging in art.' (Nechvatal, 'Whatever Happened to Cybernetics', posting to Nettime list, 4 November 2007, <http://www.nettime.org/Lists-Archives/nettime-l-0711/msg00008.html>).

³⁵ Here I am paraphrasing the definition from wikipedia (<http://en.wikipedia.org/wiki/Curator>).

³⁶ Tactical Media is a contemporary form of activism that is best characterised by the appropriation of mass media and current technology to challenge institutions of power (http://en.wikipedia.org/wiki/Tactical_media). In an interview 'Tracking Critical Net Culture' (October 8, 2002c) Geert Lovink explains: 'The tactical media was developed in Amsterdam in the "post 1989" years and is associated with the Next Five Minutes conference series as an alternative to earlier terms such as "alternative media," "subculture," and "underground." Tactical media such as small radio stations, websites and mailing lists, record labels and 'zines are all thriving because of the enormous drop in the prices of hardware. This means that it is much easier to have your independent media infrastructure. It is no longer a political choice to remain in this or that ghetto. The so-called "antiglobalization" movement proves how broad concerns are over the environment and world trade. The backbones of these movements are sites such as www.indymedia.org. Activists these days try really hard to get beyond the lifestyle level and address a variety of social groups. This capacity is partially due to better understanding of the workings of media.' (<http://frontwheeldrive.com/geert-lovink-tracking-critical-net-culture>).

³⁷ Alf Rehn, posting to IDC list, thread title 'Kurating Keen', 25 August 2007 (<https://lists.thing.net/pipermail/idc/2007-August/author.html>), IDC list archive (<http://lists.thing.net/pipermail/idc/>).

³⁸ The concept of Immateriality has been much misunderstood and perhaps confused with other popular uses of the term, such as 'of no importance or relevance'; 'inconsequential or irrelevant', or even more commonly as 'having no material body or form or substance'. In the context of the thesis the term immateriality is derived from the Autonomists, who developed its understanding in relation to transformations of social and political structures in the post-Fordist information economy. Importantly, Immateriality - contrary to the popular use of the term - does not mean 'less than material' or non-material, and 'is not something "new" in the sense that it is related to the emergence of the information commodity, but literally refers to what Deleuze and Foucault among others called the "incorporeal" (Deleuze 1990): 'If mind and body are two expressions of the same substance, but considered from two different perspectives, the incorporeal refers to the plane of events and transformations that affect the mind but also double up and interfere with the process of composition affecting the relations among bodies and their modifications.' (Terranova 2006: 31)

³⁹ Immaterial labour is a key concept in the critical theory developed by contemporary French and Italian Marxist writers and political theorists associated with the Autonomia or New Left movement that emerged in the late 1960s and 1970s. A more extensive definition of the term is provided in chapter 2.1.

⁴⁰ For example, the term cybernetic system is used 'to denote a proper subset of the class of general systems, namely those systems that include feedback loops' (http://en.wikipedia.org/wiki/Systems_theory#_note-17). Other more specific areas such as cellular automata (CA), neural networks (NN), artificial intelligence (AI), and artificial life (AL) are also related but not core issues for the focus of the thesis.

⁴¹ Among the many protocols that regulate the operation of network are: TCP/IP (Transmission Control Protocol/Internet Protocol) and UDP (User Datagram Protocol) that enable data transmission over the Internet; DNS (Domain Name System) that controls Internet addresses; and http (Hypertext Transfer Protocol) that enables the retrieval of documents over the Web.

⁴² Despite the relevance of chaos theory to analysis of the dynamics of complex systems, Cillier explains the insufficiency of this theoretical approach. His argument is that in chaos theory too much emphasis is placed on initial conditions and 'deterministic chaos' that results from non-linear interaction of a relatively small number of equations. In contrast, complexity theory emphasises the robust nature of complex systems i.e. their capability to perform in the same way under different conditions that ensures their survival and account for a much larger number of components (Cillier 1998: ix). Further key references in this field include Ilya Prigogine and Isabelle Stengers's seminal book (of 1984) *Order out of Chaos: Man's New Dialogue with Nature* (New York: Bantam Books); N. Katherine Hayles (1989) 'Chaos as Orderly Disorder: Shifting Ground in Contemporary Literature and Science', *New Literary History* 20, 305-22; and N. Katherine Hayles (1991) (ed.) *Chaos and Order. Complex Dynamics in Literature and Science* (Chicago: The University of Chicago Press). Hayles (1991) notes that in the short history of chaos theory there has been an evident split between two approaches - first is the concern with the order hidden within chaotic systems and the second is a concern with the order that arises out of chaotic systems and the issue of self-organisation. The former is represented by the work of James Gleick (1987) *Chaos: Making a New Science* (New York: Viking); Mitchell Feigenbaum (1980) 'Universal Behaviour in Nonlinear Systems', *Los Alamos Science*, pp. 4027; Benoit

Mandelbrot (1983) *The Fractal Geometry of Nature* (New York: W. H. Freeman); Robert Shaw (1981) 'Strange Attractors, Chaotic Behaviour, and Information Flow', *Zeitschrift für Naturforschung*, pp. 79-112, and (1984) *The Dripping Faucets as a Model Chaotic System* (Santa Cruz: Aerial); Kenneth Wilson (1983) 'The Renormalization Group and Critical Phenomena', *Reviews of Modern Physics*, pp. 583-600. The second approach is exemplified in the work of Arthur Winfree (1980) 'The Geometry of Biological Time', *Biomathematics*, vol. 8 (Berlin, New York: Springer); G Nicolis and Ilya Prigogine (1977) *Self Organisation in Nonequilibrium Systems: From Dissipative Structures to Order Through Fluctuations* (New York: Wiley); Ilya Prigogine and Isabelle Stengers (1984); René Thom (1975) *Structural Stability and Morphogenesis: An Outline of a General Theory of Models* (Reading, MA: W. A. Benjamin).

⁴³ The more general issue of the conceptual transformation of art objects, emerging art practices and new art forms in the context of technology - although clearly relevant - is extensively covered in the literature and is outside the scope of the thesis. However, of particular relevance to the focus on software art is a more specific transformation of apparatus related to questions of the materiality of the art object. Here, the discussion around 'dematerialisation' associated with conceptualism (Lippard 1973) is extended with reference to immateriality in networks that further questions the conditions of material production. To some extent, this is what Jacob Lillemose responds to in his essay of 2006 'Conceptual Transformations of Art', making explicit reference to Jack Burnham's 'system esthetic' and extending it to offer the term 'network aesthetics' (2006). For Lillemose, immateriality designates the new material condition that artists working with software and Internet are dealing with and is exemplified in the work of artist collectives such as 0100101110101101.org that extend 'the aesthetics of dematerialisation with new urgency, agency and energy' (2006: 124). A similar point is made by Nechvatal (2007) who - referring to Burnham's argument about cybernetic sculpture - emphasises the issue of 'not simply adopting new materials and new standards of fabrication, but evolving a new aesthetic, now synchronized with technical ideas'. Furthermore: 'The recontextualisation of the object d'art into a circular envelopment of the environment (where the viewer is pulled away from the constraining aperture of the picture frame and more and more from the gallery frame) is indicative of the immersive qualities of the era.' (Nechvatal, 'Whatever Happened to Cybernetics', posting to Nettime list, 4 November 2007, <http://www.nettime.org/Lists-Archives/nettime-l-0711/msg00008.html>).

⁴⁴ However, a number of references can be offered as a starting point for further investigation. For instance, David F. Noble in his book *Forces of Production* (1984) charts a comprehensive 'social history of industrial automation', and in even more direct relevance to this thesis, Jussi Parikka's *Digital Contagions. A Media Archeology of Computer Viruses* (2007) explores the issue of automatisisation and computerisation with particular reference to computer viruses. Drawing on their historical context Parikka explains: 'The automata illustrate a key theme of the twentieth century, earlier than computers. Automated machines had been a source of amazement since the eighteenth century, the early years of industrialisation. The Vaucanson duck and other automata incorporated the idea of simulation of life, and hence the beginnings of artificial life, in their uncanny self-movement and coordination of systemic activities. In factory production, such characteristics became everyday life. Manuel DeLanda sees this automatisisation of tasks from the human to the machine as the crucial moment in the birth of software, locating the focal point in Jacquard's loom and subsequently Babbage's interests in analytical machines and the transformation of control from humans to machines.' (2007: 229-230) Further references offered as a starting point to explore this line of inquiry might include: *Automatons and Robots* (1988) edited by Giuseppe Lippi, Turin: Comau; *Theory of Self-Reproducing Automata* (1966) John von Neumann (edited and compiled by Arthur W. Burks) Urbana, IL and London: University of Illinois Press; and *War in the Age of Intelligent Machines* (1991) Manuel DeLanda, New York: Zone Books.

⁴⁵ See note 38.

⁴⁶ See note 39.

⁴⁷ The issue of immateriality and creative practice was the subject of *Art and Immaterial Labour* conference (Tate Britain, 2008) organised by the Centre for Research in Modern European Philosophy, Middlesex University, UK. Invited speakers included Franco Berardi (<http://www.generation-online.org/p/pbifo.htm>); Maurizio Lazzarato (<http://www.generation-online.org/p/plazzarato.htm>); Antonio Negri (<http://www.generation-online.org/p/pnegri.htm>) and Judith Revel (<http://www.generation-online.org/p/prevel.htm>). The conference press release states: 'Art's materiality has been the focus of fierce debate since claims about the 'dematerialization' of art were made in New York at the end of the 1960s. More recently, in the very different context of libertarian political debates in Italy and France, claims have been made about the 'immaterial' character of labour processes based on information-technology, and of

the cultural and intellectual content of commodities. This conference will bring these two discourses together to stage a debate about contemporary art, 'immaterial' labour and new modes of production of subjectivity.' (<http://www.turbulence.org/blog/archives/003554.html>).

⁴⁸ Autonomia emerged in the late 1960s and 1970s and was founded on the intellectual heritage of the Italian 'Potero Operaio' ('Worker Power') movement of the 1950s. In the early 1990s, it was mainly associated with two magazines: the Italian *Luogo Comune* and the French *Futur Antérieur*. Central to the development of ideas around immateriality have been Lazzarato's 'Immaterial Labour' (1996), Paolo Virno's 'Notes on the General Intellect' (1996), and his co-edited collection *Radical Thought In Italy* (with Michael Hardt, 1996), his recent *A Grammar of the Multitude* (2004), as well as Michael Hardt & Antonio Negri's *Empire* (2000). More recently, the French magazine *Multitudes* (<http://multitudes.samizdat.net>) has continued discussion around these ideas. Contemporary writers such as Tiziana Terranova, Matteo Pasquinelli, Marina Vishmidt and Ned Rossiter have followed this critical trajectory to redevelop the concept of creative labour in relation to 'network' or 'information' cultures.

⁴⁹ Political theorists refer to the model of 'Toyotism' that inverts the Fordist structure of communication between production and consumption and provides 'a first sense in which communication and information have come to play a newly central role in production' (Hardt and Negri 2000: 290).

⁵⁰ The particular currency of the concept of immaterial labour has prompted number of critical responses. For example, Rossiter in his book *Organized Networks. Media Theory, Creative Labour, New Institutions* (2006), questions the notion of immaterial labour and instead suggests the concept of *disorganised labour* as a more relevant description of 'the precarious conditions of labour within informational economies and the creative industries' (2006: 43). He explains: 'Creative and informational modes of labour as they currently exist are better understood as disorganised; by conceiving work in this manner, the political dimension of labour is retained in so far as opposition and revolution have in modern times required workers to either self-organise or form a compact alliance with intellectuals, who have formed the symbolic spearhead of political change. [...] The conditions of disorganised labour correspond, of course, with the disorganised technics of capitalism, as discussed by Lash and Urry.' (2006: 158) Rossiter develops the notion of disorganised labour as a consequence of what he sees as an urgency to develop new institutional forms, or in his words 'new technics of organisation, addressing more adequately institutional systems and structures within network societies and informational economies. In response he makes a distinction between political concept of 'organised networks' and 'networked organisations'. To Rossiter, the political concept of organised networks 'seeks to overcome the inadequacy of thought and radical social-political movements and their relation to institutional forms' (2006: 17). The issue of structure and organisation, and subsequently agency in networks, has much relevance for the argument of the thesis and is explored in more detail in chapter 3.

⁵¹ The concept of 'machine' is central to Pasquinelli's analysis of cultural work in the context of immateriality and open systems. He explains: 'Cognitive labour produces machines of all kinds, not only software: narrative machines, advertising machines, mediatic machines, acting machines, psychic machines, social machines, libidinous machines. [...] Today we mean by machine the elementary form of the general intellect, each node of the network of collective intelligence, each material or immaterial device that organically interlinks the fluxes of the economy and our desires. At a higher level, the network itself can be regarded as a mega-machine of assemblages of other machines, and even the multitude becomes machinic (...). (2006: 272)

⁵² The multitude is a political term central to the conceptualisation of a new model for the organization of resistance against the global capitalism described by Hardt and Negri under the term *Empire* (2000) and others associated with Autonomist Marxism. Furthermore, Hardt and Negri define multitude as: 'composed of a set of singularities - and by singularity here we mean a social subject whose difference cannot be reduced to sameness, a difference that remains different'. They continue: 'The multitude is an internally different, multiple social subject whose constitution and action is based not on identity or unity (or, much less, indifference) but on what it has in common.' (2000: 99-100). See also the magazine *Multitudes* (<http://multitudes.samizdat.net>).

⁵³ Lazzarato refers to this as an 'aesthetic model' precisely because it involves both the creative and social elements of production. He further notes that interestingly this model (of creative/artistic activity that follows from the situationists) could be just as productively employed as a starting point as the traditional activity of the factory model (following Italian

workerist theories) to arrive at the new concept of labour (immaterial). This is because they both rely on the Marxist concept of 'living labour' (1996: 147).

⁵⁴ This draws on an earlier established model by Benjamin in response to changes at the end of the 19th century when artistic production, reproduction and reception 'have assumed collective forms'. To Lazzarato, such a description is fundamental for any genealogy of Immaterial labour (1996: 147).

⁵⁵ In using the term 'constituent power of labour', Hardt and Negri draw upon the Machiavellian concept of *constituent power*. 'that is, a product of an internal and immanent social dynamic' and 'it is always the product of the life of the multitude and constitutes its fabric of expression' (2000: 162).

⁵⁶ For an extended overview see and follow links from (http://en.wikipedia.org/wiki/Open_system).

⁵⁷ Terranova focuses her analysis on 'open cybernetic networks' to exemplify the dynamics of open systems (2006: 34).

⁵⁸ Vishmidt explains that the term 'communism of capital' is usually applied 'in a different but not unrelated sense in post-autonomist writing, referring to the sociality bred by "immaterial labour" creating the conditions for an immanent overthrow of capital in its very profit centres' (2006: 54).

⁵⁹ The book includes von Bertalanffy's earlier work from the 1930s and his first articles published in the 1940s and 1950s.

⁶⁰ Other researchers in the field (in the 1950s) include Anatol Rapoport, Kenneth E. Boulding, William Ross Ashby, Margaret Mead, Gregory Bateson and C. West Churchman. Systems thinking was widely accepted in other areas, for instance from the 1960s, systems theory was adopted by the fields of computing and information technology, in particular to software engineering and computer-aided software engineering tools. (http://en.wikipedia.org/wiki/Systems_theory#_note-17)

⁶¹ For instance, as earlier mentioned, this has been explored by Burnham in 'Systems Esthetic' (*Artforum*, 1968) and 'Real Time Systems' (*Artforum*, 1969), Nichols in 'The Work of Culture In the Age of Cybernetic Systems' (1988) and more recently in the *Open Systems* exhibition at the Tate Modern, London (2005).

⁶² The paradigm of information technology that Castells proposes is described as a result of 'clustering' of information technologies around networks of firms, organisations, and institutions. Most accurately it is characterised, according to Castells, by the pervasiveness of effects of new technologies; the networking logic of any system (increasing complexity of interaction and unpredictable patterns of development arising from the creative power of such interaction); flexibility (to reconfigure in response to constant change and organisational fluidity of society); and convergence of specific technologies into a highly integrated system (1996: 61-62).

⁶³ Leading to this, an interest in feedback and 'derived concepts such as communication and control in living organisms, machines and organisations' as a field of study was already present as early as 1935 in the work of Russian physiologist P.K. Anokhin and Romanian scientist Stefan Odobleja, whose book *Psychologie Consonantiste* (1938) describes many cybernetic principles. Other key articles that led to the formulation of cybernetics as an epistemological approach were 'Behavior, Purpose and Teleology' by Arturo Rosenblueth, Norbert Wiener, and Julian Bigelow and 'A Logical Calculus of the Ideas Immanent in Nervous Activity' by Warren McCulloch and Walter Pitts (both published in 1943). Also in the early 1940s, John von Neumann's contribution ('cellular automata' and 'the Von Neumann Universal Constructor') was particularly significant to the development of cybernetics in that it introduced the concept of self-replication that cybernetics adopted as central. The formulation of cybernetics is credited to Wiener and his book of 1948 *Cybernetics, or Control and Communication in the Animal and Machine* and the core of architects of cybernetics more generally were Claude Shannon, von Bertalanffy, von Neumann, Warren McCulloch, Craik and others. The scientific concern with regulatory processes in relation to complex systems (whether digital, mechanical or biological) and in particular the process of self-organisation follow somewhat the original use of the term cybernetics in the context of 'the study of self-governance' by Plato (in his work *The Laws*) to describe the governance of people. In a modern application of the term: 'The field of Cybernetics came into being when concepts of information, feedback and control were generalized from specific

applications to systems in general, including systems of living organisms, systems of self-reference and systems of language. Fundamentally an applied philosophy, cybernetics has taken on problems of subjectivity in science while still addressing how to make intelligent artifacts. It stands today as a major influence on biology, cognitive and computation science, and epistemology.' (Pangaro 2001, <http://www.pangaro.com/published/cyber-macmillan.html>). Further references: (<http://www.univie.ac.at/constructivism/HvF.htm>), (In Rossiter 2006: 181-183).

⁶⁴ In the 1960s the theory of second-order cybernetics was put forward to investigate the construction of models of cybernetic systems. This approach, originated in the work of von Foerster (and his first essays later published in his book *Observing Systems*, 1982), popularised through the work of Gregory Bateson and Margaret Mead, focuses on 'self-referential systems and the importance of eigenbehaviors for the explanation of complex phenomena' (von Foerster 1979). For further references see (Hayles 1999).

⁶⁵ In addition to the possibility of change over time, the system can also be considered as adaptive i.e. having the capacity to learn from the experience, reinforcing further change. This is key to the concept of complex adaptive system (that originates from the work of John Holland, Murray Gell-Mann and others associated with the Santa Fe Institute in 1980s and 1990s) - made up of multiple interconnected elements and adaptive in that they have the capacity to change and learn from experience). When applied to online curatorial system as considered in the thesis, such variable that determine change over time might for instance include an online network of users, that additionally has a capacity to learn from the experience of using such a system. See (Hayles 1994: 16).

⁶⁶ The exhibition *FEEDBACK* (2007) was important in situating current art practices that involve the Internet (telematics, networks, software) in a historical context of instruction-based, generative, and conceptual art (Cornell 2007). See note 27; exhibition website (http://www.LABoralcentrodearte.org/feedback/concept_001_inl.html), Rhizome Interview (<http://rhizome.org/thread.rhiz?thread=26268&text=48766#48766>).

⁶⁷ Generative Art definitions can be found at (<http://www.generative.net>).

⁶⁸ Scale-free topology was discovered in 1999 by the brothers Michalis, Christos and Petros Faloutsos who found that the Internet followed power laws at both the router level and autonomous system (AS) level. (Barabási 2002: 152, Schintler et al. 2003, Faloutsos, et al. 2003: 514-524). What Barabási refers to as a power model of distribution is characterised by 'many small events coexist with a few larger events' and so-called unique degree exponent that tells about a number of large events and operates preferential attachment. Thus power laws apply to complex systems (such as the Internet or Web) and are inherent to self-organisation. This model follows as a result of thinking about complexity of large networks as subject to some kind of order, organising principles rather than randomness. Prior to this, thinking about the network was dominated by the random network theory since its introduction in 1959. This theory follows what is termed Poisson distribution model (otherwise known as the bell curve model) in which 'there is a prominent peak indicating that the majority of nodes have the same number of links (average node)' while simultaneously 'on two sides of the peak the distribution rapidly diminishes making significant deviations from the average although these are rare'. Therefore, a random network has a 'characteristic scale in its node connectivity, embodied by the average node and fixed by the peak of the degree of distribution' (Barabási 2002: 72, 81, 90, 152).

⁶⁹ Knahl and Cox (2007) provide more detail, listing important additions since the initial specification of TCP/IP. These include: the Border Gateway Protocol (BGP), the Domain Name System (DNS) protocols and the application layer protocols (i.e. email protocols such as POP3, IMAP and SMTP or WWW protocols such as HTTP) and Voice over IP (i.e. Session Initiation Protocol) that is currently under development.

⁷⁰ Terranova adds useful detail on this. She sees the Internet as a highly entropic system of randomness and indeterminism and thus 'tendentially homogeneous'. To contain this, the system is subject to regulation via the DNS protocol that regulates the top-level domains, space of addresses (a homogeneous space of cells and grids). Each top-level domain is however infinitely divisible into sub-domains, and further sub-domains and smaller addresses 'neatly branching out from its umbrella to identify individual users or machines, from servers to personal computers to all kinds of communication devices' (2004: 44). Further to this 'abstract space (...) corresponds a concrete assemblage of technical machines, the DNS servers, which are arranged in hierarchical order. Thirteen root servers, ten of which are currently located in the USA, two in Europe and one in Asia, for example, contain information about the next set of DNS machines, that is the authoritative name servers. (...) Finally, to the relatively centralised

structure of the naming system corresponds a centralised governing body – a kind of global regulatory board. While the DNS was famously run for years single-handedly by Internet pioneer Jon Postel, since his death it has been supervised by a non profit organisation, ICANN – a corporation that has typically been subject to heated controversies about accountability and democratic governance of the Internet' (Terranova 2004: 45)

⁷¹ Galloway refers to the idea of a distributed network model on the Internet, first proposed by Paul Baran in 1964. Also see note 1.

⁷² These ideas explored by Galloway have been since extended in his latest co-authored book (with Eugene Thacker) *The Exploit. A Theory of Networks* (2007). Expanding beyond the political description of networks, network protocols and structures of control within networks in his earlier book (2004), the later book develops an argument for an entire new topology to resist and reshape the network form; a topology 'that is as asymmetrical in relationship to networks as the network was in relationship to power centers. Resistance is asymmetry. The new exploit will be an 'antiweb'. [...] It will have to consider the radically unhuman elements of all networks (Galloway and Thacker 2007: 22). Note: 'the exploit' is a hack.

⁷³ To Rossiter, 'communication within networks is about relational processes not representational procedures' (2006: 13).

⁷⁴ Rossiter's networked organisation model is well exemplified in educational institutions such as universities (in the UK and US at least). Although clearly networked (with other institutions such as increasingly enterprise, military and governmental agencies) they are far from horizontal, collaborative and distributed structures. To Nick Dyer-Witheford what they demonstrate is, to use his term, 'cognitive capitalism' – a commercial appropriation of general intellect: 'Universities are now frankly conceived and funded by policy elites as research facilities and training grounds for the creation of the new intellectual properties and technocultural subjectivities necessary to post-Fordist accumulation regime.' (2005: 71) Inherent to this are new management techniques 'that appear to place value of creativity and enterprise in the 'knowledge-for-profit' economy' (Cox, Krysa 2005: 16) to support old organisational forms of 'vertical integration' coupled with 'representative tenets of liberal democracy' (Rossiter 2006: 14).

⁷⁵ Also see (Ascott 2003: 367-371).

⁷⁶ For more on this see (Latour 2005: 52-55).

⁷⁷ Relevant to this is a point made by Stephen Downes about 'distributed creative systems' and the issue of their openness. In his posting to the IDC list (11 October 2007) he argues against a more popular view that truly distributed creative systems are those with all nodes open (as articulated for instance in an earlier posting by John Hopkins). Instead, drawing on the work of Francisco Valera of 1987 with respect to the immunology and human perception, Downes suggests that the openness of the system (and distribution of power and control) is not measured by the number of channels open (all is the best) as the 'maximal connectivity can result in the opposite of a truly distributed creative system. It can result in a maximally centralized system.' Thus, for Downes: 'Maximally distributed creativity isn't about opening the channels of communication, at least not directly. It is about each person having the potential to be a member of a receptive community, where there is a great deal of interactivity among the members of that community, and where the community, in turn, is a member of a wider community of communities.' (<https://lists.thing.net/pipermail/idc/2007-October/002873.html>)

⁷⁸ Of particular relevance to this discussion are for instance Goriunova (2004), Fuller (2003).

⁷⁹ Ceruzzi provides an extensive historical study of programming and development of software and its relation to the development of computers (hardware), which are both beyond the scope of this thesis. With reference to the term 'software' Ceruzzi refers to the RAND Corporation mathematician Merrill Flood who arguably coined the term in the 1940s, although the term appears in print in computer journals and trade press only around 1959 (2003 [1998]: 372).

⁸⁰ Florian Cramer derives much of contemporary software art discourse from two critical lines of thinking: 'The older one around Matthew Fuller (essay 'Software as Culture'), Graham Harwood and the groups I/O/D and Mongrel (...) [and] The other group involves the programmer – artist Adrian Ward (...) and Alex McLean (...), the theoretician Geoff Cox and participants in the mailing list "eu-gene", the website <http://www.generative.net> and the "DorkBot" gatherings in London (...)'. (Cramer, in Goriunova and Shulgin 2002: 23)

⁸¹ Fuller notes that in the study by Richard Feynman thirteen levels of operating system are noted - from the most basic 'level of electronic circuitry - registers, gates, buses - to number 13, the Operating System Shell, which manipulates the user programming environment. By a hierarchical compounding of instructions, basic transfers of 1's and 0's on level one are transformed, by the time we get to thirteen, into commands to land aircraft in a simulation or check whether a forty-digit number is prime' (2003: 4). More recently many more levels have become involved including 'various protocols of interface, licensing, network, the ways in which computation has been coded and styled for various markets' (Fuller 2003: 21).

⁸² Examples in relation to the models include: critical software - *Auto-Illustrator* (Signwave aka Adrian Ward, 2000) (<http://www.autoillustrator.com/>); social software - *Linker* (1999) and *Nine(9)* (2003) by Mongrel (<http://www.mongrel.org.uk/Linker>) and (<http://9.waag.org/>); speculative software - *london.pl* (Harwood, 2001) (<http://www.mongrelx.org/home/index.cgi?LondonPL>).

⁸³ In addition to the example of the 'I Love You' virus, another is the 'Code Red' worm that in the summer of 2001 spread like an infectious virus turning a large number of computers 'into zombies' and 'simultaneously throwing traffic at white-house.gov' (Barabási 2002: 155). The idea of a contemporary form of 'sabotage' is well reflected in the description by Barabási: 'Code Red was only a proof-of-principle demonstration of what automated viruses could achieve. More sophisticated versions could result in unparalleled damage. Disabling a few major nodes [in the computer network] would not be sufficient to break the network into pieces, but the cascading failure of the other routers resulting from the redirection of traffic to smaller nodes would finish the job.' (2002: 155) For other examples of worms and viruses that made headlines see Galloway (2004: 176-184).

⁸⁴ Another example is Carl Banks's aircraft simulator (<http://www.loccc.org/1998/banks.c>); (<http://www.aeroplayer.com/software/>).

⁸⁵ Examples cited are: Etoy (<http://www.etoys.com/>) and JODI (<http://www.jodi.org>).

⁸⁶ Examples cited are: 0100101110101101.org (<http://0100101110101101.org>) Epidemi[C] (<http://www.epidemiC/>) and (<http://www.epidemiC.ws./love.mp3>).

⁸⁷ That code itself 'works' or performs is made an issue in 'Coding Praxis' (2004) by Geoff Cox, Alex McLean, Adrian Ward, and in their earlier essay 'The Aesthetics of Generative Code' (2001) in which they argue that any separation of code and the resultant actions would simply limit the aesthetic experience (and other transformative potential, it should be added).

⁸⁸ The technological, political, and economic tendencies in computer virus discourse are a particular focus in *The Digital Contagions. A Media Archaeology of Computer Viruses* (Parikka 2007) that (with relevance to this section of the thesis) reveals 'how deeply the definitions of computer worms and viruses are embedded in issues of media, risk society, and (viral) capitalism' (2007: 7). The book is important as it offers the most comprehensive critical analysis of the phenomenon of computer viruses from cultural and historical perspective to date.

⁸⁹ The *I love you [rev.eng]* (2002-2004) exhibition was curated by digitalcraft (<http://digitalcraft.org>) as part of a three-year research project at the Museum of Applied Arts, Frankfurt, Germany. Its objective was to establish a collection of digital artifacts to ensure their long-term survival. The exhibition, originally presented in Frankfurt, has been extended and, in 2004, toured under the title *Made in Germany - I love you [rev.eng]*, to Brown University, Providence, Rhode Island, US; and the Museum for Communication in Copenhagen, Denmark. For more information on this exhibition see Alessandro Ludovico, 'I love you [rev.eng]. The Aesthetics of Computer Viruses. German Exhibition on International Tour', in *Neural.it* (<http://neural.it/>) and in his *Nettime* posting, September 2004.

⁹⁰ Over a five-hour period during 8 May 2000, launched from the Philippines the ILOVEYOU virus (or 'Love Bug') spread across Asia, Europe and the United States via e-mail messages. It clogged Web servers, overwrote personal files and caused corporate IT managers to shut down e-mail systems. Preventative advice at the time read: 'If you receive email with a subject line with the phrase ILOVEYOU (all one word, no spaces) in it... DON'T OPEN the attachment named Love-Letter-For-You.txt.vbs.' It was the most damaging computer virus to date causing estimated over 10 billion US dollars damage and 45 million destroyed computers worldwide. (Nori 2002, Barabási 2002)

⁹¹ The Web Stalker (1997), I/O/D (<http://bak.spc.org/lod/lod4.html>).

⁹² CODEDOC (2002) was curated by Christiane Paul for *artport* (Whitney Museum of American Art Portal to Net Art) and included the following artists: Golan Levin (Java), Mark Napier (Java), Brad Paley (Java), Scott Snibbe (Java), Martin Wattenberg (Java), Maciej Wisniewski (Java), John Klima (Visual Basic), Camille Utterback (C), Mary Flanagan (Lingo), Kevin McCoy (Lingo), Sawad Brooks (Perl), Alex Galloway (Perl / Text). A second installment of CODEDOC with eight additional artists (Ed Burton, epidemiC, Graham Harwood, Jaromil, Annja Krautgasser & Rainer Mandl, Joan Leandre, Antoine Schmitt, John F. Simon Jr.) was commissioned by Ars Electronica for the 2003 Ars Electronica Festival 'CODE -- The Language of our Time'. CODEDOC II launched on September 6, 2003. See (<http://artport.whitney.org/exhibitions/past-exhibitions.shtml>) and (<http://www.aec.at/de/festival2003/programm/codedoc.asp>).

⁹³ Quoted from the project website (<http://artport.whitney.org/exhibitions/past-exhibitions.shtml>).

⁹⁴ The following section draws upon my co-authored chapter (with Grzesiek Sedek) 'Source Code' (Fuller 2008).

⁹⁵ The process of compiling is twofold: the source code is converted into an executable file either automatically by a compiler (i.e. the GNU C Compiler) for a particular computer architecture and then stored on the computer, or executed on the fly from the human readable form with the aid of an interpreter.

⁹⁶ The 'compiler' translates the source code into a partially compiled intermediate format, which is later run by a fast interpreter (called a virtual machine). For a useful definition see (http://en.wikipedia.org/wiki/Programming_language/); for an extensive study of programming languages and code see for instance Knuth 1981), Fuller (forthcoming 2008), *A Dictionary of Computing*, *Oxford Reference Online* (<http://www.oxfordreference.com>).

⁹⁷ More extensive analysis of the term algorithm is beyond the scope of the thesis but there are a number of references that deal with the subject in depth. For instance, Weibel (2007) explores the concept of algorithm in computational terms and from a historical perspective, excavating a useful reference to Andrey A. Markov's 1906 theory of stochastic processes that later in the 1950s and 1960s was applied to the stochastic, or random, generation of poetry and music, and that later led to the foundation of an algorithmic information theory by Gregory Chaitin and Andrei Solomonov. Importantly, Weibel points to the fact that algorithms are much older than computers, although they 'have been most famously deployed in computer programming'. The successful execution of a computer algorithm follows the first ever algorithm written specifically for a computer over a century ago (1842-1843) by Ada Lovelace (to compute Bernoulli numbers) but never executed since Charles Babbage's *Analytical Engine* (1834) was never completed. Importantly however, Weibel's interest in the historical and computational development of algorithms informs his exploration of its relevance to art. He explains: 'For centuries algorithms have been used intuitively as control systems, instructions, rules of play, and as plans and scores in architecture and music. [...] The artists' books of the Renaissance, such as Leon Battista Alberti's tract *De re aedificatoria* (1452), Piero della Francesca's *De prospectiva pingendi* (c. 1474), or Albrecht Dürer's illustrated book *Underweysung der Messung* (1525), already amounted to manuals for making paintings, sculptures and buildings. Mathematical aids and even small mechanical contraptions were used by composers from Bach to Mozart, from Schöenberg to Joseph Schillinger. A central role is played in modern music by serial and static processes, by techniques and algorithms which are aleatoric and stochastic, permutative and combinational, recursive and fractal; and this function is exercised not just intuitively, but also in the sense of high-precision mathematics.' (2007: 24) 'He continues: 'There are two different uses of the algorithm in modern art: intuitive application, as in the Fluxus movement [based on natural languages - sequences of signs in the form of letters can be instructions for human beings to act], and exact application, as in computer art [based on programming languages, artificial languages, or digital codes - sequences of signs in the forms of digits are instructions for machines to act].' (2007: 24) Other important reference in this connection is the forthcoming anthology *Software Studies* (Fuller 2008) that provides a compendium of software-related terms and concepts.

⁹⁸ The metaphor is also used by the Belgian artists group Constant in their project *Cuisine Interne Keuken* (2004) to examine the economics of the internal organisation of the cultural system and the workplace - a system that consists of components (ingredients), tools (utensils) and work and creation processes (recipes) (http://www.constantvzw.com/cn_core/cuisine/).

⁹⁹ In this connection, Ceruzzi points to some earlier examples of programs such as COBOL that had 'the ability to use long character names that made the resulting language look like ordinary English'. Thus, the program was self-documenting, instructions were sufficient descriptions for

both machine and humans, and programmer's comments were not required (2003 [1998]: 92-93).

¹⁰⁰ Although the stored-program principle is commonly credited to von Neumann for his 'First Draft of a Report on the EDVAC' (1945), he was not the sole creator of 'von Neumann Architecture'. According to Cerruzi, it was also J. Presper Eckert and John Mauchly who conceived of the similar idea earlier in 1944 (2003 [1998]: 21-22).

¹⁰¹ UNIVAC (UNIversal Automatic Computer) was designed by Eckert and Mauchly (Ceruzzi 2003 [1998]: 20).

¹⁰² For an extensive list of licences see (<http://www.opensource.org/licenses/>), or (<http://www.fsf.org/licensing/licenses/>).

¹⁰³ Examples cited are: BSD (Berkeley Software Distribution) (<http://www.bsd.org/>); GPL (General Public License) (<http://www.gnu.org/>); GNU/Linux project (<http://www.kernel.org/>); MIT (Massachusetts Institute of Technology) OpenCourseWare (<http://ocw.mit.edu/>); Microsoft End User License Agreement (<http://msdnaa.oit.umass.edu/Neula.asp>).

¹⁰⁴ Also see: Free Software Foundation (<http://www.fsf.org/>) and Open Source Initiative (<http://www.opensource.org>).

¹⁰⁵ Linux is open source software: a free Unix-type operating system originally created by Linus Torvalds with the assistance of developers around the world. Developed under the GNU General Public License, the source code for Linux is freely available to everyone online (<http://www.linux.org/>).

¹⁰⁶ Knuth discusses this issue in *The Art of Computer Programming* (1981 [1968]: 182).

¹⁰⁷ CVS, a version control system commonly used in open source projects, is an important management mechanism that allows several developers to work on the same files both simultaneously and remotely. It allows the recording of individual histories of sources files and documents while storing it on a single central server.

¹⁰⁸ Examples cited are: SourceForge (<http://sourceforge.net/>); Freshmeat (<http://freshmeat.net/>); Code Snippets (<http://www.bigbold.com/snippets/>); Snipplr (<http://snipplr.com/>); Koders (<http://www.koders.com/>); Krugle (<http://www.krugle.com/>); Codefetch (<http://www.codefetch.com/>); Codase (<http://www.codase.com/>).

¹⁰⁹ Examples cited are: PerlMonks.org (<http://perlmonks.org/>) and Sweetcode.org (<http://www.sweetcode.org/>).

¹¹⁰ In relation to artistic practice, the idea of making source code of work public is evident in the example of live programming. Cox comments: 'In this area of software arts practice programmers make music in keeping with the expressive qualities of live performance, by using interpreted scripting languages (such as perl) and coding in real-time with the source code on public display.' (2006: 76)

¹¹¹ The phenomenon of computer viruses discussed earlier in this section demonstrates the aesthetisation of code quite explicitly. For the purpose of the art context, the usually harmful properties of viruses were typically removed and exhibited as aesthetic systems. As an example, the notorious work 'biennale.py', a computer virus programmed in Python by the artist collective [epidemiC] and net art group 0100101110101101.org, 'operated with the sole purpose "to survive" by acting upon its exhibition context of the 49th Venice Biennale'. Subsequently, the work was included along with other examples in *I Love You [rev.eng]* (2002), a larger show dedicated to the phenomena of computer viruses in an artistic context. See (Nori 2002), (Ludovico 2002: 40).

¹¹² For more detail see a useful definition (http://www.wikipedia.org/wiki/Obfuscated_code).

¹¹³ For further details see (http://www.runme.org/categories/+code_art/).

¹¹⁴ For further details see (http://www.digitalcraft.org/iloveyou/c_code.htm).

¹¹⁵ *Codechat* is a project developed by artist Pall Thayer, project website (<http://pallit.lhi.lis/~palli/codechat/codechat.php>). The prototype was released in August 2007

and the final version will be released under the General Public Licence. More information about the project is available online (<http://pallit.lhi.is/~palli/codechat/>).

¹¹⁶ A brief genealogy of such attempts referred to by Dietz include online tours of existing physical exhibitions (augmented with extra information) and Immersive Interfaces extending and re-formatting physical exhibitions in a gallery space for online spaces. With respect to the use of the Web to extend the artistic programme of an art institution, Dietz refers to the example of *The White House Collection of American Craft* (opened on the web in April 1994) as part of the National Museum of American Art programme. It was described as an 'online tour' and included video and audio material of the curator discussing some of the works in the exhibition. In addition, the online component included an exclusive series of artists' interviews and a guest book. (Dietz 1997) Another, more current example of an 'online tour' was *Alternating Currents: American Art in the Age of Technology* (1997) at the San Jose Museum of Art, which presented selections from the Permanent Collection of the Whitney Museum of American Art (<http://www.sjmusart.org/>). An example of the latter approach involving Immersive Interfaces ('you are here') using for example QTVR software application (Quick Time Virtual Reality) is the Walker Art Centre's *Andersen Window Gallery* that featured: 'a Media Bar with material ranging from the low tech - books and magazines - to high tech - an online computer for visitors to navigate through a range of Web sites and a touch-screen monitor devoted to the works on view in the exhibition' <http://www.walkerart.org/archive/F/B1A3910A5B8838566131.htm>). *Thomas Moran* at the National Gallery of Arts in Washington (1997) used RealSpace (<http://www.nga.gov/feature/moran/index.shtml>); and *The Virtual Endeavour* at the Natural History Museum in London used VRLM (Virtual Reality Modeling Language) (<http://www.nhm.ac.uk/>).

¹¹⁷ The understanding of the museum as an ideological construct related to specific social, political and economic contexts is representative of the field of inquiry termed as 'new museology' (a term derived from Peter Vergo's edited book *New Museology* of 1989). The book explores the historical development of the museum's role in society from the position of a political and cultural critique.

¹¹⁸ These are: *Ars Electronica* (1997), J. Paul Getty Museum (1998), and KIASMA (1998).

¹¹⁹ Other examples of early attempts to incorporate interactive technologies referred to by Fahy include the Getty Art Museum's interactive videos of Greek vases and rare manuscripts, and the project by The National Gallery of Art (Washington) - the *Micro Gallery* established in 1991. The project website provides a detailed overview of the system. (http://www.nga.gov/programs/micro_ga.htm) These and other examples of interactive, multimedia exhibitions in art museums are further discussed in 'Hypermedia & Interactivity in Museums, Proceedings of an International Conference' (1991) edited by David Bearman and referred to in Pierroux (1998). Also see: Fahy (1995: 91).

¹²⁰ Examples of museums that incorporated multimedia kiosks include: San Francisco Museum of Modern Art's 'Public Programs' - multimedia programs located at the Interactive Study Area of the museum (http://www.sfmoma.org/PROGRAMS/Multimedia_prog); Minneapolis Institute of Arts' 'Interactive Media Programs' - computer programs and audio stations located throughout the gallery spaces with interactive touch screen programs (<http://www.artsMIA.org/education1.html>); and Museum of Modern Art, New York's multimedia presentation of the Bonnard exhibition designed for MoMA's Web site (accessible in a touch screen kiosk in the entry to the exhibition (<http://www.moma.org/docs/menu/index.htm>)).

¹²¹ Examples of these include: Fine Art Museums of San Francisco's *Gallery One* (<http://www.thinker.org/fam/education/galleryone.html>); Dallas Museum of Art's *Collections Information Center*, 1993 (<http://dma.unt.edu/>).

¹²² Pioneering examples in this respect are: The National Museum of American Art's *Inventory of American Paintings* database (which now offers over 300,000 detailed records of paintings in public and private collections on the Internet); Getty's Information Institute (USA, founded in 1983, <http://www.gii.getty.edu/index/databases.html>) and Computer Interchange of Museum Information (CIMI) (USA, founded in 1990, <http://www.cimi.org/index.html>). These innovative database systems were later integrated into Web interfaces. Consortiums such as AMICO (Art Museum Image Consortium) and collaborative projects such as IAIA (Integrated Arts Information Access) (<http://www.amn.org/AMICO>) were representative of the commitment art museums were making toward becoming online interactive repositories - in other words, a shared multimedia digital library. Other references that considered early implications of use of the Internet by museums include for instance: Charlie Gere 'Museums, Contact Zones and the Internet' (published in *Museum Interactive Multimedia 1997: Cultural Heritage Systems Design and*

Interfaces, selected papers from ICHIM 97 conference, edited by D. Bearman and J. Trant (Archives & Museum Informatics, 1997) and Maxwell L. Anderson (1997) 'Introduction' (published in *The Wired Museum*, edited by Katherine Jones-Garmill, American Association of Museums: Washington, D.C.). In this connection, the early debates on the impact of the Internet in art institutions (museums more specifically) were understandably cautious and polarised – while at the time Gere saw the Internet as the paradigm of market capitalism and warned that 'rather than offering radical possibilities for what museums might be, the Internet paradigm might instead simply be a way in which market forces control museums in place of the State', Anderson more pragmatically considered potential disadvantages such as 'diminution in the cash value' of museums' collections by offering them up for free online public access, against the benefit for democratising access to content and attracting wider public use: 'Thus we will be in a position to earn less cash value from digital dissemination, but earn more in our value to society at large.' (Pierroux 1998: 27, 65)

¹²³ See (<http://archive.comlab.ox.ac.uk/other/museums/old-index.html>). In 1994, the Virtual Museums Library was set up to provide a directory service for museums' websites and serve as a public record of these early museum websites (later from 1998 the responsibility for the site was assumed by the Museum Documentation Association). Following the first round of art museums that pioneered the field in establishing a web presence in 1994, a number of museums followed in 1995 and were linked to the Virtual Library Museums Pages: the Getty Museum, High Museum of Art in Atlanta, Vatican Collection, Louvre, Metropolitan Museum of Art (November 1995), Whitney Museum of American Art, National Museum of American Art (providing access to over 600 images on the Web site and two national art inventories databases through the Smithsonian Institution Research Information System (SIRIS) database network), San Francisco Museum of Modern Art; and in 1996 – MoMA, Royal Ontario Museum, Montreal Museum of Fine Arts, National Gallery of Canada and the comprehensive National Gallery of Art Web site came online in January, 1997 (Pierroux 1998).

¹²⁴ Pierroux notes that initially there was certain reluctance among curators to become involved in developing content and projects for the Web. She points to the first conference organised for professional curators working with new technology, *Museums and the Web* in Los Angeles in 1997, where this became apparent.

¹²⁵ Examples of curated links include: Guggenheim Museum's *Cyberatlas* (<http://cyberatlas.guggenheim.org/intro/ca-f.html>); the Whitney Museum of American Art's web links (<http://www.echonyc.com/~whitney/weblinks/main.html>), or SFMOMA's 'graphic design' collection of acquired net.art sites. *Cyberatlas* was a Web-map project designed as a filter in the traditional curatorial sense, where curatorial filtering on the Web is a transitional process that Dietz (1997) describes accordingly: 'The emphasis will shift from simply 'creating' content to presenting a context for it – just as one of the roles of the curator is to identify, contextualize and present a point of view about works of art' (quoted in Pierroux 1998).

¹²⁶ The issue of changes and the new role of contemporary art museums in relation to commissioning new media art were explored by Susan Morris in her research report 'Museums and New Media Art' (2001) commissioned by The Rockefeller Foundation. The report (limited in research scope predominantly to the US with the exception of the Tate in the UK) was commissioned to research expanding traditional mission of museums (that is to collect, preserve and interpret art works) to include the activity of commissioning new media art. Morris cites The International Council of Museums (ICOM) definition of museums as: 'a non-profit-making, permanent institution in the service of society and of its development, and open to the public, which acquires, conserves, researches, communicates and exhibits, for purpose of study, education and enjoyment, material evidence of people and their environment.' (2001: 7) In the report, she traces the history of changes to the central mission of museums and notes that in the 20th century museums began to expand this brief and sought to commission, exhibit and even sell new works (for example Whitney Biennial or The Wadsworth Athenaeum in Hartford, US, in the 1930s) thus assuming the patronage of new art. She further notes that in the 1960s some museums were able to commission moving-image art works (for instance, Whitney, MOMA, or the Everson Museum in Syracuse, NY) and by the 1970s museum patronage became more formalised through implementing the format of an experimental, contemporary art space within a museum (one such successful example was the Matrix programme of commissioned exhibitions and performances, or MOMA's Project series of 1971). In relation to art works specifically created for the Web, the first cited example commissioned by a museum is 'Brandon: A One-Year Narrative Project in Instalments' (1998) by Shu Lea Cheang. The work was commissioned by the Guggenheim (in collaboration with Society for Old and New Media, the Institute on the Arts and Civic Dialogue, and the Banff Center for the Arts) and launched with support from The Rockefeller Foundation. The report also provides a list of examples of diverse approaches taken by museums in relation to commissioning new media art and an online

component. For further examples and details see (<http://www.sciencemuseum.org.uk/online/frameset.asp>).

¹²⁷ For example, the Walker Art Center has received a large grant to commission four net.art projects to be presented in their *Emerging Artists/Emergent Medium* programme (<http://www.walkerart.org/gallery9/jerome/index.html>); Dia Center for the Arts supports artists in production of online and off-line projects in conjunction with exhibitions in the physical space, all of which are available through their site (<http://www.diacenter.org/>); MoMA has been developing a series of online projects and all are archived as 'Past Exhibitions' on their 'Online Projects' pages (<http://www.moma.org/onlineprojects/index.html>) (all quoted in Pierroux 1998).

¹²⁸ Permanent online collections would typically be presented either through 'collection overviews' by image, location, department, artist, narrative, etc., or through 'guided tours' providing a more in-depth look at key works from the museum collection; accompanied by more interactive features. Examples of these include: the Walker Art Center's 'Andersen Window Gallery', (<http://www.walkerart.org/programs/andersen>), Centre Georges Pompidou 'Modern Art Collection' (<http://mnam-doc.cnac-gp.fr/english/museum/collection96/>), and National Museum of American Art 'Kaleidoscope' tours (<http://www.nmaa.si.edu>). Special online exhibitions would be online versions of special exhibitions held in the museum, usually based on extracts from the exhibition catalogue and developed as part of the interpretation. Early examples in this connection cited by Pierroux include the National Art Gallery of Art's 'The Railway' (<http://www.nga.gov/exhibitions/railwel.htm>) and National Museum of American Art's 'Online Tours of Special Exhibitions' (<http://nmaa-ryder.si.edu/collections/online-index.html>).

¹²⁹ Full references include: *Gallery 9* (Walker Art Center, Minneapolis) (<http://gallery9.walkerart.org>); *artport* (Whitney Museum of American Art, New York) (<http://artport.whitney.org/>); Tate Online Events (UK) (<http://www.tate.org.uk/onlineevents/>); Rhizome (with the New Museum, New York) (<http://www.rhizome.org>); *[R][R][F], Remembering - Reprising - Forgetting*, 2003-present, by Wilhelm Agricola de Cologne (<http://www.newmediafest.org/rrf/>). These developments in art institutions that respond to the potential of the Internet go hand in hand, according to Dietz, with developments in artistic and curatorial practice. The trajectory spans from practice involving predominantly digitising physical objects for online display, curating (listing and annotating) web links, to eventually curating art created specifically for the web and curating in a web-specific context. Early examples of incorporating web specific art in curatorial practice (within established and independent institutions) include the California Museum of Photography at UC Riverside, @art (an electronic art gallery affiliated with the School of Art and Design at the University of Illinois), Dia Center (New York). Examples of collecting web art include The San Francisco Museum of Modern Art (acquiring websites), The Whitney Museum of American Art; and Walker Art Center (all cited in Dietz 1997).

¹³⁰ Ars Electronica Festival, Linz, 1979 - ongoing (<http://www.aec.at/>), ISEA (The Inter-Society for Electronic Arts) (<http://isea2006.sjsu.edu/>). Alternative platforms for the presentation, distribution and contextualisation of emergent cultural practices have a distinct history that relates to the emergence of media festivals as a response to the general reluctance of mainstream art institutions to respond to new practices (and emphasises their reactionary character). For instance, this is what Piotr Krajewski explores in his essay 'An Inventory of Media Art Festivals' (2006) emphasising the strategic importance of festivals in engaging with media works and facilitating the presentation and distribution of emergent practices - the function that mainstream art institutions failed to deliver.

¹³¹ *CRUMB* (Curatorial Resource for Upstart Media Bliss), Sunderland University, UK (<http://www.crumbweb.org>), *Open Congress* (<http://opencongress.omweb.org/wakka/HomePage>).

¹³² The original *Gallery 9*, established and run by Steve Dietz from 1997 to 2003, is available in the Walker Art Centre's Web Archives online (<http://www.walkerart.org/archive/7/96D3639B6E5717946167.htm>). The current version of *Gallery 9* was launched in April 2004 and is available online (<http://gallery9.walkerart.org/>).

¹³³ Created by Benjamin Weil in 1995, *ada'web* was originally located at <http://www.adaweb.com>, and currently is online (<http://www.walkerart.org/archive/2/AD737122FD544FA56164.htm>). On the history of *ada'web* see Weil (1998) 'UNTITLED (ADA'WEB)' online (<http://www.walkerart.org/archive/A/AC7371BBE6DD46CA6165.htm>).

¹³⁴ *Art Dirt* (<http://www.walkerart.org/archive/9/A373718EC77CE75B612F.htm>).

¹³⁵ Other examples of 'online portals' include the Guggenheim's *Apertures*, which Morris describes as a fairly centralised repository but operating intra-institutionally (cited in Morris 2001). Described as 'napster for art' it was an attempt to open up museums to the idea of 'network' through creating 'a way of exchanging bookmarks and dynamically altering them, colliding them together or subtracting one from another'. Jon Ippolito comments on this: 'you could essentially build your own personalised curator, by a certain percentage of my bookmarks, Steve Dietz's, Benjamin Weil's and Christiane Paul's and putting them together in a chain' (in Morris 2001: 34). Other examples of online portals are: *Crossfade*, a collaboration between SFMOMA, the Goethe Institute, ZKM and the Walker Art Center (<http://www.sfmoma.org/crossfade>); the earlier mentioned Guggenheim's *Cyberatlas* that commissions and collects series of maps of cyberspace with a particular focus on sites related to visual art and culture (<http://www.cyberatlas.guggenheim.org>); *Shock of the View*, a collaboration between the Walker Arts Center, Davis Museum and Cultural Center at Wellesley College, The San Jose Museum of Art, the Wexner Center for the Arts at Ohio State University and Rhizome (http://www.walkerart.org/salons/shockoftheview/sv_front.html) that was initiated as a discussion listserv in 1999 with a parallel series of exhibitions.

¹³⁶ This information is derived from an email conversation between myself and Kelli Dipple, curator of Tate Online Events and curator of the newly extended 'Net Art Commissions' section at Tate (13 August 2007). The first (but not final) iteration of these changes can be found online <http://www.tate.org.uk/tateplayer>.

¹³⁷ In the UK, this is exemplified in the work of Kayle Brandon and Heath Bunting (working together since 2001), both part of the *Irrational.org* and one of the early pioneers of net art and net activism; Kate Rich (of BIT and *Irrational.org*), Julian Priest and James Stevens's project *consume.net* to develop DIY community wireless networks around London (working since 2001, under the telling motto 'Trip the loop, make your switch, consume the net'; *The People Speak* project that develops DIY tools to bring people together through conversation and play; or The University of Openess, a self-institution for independent research, collaboration and learning. Elsewhere, the recent exhibition 'Radical Software: Art, Technology, and the Bay Area Underground' (curated by Will Bradley at the California College of Arts's (CCA) Wattis Institute in San Francisco, November 2006– March 2007) offered a historical look at the work of DIY programmers, hackers and activists mostly from the 1970s and 1980s generation, including Copenhagen Free University (a DIY educational self-institution), amongst many others. Examples cited (<http://www.irrational.org>), (<http://consume.net/>), (<http://thepeople.net/>), (http://uo.twentiethcentury.com/index.php/Main_Page), (<http://www.wattis.org/>).

¹³⁸ The issue of how social technologies can be adapted for mainstream art galleries is demonstrated for example in the Saatchi gallery online project 'Your gallery'. It plays on the earlier popular online social platform 'Myspace' (operating under the slogan 'a place for friends'), and more recently 'YouTube' (operating under the slogan 'Broadcast Yourself'). It offers to 'showcase your art to thousands of visitors every day', and the added attraction of displaying work on Saatchi's online 'gallery' is the possibility of being selected by invited 'experts – critics' to the so called 'Saatchi Online top 10', or even more prestigious prize of being selected for shows in physical venues. This demonstrates that, despite the claims of many: 'communities like this supplement rather than supplant: eBay created a new market and new opportunities for small businesses, but it has not replaced conventional retail', quoted in the IDC List posting from Chris Byrne, 17 August 2007, List Archive (<http://mailman.thing.net/pipermail/idc/>). References: (<http://www.saatchi-gallery.co.uk/yourgallery/>), (<http://www.myspace.com/>), (<http://www.youtube.com/>).

¹³⁹ The description of social technologies and critical concerns that underpin current discussions in this field is derived from the *Art & Social Technologies* research group (at the University of Plymouth, UK) (<http://www.art-social.net>).

¹⁴⁰ For Graham (2006), focusing discussion around 'models of curating' is an attempt to identify the most effective process for exhibiting new media artworks. As an example, in March 2003 these models included 'curator as producer'; in April 2005 they included 'curator as co-producer' or even 'curator as multitasking maniac'; and in June 2005 they included 'curator as editor' and 'curator as filter'. Artist/curator models are also under debate: Yara Guasque recently pointed out that in Brazil the aesthetics of curating are necessarily DIY or 'construct by yourself' and Luis Silva linked to the debate with the notion of blogging as curating. (<http://www.crumbweb.org>).

¹⁴¹ In this sense the Open Congress methodology can be compared to a CVS (a version control system) – a commonly used term in open source projects and an important management

mechanism that allows several developers to work on the same files simultaneously and remotely. It allows the recording of individual histories of sources files and documents while storing it on a single central server.

¹⁴² *Node.London* (2005) (<http://nodel.org/>).

¹⁴³ unDEAF, Rotterdam (2007) (<http://undeaf.v2.nl/>).

¹⁴⁴ These ideas have since been developed in the recently successfully submitted PhD thesis *Art Platforms. The Constitution of Cultural and Artistic Currents on the Internet* (2007), University of Arts and Design Helsinki.

¹⁴⁵ For more information see (<http://vercodigofonte.blogspot.com/2005/11/on-blogging-as-curating.html>).

¹⁴⁶ The project is described in the following way: 'TAGallery by CONT3XT.NET extends the idea of a tagged exhibition and transfers the main tasks of non-commercial exhibition-spaces to the discourse of an electronic data-space. The method of tagging allows the attribution of artworks to different thematic fields. In TAGallery the act of selecting and recombining – besides chronologically ordered show-rooms, exhibition-titles in a semantically concentrated form and various ways of contextualizing the presented artworks – will be published as well: The continuous progression of curating can be followed by the public, using newsfeeds.' The TAGallery is located online (<http://del.icio.us/TAGallery>). The first TAGallery-exhibition 'dead.art(-missing!)LINKreSources' deals with the idea of a 'link' as metaphor for networking, collaborating, contextualizing as well as with its reversed connotation: missing or broken link. The link that is not working stands for the ephemerality of Web-based art-forms. The requested URL not found on the server emphasises just as much the need for human care and maintenance as technology itself. References: Gallery (<http://del.icio.us/TAGallery>), Exhibition (http://del.icio.us/TAGallery/EXHIBITION_dead.art).

¹⁴⁷ EXHIBITION_003_link.of.thought_thought.of.link was tagged/curated by Ursula Endlicher and Ela Kagel, who started the blog 'Curating NetArt' in May 2006. Their exhibition 'link.of.thought_thought.of.link...' for TAGallery is an extension of this blog in dialogue-form and a meta-curatorial statement of their perspective on the challenges of curating media/net/art. With projects/works by: UBERMORGEN/Alessandro Ludovico/Paolo Cirio, Jo-Anne Green/Helen Thorington (Turbulence), Aleksandra Domanovic/Oliver Laric/Christoph Priglinger/Georg Schnitzer, Cornelia Sollfrank, Eva Grubinger/Thomas Kaulmann, 0100101110101101 (Eva and Franco Mattes), Ruth Catlow/Marc Garrett (Furtherfield), Graffiti Research Lab, Mushon Zer-Aviv/Dan Phiffer. References; Exhibition (http://del.icio.us/TAGallery/EXHIBITION_link.of.thought) Curator's dialogue (http://del.icio.us/TAGallery/TEXTS_link.of.thought), Curator's bio/CV (http://del.icio.us/TAGallery/TAGGERS_link.of.thought), Curator's blog (<http://curating-netart.blogspot.com>).

¹⁴⁸ In this respect see (http://del.icio.us/TaGallery/EXHIBITION_link.of.thought). Other examples of the use of blog in relation to (public) curating, as listed in CRUMB List posting from 15 August 2007, include: <http://www.curating.info> (run by Michelle Kasprzak), <http://museumtwo.blogspot.com/> (run by Nina Simon), <http://curating-netart.blogspot.com> (run by Ursula Endlicher and Ela Kagel), <http://leisurearts.blogspot.com/> (run by an anonymous group). More generally in relation to new media art, examples of blogs listed in the same CRUMB posting were: <http://www.we-make-money-not-art.com> (run by Regine Debatty); <http://blog.furtherfield.org> (run by furtherfield/http); <http://www.test.org.uk> (run by Matt Locke), <http://www.eyebam.org/reblog/> (run by a different person every two weeks), <http://blogs.walkerart.org/newmedia/> (run by designers/producers), <http://www.colnoperated.com/> (the site of artist Jonah Brucker Cohen). The CRUMB List Archive can be found online (<http://crumbweb.org/discussionMenu.php?id=9&showList=1&ts=1199034774>).

¹⁴⁹ For more information see (<http://del.icio.us/>).

¹⁵⁰ Luis Silva further explains the idea of social bookmarking and its relation to curating: 'Social bookmarking allows for users to easily store lists of resources (websites, for instance) and have them available to the public, allowing people with the same interests (or not) to share and have easy access to relevant information on a specific subject. But the most important feature of social bookmarking lies in the categorization of these resources by the users themselves. Tagging is the word that comes to mind. Tagging consists basically in the possibility these social bookmarking services have of allowing the users not only to bookmark something, but to informally assign tags (relevant keywords) to it, thus creating meta-data about the tagged

resources in a collective way, rather than individually, something that can be seen as a second layer of meaning, but determined by the users rather than the original producer of the content. This is what is called folksonomy, a user-generated taxonomy used to retrieve and categorize web content.' (http://del.icio.us/TAGallery/STATEMENTS_I.tag_you). The works tagged for the exhibition *I tag you tag me* include: 53os, _____ING, Agnes de Cayeux, Alan Bigelow, Alexander Mouton, Anders Weberg, Ben Rubin, Brian Caiazza, Carlos Katastrosky, Chiara Passa, Chih Min, Christiaan Cruz, Chromakey, Cici Moss, Concept Trucking, G. H. Hovagimyan, Garrett Lynch, J. R. Carpenter, James Whipple, Jimpunk, John Freyer, John Michael Boling, Josh On, Kenneth Tin-Kin Hung, La Molleindustria, LeisureArts, Les Liens Invisibles, Lev Manovich, Marc Kremers, Marek Walczak, Mario Klingemann, Mark Hansen, Mark Napier, Martha L. Deed, Martin Wattenberg, Mary-Anne Breeze, Millie Niss, Mouchette, Nano Corporation, Oleg Marakov, Olla Lialina, Patricia Gouveia, Peter Sinclair, Regina Célia Pinto, Ricardo Miranda Zuñiga, Santiago Ortiz, Stewart Smith, Yael Kanarek, YOUNG-HAE CHANG HEAVY INDUSTRIES, and others. The list of artists contributing to the show can be extended at the original account online (http://del.icio.us/I_tag_you_tag_me) (Username: I_tag_you_tag_me, Password: ole166). References: Exhibition at TAGallery (http://del.icio.us/TAGallery/EXHIBITION_I.tag_you), Statement (http://del.icio.us/TAGallery/STATEMENTS_I.tag_you), Initiator/curator (http://del.icio.us/TAGallery/TAGGER_I.tag_you), Browsing by 6pli (Santiago Ortiz) (http://del.icio.us/TAGallery/VISUALIZE_I.tag_you).

¹⁵¹ The *AddArt* project by Steve Lambert has been selected for the Rhizome's 2007-2008 Commissions. The project is essentially a Firefox extension that replaces ads on web pages with art images from a curated database and in this way 'turns your browser into an art gallery'. In addition, a supporting website provides information on artists and curators, and a schedule of *AddArt* shows. It operates the policy of one artist shown per page while the curatorial responsibility is 'passed among curators through recommendations, word of mouth, and solicitations to the *AddArt* site.' For further description see (<http://www.addart.eyebam.org/>).

¹⁵² Less specifically in relation to online curating but more generally computer-based art, Inke Arns and Jacob Lillemose (2005) describe three tendencies in curating. Paraphrasing these: institutionalised curating, that is represented by high profile figures and events (while the high profile of the curator allows presenting digital art within the context of an established art institution and thus creates historical links, and links with other mainstream art forms); institutionalized but within a context that deals with computer based art (examples include media art festivals where a curator [or a team] from the institution selects the works for the exhibition, an appointed jury selects the works for the competition; included in this tendency are also spaces and organisations that have made computer based art their field of interest, like the *Electrohype* in Malmö, *ZKM* in Karlsruhe and *V2* in Rotterdam); and the curatorial formats and strategies found in organizations, groupings and platforms based primarily on the net (like *Runme*, *Rhizome* and *Eyebeam*). Arns and Lillemose argue that new approaches to art, for instance computer-based art, should be presented outside the white cube and demand new and more democratic approaches to curating in which the figure of the single and affiliated curator is replaced by 'a diversity of non-hierarchical and multi-person curatorships' (<http://www.projects.v2.nl/~arns/Texts/Media/ArticleforArgos-Arns-Lillemose.pdf>).

¹⁵³ See (<http://www.Artnetweb.com/port/>).

¹⁵⁴ *The Intelligent Labelling Explorer* (ILEX) (<http://www.cogsci.ed.ac.uk/~alik/illex.html>) is described as follows: 'The first phase of the *Intelligent Labelling Explorer* project has built the ILEX-1 system, which uses Natural Language technology to generate descriptions of objects displayed in a museum gallery. Each description appears on a Web page, and the user can move from page to page, viewing the objects in any order, mimicking the experience of someone walking through the museum. Crucially, these descriptions aren't simply retrieved from a storage space, but are generated on demand by combining canned text with fully generated text in a coherent way. [...] To date, two versions have been implemented (ILEX-0 and ILEX-1); both describe objects in the National Museums of Scotland's 20th Century Jewellery Gallery.' (Hitzemann, Mellish & Oberlander 1997 and <http://www.archimuse.com/mw97/mw97mon.htm>).

¹⁵⁵ The conceptual rationale behind the project is summarised in the following literature: (http://www.museumlearning.org/scripts/search_display.php?Ref_ID=946); (Oberlander 1997) (<http://www.hcrc.ed.ac.uk/illex/final.html>); (Hitzeman, Mellish, Oberlander 1997) (http://66.102.9.104/search?q=cache:dn4pQevg1JUJ:www.cstr.ed.ac.uk/downloads/publications/1997/Hitzeman_1997_a.ps+ilex+virtual+curator&hl=en&ct=clnk&cd=7&gl=uk&client=firefox-a/); (Dietz 1997) (<http://www.afsnitp.dk/onoff/Texts/dietzcuratingont.html>).

¹⁵⁶ *Desktop Is*, Alexei Shulgin (1997-98) (<http://www.easylife.org/desktop>).

¹⁵⁷ *C@C – Computer-Aided Curating*, Eva Grubinger (1993–1995) (<http://www.evagrubinger.com/>).

¹⁵⁸ Eva Grubinger's review of the project, 'C@C: Computer-Aided Curating (1993–1995) Revisited', has been recently published in 'Curating Immateriality' (Krysa 2006). For further information see (http://www.aec.at/en/archives/festival_archive/festival_catalogs/festival_artikel.asp?iProjectID=8638).

¹⁵⁹ For a technical description of the *FLOAT* project see (http://fundamental.art.pl/float_00.htm).

¹⁶⁰ See (<http://www.freeconcept.net/>) or (<http://fundamentalresearch.org/FACE/face.htm>).

¹⁶¹ See note 160.

¹⁶² See note 160.

¹⁶³ Arns and Lillemose (2005) point to examples of 'distributed curatorship' that do not necessarily involve technology: 'one does not necessarily have to look at new forms of net (activist) art, software art or generative art to find unusual models of shared and distributed curatorship. The most recent examples in the context of contemporary visual arts are the exhibition *Collective Creativity* (on collective practices and group enjoyment) by the Zagreb-based curators' collective WHW currently on display in Kassel, the exhibition 'On Difference' at the Württembergischer Kunstverein in Stuttgart curated by a distributed network of artists and curators, the *East Art Map* initiated in 2002 by the Slovenian artists' collective Irwin (NSK) and Jochen Gerz's *Anthology of Art* which was developed online between 2001 and 2002. All these alternative, or distributed forms of curatorial models have developed in the field of contemporary visual art.' References (respectively): (http://www.fridericianum-kassel.de/ausst/ausst-kollektiv.html#interfunktionen_english), (<http://www.wkv-stuttgart.de>), (<http://www.eastartmap.org>), (<http://www.anthology-of-art.net>), (<http://www.projects.v2.nl/~arns/Texts/Media/ArticleforArgos-Arns-Lillemose.pdf>)

¹⁶⁴ Project website (<http://www.nodecurated.net/>).

¹⁶⁵ Furthermore: 'This tool synthesises the basic parameters defined in the functions of author as manager and work of art as a tool, where the user plays the determinant role in its configuration. Nevertheless, this project aims to be a tool of analysis of the practices of creation on the net. In this way, an open context is defined in the environment of cultural production on the net, favouring the presence of conceptual suggestions in the area of digital practices.' For further details see project website (<http://www.nodecurated.net/>).

¹⁶⁶ *net art locator* (low-fi) (<http://www.low-fi.org.uk>). low-fi is an artist collective focusing on net art; and mediation and distribution systems. In addition to 'net art locator' the collective also commissions and curates offline. Current members are: Kris Cohen, Rod Dickinson, Jenny Ekelund, Luci Eysers, Alex Kent, Jon Thomson, Chloe Vaitsoy; and other members include Ryan Johnston, Pierre le Gonidec, Anna Kari and Guilhem Alandry. Also see a feature on 'Net Art Locator' in Krysa (ed.) (2006: 181–189).

¹⁶⁷ The UK Museum of Ordure (UKMO) exists predominantly online although it occasionally runs offline projects (<http://www.museum-ordure.org.uk/Projects/>). It is managed by three trustees – Stuart Brisley (Director), Geoff Cox (Treasurer) and Adrian Ward (Secretary). A longer statement on the concerns of the Museum can be found on its website (<http://www.museum-ordure.org.uk>).

¹⁶⁸ For more information on Web Curator Tool (WCT version 1.1.) software [Fig. 29] initiated by the International Internet Preservation Consortium, described as an open source tool for collecting and archiving web material, or 'managing the selective web harvesting process', see (<http://www.webcurator.sf.net>). What this recent development demonstrates is an increasing line of thinking about the Internet – both metaphorically and literally – as a research tool and as an enormous public archive. It is also symptomatic of current discussions around open source models of knowledge production and distribution, in keeping with the inherent structures of networks. Furthermore, it suggests a certain relationship between the practices of software, curating and archiving whilst at the same time confuses the connections between online production, storage, display and access. Examples of online collaborative repositories, curatorial platforms and distributed curatorial systems described in the thesis (in particular in chapters 5 and 6) largely demonstrate this tendency. The significance of this in relation to archiving is in

the possibilities offered by the relatively automated functions embedded in online curatorial software such as collecting (often in the open submission process or through crawling the web) indexing and repositing that emphasise the relation to archiving where the database lies at the centre of operations and furthermore that exemplify how 'archivisation produces as much as it records the event' (Derrida 1996: 16–17). Indeed, online repositories, curatorial platforms and software systems such as Rhizome's Archive or Tate Online demonstrate this point in that they are active in the production of meaning and also more overtly stresses participatory potential of archives as an open, public resource and research tool [Fig. 30, 31]. For a full version of the presentation that deals with this issue see (<http://www.wrocenter.pl/pl/wro07symposium>).

¹⁶⁹ *Runme* (<http://www.runme.org>), launched in January 2003, is a collaborative project developed by Amy Alexander, Florian Cramer, Matthew Fuller, Olga Gorunova, Thomax Kaulmann, Alex McLean, Pit Schultz, Alexei Shulgin, and The Yes Men. Further members are Hans Bernhard and Alessandro Ludovico. The Runme.org website has been conceptualised and administrated by Amy Alexander, Olga Gorunova, Alex McLean and Alexei Shulgin; and was developed by Alex McLean.

¹⁷⁰ The Readme festival places an emphasis on software art development and its critical contextualisation. Organised by Olga Gorunova and Alexei Shulgin, it was first held in Moscow in 2002 and subsequently in Helsinki, Aarhus and Dortmund (<http://readme.runme.org>).

¹⁷¹ It should be noted that a more recent tendency is for festivals to drop specific categories. For instance WRO Media Art Festival in Wroclaw (Poland) and Transmediale in Berlin (Germany) have both adopted this approach since 2001 and 2005 respectively.

¹⁷² The listed projects are: *Do it with Others* (2007) (<http://www.http.uk.net/docs/exhib12/exhibitions12.shtml>) and *Hack -able Curator* (2007) (<http://www.hackablecurator.org.uk/>).

¹⁷³ As a further historical contextualisation of the project conceptual idea Catlow explains the process in more detail: 'Historically Mail Art has a difficult relation to the old question about whether it belongs in a gallery (obvious eg Ray Johnson's "Dear Whitney Museum I hate you" mail art). What we try to explore and give room to in this approach to curating is a more dynamic and malleable context for the work. At HTTP we are in the fortunate position to be able to give space to this approach because of our relative informality, autonomy and independence, a decent-enough technical resource and our small but enthusiastic and broadly-skilled team of artist/producers and (for the time-being) curious and engaged visitors. Of course lots of people are not interested in all these different parts of the process. Many contributors prefer to leave the issues surrounding the display and dissemination of their artwork to others. But one of the reasons we chose to focus on the Mail Art theme was because of its reflexive nature. It considers all aspects of the artwork's passage through existing communication channels (through time and space) to the recipient(s) as contributing to the *raison d'être* of the work. This is interesting to us as artists.' (Catlow, posting to CRUMB list, 24 March 2007, <http://www.crumbweb.org>).

¹⁷⁴ There is a distinction here to be made between the term 'hacking' and what some refer to as 'cracking'. While hacking (performed by a 'hacker') describes a computer expertise and skills used to solve difficult technical problem without causing computer harm, cracking (performed by a 'cracker') implies using technical expertise to break into computer systems for malicious purposes causing harm (for instance shutting down computer systems) (Barabási 2002: 116). The term 'hack' is a particularly misunderstood term in popular culture and usually carries negative connotations. In contrast, in the computer programming community, the term refers to a clever solution to a problem, thus a creative and transformative act. The historical roots of this practice go back to 'appropriation and (post-Duchampian) practices of hacking new material out of found objects. One can think about hacking all sorts of everyday objects and everyday life situations – hacking buildings, bodies, sexuality, machines, code, texts, ideologies.' For more references see (<http://www.kurator.org/hack>).

¹⁷⁵ *Hack-able curator* (2007) is a collaborative project by Anita Barwacz, Lindsey Bedford, Andy Bennett, Anaisa Franco, Martha Patricia Nino and Richard Wilkes (students of the masters programme in Digital Art and Technology at the University of Plymouth, UK). It was first shown as part of the *SLOW* exhibition (January – March 2007) at the Plymouth Arts Centre, Plymouth, UK (<http://www.hackablecurator.org.uk/>).

¹⁷⁶ Other recent projects that even more explicitly exploit social technologies to construct open public platforms for participatory production and user generated content include Axel Roch's *Mikrogalleri.es* (2007): 'the new ZKM platform that allows online users to present images in distributed places for art and in real at remote locations, at the same time each user creates new

art images online to share' (<http://mikrogalleri.es/>). There is a current proliferation of projects in this vein and in addition to the list of pertinent examples I have provided in this respect in chapter 5.2, the list could undoubtedly be continued. However, a more comprehensive catalogue of these is outside of the focus of the thesis.

¹⁷⁷ Of relevance here, are recent publications in the field of contemporary arts such as Claire Bishop's *Participation* (2006), Rossiter's *Organized Networks* (2006) as mentioned above, or established in recent critical discussions around the claims of social technologies held on the IDC mail list (also mentioned earlier); or indeed in political theory, such as Ernesto Laclau and Chantal Mouffe's *Hegemony and Socialist Strategy: Towards a Radical Democratic Politics* (1985).

¹⁷⁸ Conventionally, debates in the field largely focus on curating in relation to its exhibiting aspect (such as space/venue, exhibition design, works to be exhibited, theme, etc) or the curatorial function (what roles curators take) but the underlying mechanisms or the 'source code' of curatorial protocols remain relatively hidden.

¹⁷⁹ For details about the project and credits, see note 8. For further information, see KURATOR (<http://www.kurator.org/wiki/main/read/Kurator>); to view the project online, see (<http://software.kurator.org/v1/>); to view an archived prototype version (v 0.1), see (<http://www.kurator.org/wiki/main/read/dev>).

¹⁸⁰ For more information on the GPL (General Public License), see (<http://www.gnu.org/>); for details of *kurator's* license, see (<http://software.kurator.org/v1/license.php>); for details of *kurator's* terms of use, see (<http://software.kurator.org/v1/terms.php>).

¹⁸¹ *kurator* (v.0.1) (<http://www.kurator.org/wiki/main/read/dev>). In this version, the site was structured around the following modules: upload, repository, source browser, plain text search, identifier search, file search, comment search, add your comment, auto-kurator and modify kurator (the latter two were not fully implemented). [Fig. 32] The software was programmed mostly in perl, and html is generated using templates processed by perl cgi scripts. The code is stored in plain files and referenced in a database; the code source trees are expanded and then indexed using ctags, results are inserted to MySQL database. The system has common code with the LXR system (linux cross-reference project), and could be extended or modified. However, in this version the system is self-contained and does not have connections to other external online systems. Next, in contrast to more conventional submission formats of art works as a result of the execution of binary code, this system allows submission of works as source code in one of the following formats: tar.gz, tgz, tar, gz, zip. These formats work as an extension check, and based on this, files are then unpacked. The system uses text file that means the filenames are stored in a plain text file. A range of predefined tags (i.e. description, filename, author, etc.) provides a more traditional way of accessing projects in the repository. In this version there is no database of users and submission of source code does not require authentication and is anonymous. Thus projects for the repository are submitted in an open and unmoderated process and users choose how they wish to classify and describe works they submit. Submitted works, either as separate files or compressed, are then opened, uncompressed, repositied and indexed by the system of modules. 'Repository' files all the submitted projects with a download function. Indexing/processing of projects in the database depends on modules selected by users. For example, the 'Source Browser' is based on existing ctags and lxr and operates on the code itself indexing all the function declarations, data definitions, etc. It allows browsing cross-referenced source code/source tree - content. 'Plain Text Search', alongside the usual functionality of ctags, allows cross-referencing of over thirty different computer languages and searching any string of characters or words. 'Identifier Search' allows searching a unique string representing the name of the function whereas 'File Search' allows searching according to the filename of submitted projects. 'Comment Search' allows searching for comments included with the source code that are normally removed from the software in the compilation process whereas the 'Add Your Comment' module allows users to extend existing comments in the source code adding another layer of commentary. Finally, 'Auto-Kurator' enables generative selections and new displays from the existing repository of submitted works. Using these modules automatically creates what in curatorial terms would be described as 'selections' or 'displays'. Based on user input from the selection of modules, the system produces a 'Results' page listing specific projects with different viewing options, information about the project and the availability of the source code. Depending on modules used the resultant page can be displayed as a list of works by project title, author, source code, or file names. The 'Auto-Kurator' option is analogous to the task of an autonomous curator making its own selections. Furthermore, the 'Modify Kurator' module provides users with the possibility of modify existing specific modules, and adding new ones by sending a patch. Soliciting user feedback and evaluation of the project (traditionally part of the curatorial protocol) is in this case facilitated through two mechanisms - comments with each

submitted project and comments about the *kurator* itself, with suggestions for modification. Further references: for more on LXR see (<http://sourceforge.net/projects/lxr>).

¹⁸² *kurator* (v1.0) (<http://software.kurator.org/v1/>).

¹⁸³ The subsequent development of the project was supported by a commissioned evaluation from George Grinsted (November, 2006). Divided into three sections, it provides a comprehensive critique of the project and suggestions for future development extrapolated to the diagram included in the section [Figure 33].

¹⁸⁴ At the time of the submission of the thesis the web crawler function is not implemented and more research is required to find the optimal way of integrating this function with the software.

¹⁸⁵ For an extended definition of 'web crawler', see (http://en.wikipedia.org/wiki/Web_crawler).

¹⁸⁶ For details of *kurator*'s terms of use, see (<http://software.kurator.org/v1/terms.php>).

¹⁸⁷ At the time of the submission of the thesis, a sample display 'Barszcz C Recipe' (March 2008) was created for the project home page (Featured Display) by the KURATOR team. [Fig. 35] The display explores the parallel between programming and cooking recipes. 'Barszcz C Recipe' includes one example of a recipe expressed as source code: string based cooking in programming language C (2006) by Jaromil (<http://software.kurator.org/v1/>).

¹⁸⁸ PHP (a recursive acronym for 'PHP: Hypertext Preprocessor') is a programming language used mainly in server-side scripting, but can be used from a command line interface or in standalone graphical applications. HTML (Hypertext Markup Language) is the predominant markup language for web pages. API (Application Programming Interface) is a source code interface that a computer application, operating system or library provides to support requests for services to be made of it by a computer program. Ajax (Asynchronous JavaScript and XML) is based on JavaScript and HTTP and is described as a 'group of inter-related web development techniques used for creating interactive web applications'. It uses the nonstandard XMLHttpRequest object to communicate with server-side scripts and is asynchronous (that is extra data is requested from the server and loaded in the background without interfering with the display and behavior of the existing page). Ajax is used to increase the web page's interactivity, speed, functionality, and usability. Further information and quotes from: (<http://www.php.net>), (<http://en.wikipedia.org/wiki/HTML>), (<http://www.sel.cmu.edu/str/descriptions/apl.html>), (<http://en.wikipedia.org/wiki/AJAX>), (http://developer.mozilla.org/en/docs/AJAX:Getting_Started).

¹⁸⁹ For further details on presentations, see Appendices 8.1.3.

¹⁹⁰ For further details of related published papers, see Appendices 8.2. For further details of related conference papers, see Appendices 8.3.

[all web sites in end notes last accessed 17/01/08]

8. Appendices

8.1. Selected Projects

Research towards production of the thesis led to the production of two projects during the registration period (2002–2008) included in addition to the *kurator* project (presented in chapter 6.2) in support of the thesis. Each of these projects, a conference and edited book, combines critical investigation relating to the research with elements of curatorial practice. Diverse formats of the projects submitted emphasise the development of a critical investigation from initial formulation of the research (conference, 2005) and theoretical exploration (book, 2006), through to the subsequent production of the curatorial online software project *kurator* (2008). What follows is documentation of three projects: *CIS* conference, *CI* book and *kurator* software on DVD, including audio, visual, print materials and source files (where relevant).

8.1.1 CURATING, IMMATERIALITY, SYSTEMS

Format: curatorship of programme of events, including International conference on curating digital media, project presentation and real time coding performance

Location: Tate Modern, London (also streamed in real time and archived online)

Date: 4 June 2005

URL:

<http://www.tate.org.uk/onlineevents/archive/CuratingImmaterialitySystems/>

<http://www.tate.org.uk/onlineevents/archive/CuratingImmaterialitySystems/slub.htm>

<http://www.kurator.org/wiki/main/read/Curating+Immateriality+Systems>

Curating, Immateriality, Systems is a programme of events including International conference on curating digital media, *kurator* (v0.1) project presentation and a real time coding performance by SLUB.

The programme was the opening event of the *COde Of practice* season at Tate Modern (4 June – 31 September 2005) that further included the *Open Systems Rethinking Art c.1970* exhibition and symposium, and *COde Of practice* online panel discussion.

It investigated critical ideas and models of curatorial practice that have emerged in response to the Internet. It was distinctive in applying critical ideas of Immateriality (from Autonomist Marxism) to curating and furthermore in exploring a number of examples of curatorial practice that overtly engages with technological systems.

The conference featured presentations from leading theorists, curators and artists: Inke Arns (Hardware Medien Kunst Verein, Dortmund, Germany), Josephine Berry Slater (MUTE, UK), Geoff Cox (UoP, UK), Olga Goriunova and Alexei Shulgln (Runme/Readme, Russia), Eva Grubinger ('C@C', Germany), Piotr Krajewski (WRO Media Art Biennale, Poland), Jacob Lillemose (ArtNode, Denmark), Franziska Nori (Digitalcraft, Museum of Applied Arts, Frankfurt, Germany), Christiane Paul (Whitney Museum of American Art, New York), Grzesiek Sedek (Wimbledon School of Art, UK), Tiziana Terranova (Università degli studi di Napoli L'Orientale, Italy), Dominic Wilsdon (Tate Modern), and live-coding performance by SLUB.

SLUB (<http://www.slub.org/>), collaboration between Adrian Ward and Alex McLean, performed generative software applications in real-time in the Starr Auditorium.

The project was organised in partnership with Tate Modern, funded by the Arts Council England with additional support from the Danish Arts Council.

Reviews and references:

- *C0de Of practice*
http://www.tate.org.uk/onlineevents/archive/code_of_practice/
C0de Of practice forum <http://www.tate.org.uk/contact/forums/onlineevents/>
- Rhizome, 'Kurating by Numbers', review by Marina Vishmidt, 2005
<http://rhizome.org/news/story.rhiz?timestamp=20050610>
- Inke Arns & Jacob Lillemose (2005) 'It's contemporary art, stupid. Curating computer based art out of the ghetto', paper published in *Argos Festival*, ed. Anke Buxmann, Brussels: Frie Depraetere, argoseditions.
- Oliver Grau (ed.), (2005) *Media Art Histories*, Cambridge, Mass.: MIT Press, pp.272.
- Lizzie Muller and Ernest Edmonds (2006), 'Living Laboratories: Making and Curating Interactive Art', *Siggraph*
<http://www.siggraph.org/artdesign/gallery/S06/paper2.pdf>

8.1.2 CURATING IMMATERIALITY: THE WORK OF THE CURATOR IN THE AGE OF NETWORK SYSTEMS

Format: edited book of critical essays and contributions, DATA browser series, vol 3; 288pp., Paper Perfectbound; 17 essays + 1 Introductory chapter, ISBN 1-57027-173-93. All texts released under a Creative Commons License 2006.

Publisher: Autonomedia, Brooklyn, New York

Distributor: Autonomedia (US), Pluto Press (Europe).

Date: 2006

URL:

<http://www.data-browser.net/03>

<http://www.plutobooks.com/>

<http://www.autonomedia.org/>

The book, an anthology of new critical writing features contributions from leading curators, critics and artists: 0100101110101101.ORG & epldemi[C], Josephine Berry Slater, Geoff Cox, Alexander R. Galloway & Eugene Thacker, Olga Gorlunova & Alexei Shulgin, Beryl Graham, Eva Grubinger, Piotr Krajewski, Jacob Lillemose, low-fi, Franziska Nori, Matteo Pasquinelli, Christiane Paul, Trebor Scholz, Grzesiek Sedek, Tiziana Terranova, Marina Vishmidt.

Curating Immateriality is volume 3 in the DATA browser series that draws upon the academic expertise of the international board of advisors and a collective editorial board (of which I am a member). The series, commissioned and published by the independent and radical publishers Autonomedia (New York), is a platform for experimental critical practices and thinking.

This volume investigates curatorial practice that engages with technological systems (computational systems, software, the Internet). Although there is much existing research in the field of curating new media, the book is distinctive in relating curating to post-Marxist thinking around immaterial labour and establishing a link between curatorial practice and the critical discourse around software. The book extends discussion from the earlier conference *Curating, Immateriality, Systems* (Tate Modern, 2005) and was informed by previous research published in the chapter 'Distributed Curating and Immateriality' (written 2004, forthcoming 2008) in Christiane Paul (ed.), *New Media Curating*, Berkeley: University of California Press.

Reviews:

- Leonardo Reviews (Jonathan Zilbergon, 2006)
http://leonardo.info/reviews/sept2006/curating_zilberg.html

- **Neural (Alessandro Ludovico, 2006)**
http://www.neural.it/nnews/curating_immateriality_e.htm
- **Rhizome (Luis Silva, 2006)**
<http://rhizome.org/editorial/fp/reblog.php/2145>
<http://rhizome.org/discuss/view/22025#42736>
- **MUTE (Jonathan Harris, 2007)**
<http://www.metamute.org/en/Control-Alt-Delete>

References:

The book was included as required reading for curatorial postgraduate courses including MFA in Curatorial Practices at the Brown University, US

(<https://wiki.brown.edu/confluence/display/MarkTribe/Curatorial+Practices+GISP+-+Spring+07+Syllabus>); University of California at Santa Barbara (Media and Materiality course, 2007;

<http://transcriptions.english.ucsb.edu/curriculum/courses/schedule.asp?CourseID=300>).

It was acquired by major academic libraries such as Stanford, UC Berkeley

(<http://www.lib.berkeley.edu/ARTH/artfeb07.html>); The University of New Mexico (<http://elibrary.unm.edu/falref/new/newdec2006.htm>).

8.1.3 KURATOR

Format: curatorship of an online software project

Date: 2005–2008

URL:

<http://www.kurator.org/wiki/main/read/Kurator>

<http://software.kurator.org/v1>

kurator is an online software system and a platform for curating source code. It is a collaborative project developed by Joasia Krysa (curator, producer and director), Grzesiek Sedek (curator/programmer) and Duncan Shingleton (curator/programmer), with contributions from Geoff Cox, Hugo de Rijke, George Grinstead, Giles Macleay and Adrian Ward. The first prototype version of the software (v 0.1) was programmed by Grzesiek Sedek in 2005 and presented as part of *Curating, Immateriality, Systems* events at Tate Modern, London, UK. Subsequent version (1.0) was programmed by Duncan Shingleton and was pre-launched at 'circulating contexts: CURATING MEDIA/NET/ART' event organised by CONT3XT.NET in Vienna, October 2007, with public release in March 2008.

The project is funded by Arts Council England; produced and managed by KURATOR for the purpose of fostering software development and content creation under Open-Source Initiative ('OSI')- approved licenses. License subject to the GNU General Public License (<http://www.gnu.org>), terms and conditions of use are available from <http://www.kurator.org/wiki/main/read/terms+of+use>.

Reviews and references:

- *Rhizome* ('Kurating by Numbers', Marina Vishmidt, 2005)
<http://www.rhizome.org/netartnews/story.rhiz?×tamp=20050610>
- 'Twilight of the Widgets' (Marina Vishmidt, chapter in *Curating Immateriality* (DATA browser 03, New York: Autonomedia, 2006, pp. 39-63)
- 'Code Of practice' panel discussion (Tate Online, 2005)
http://www.tate.org.uk/onlineevents/archive/code_of_practice/
<http://www.tate.org.uk/contact/forums/onlineevents/>
- CONT3XT.NET, <http://curating.cont3xt.net/>

Presentations:

- Tate Modern (London June 2005), in conjunction with *Curating, Immateriality, Systems* conference
<http://www.tate.org.uk/onlineevents/archive/CuratingImmaterialitySystems/>
- Centro de Artes Digitais Atmosferas (Lisbon June 2005), in conjunction with the launch of *Online Portuguese Net Art 1997 - 2004* exhibition,

http://www.atmosferas.net/netart/conferencia_en.htm

- Tate Britain (London October 2006), as part of *Open Congress* event, <http://opencongress.omweb.org/modules/wakka/HomePage>
- Piet Zwart Institute (Rotterdam, February 2006), as part of *Software Studies* workshop, <http://pzwart.wdka.hro.nl/mdr/Seminars2/softstudworkshop>
- CONT3XT.NET (Vienna 2007), as part of *Circulating Contexts* conference, <http://curating.cont3xt.net/>
- Computer Art Congress (Mexico City, March 2008), <http://europia.org/CAC2/>
- ISEA 2008 (International Symposium on Electronic Art) (Singapore July – August 2008), as part of *Open Systems Curating* panel (In the 'wiki wiki' symposium), forthcoming <http://www.isea2008.org/>

Related publications:

- Krysa J., Sedek G., 'Source Code' (2008), co-authored chapter In *Software Studies: A Lexicon*, book edited by Matthew Fuller, Cambridge, Mass.: MIT Press, <http://mitpress.mit.edu/catalog/item/default.asp?tttype=2&tid=11476>
- Krysa J., Shingleton D., (2007) 'Kurator Software: version beta 1.0', chapter In *circulating contexts -- Curating/Media/Net/Art*, edited by CCONT3XT.NET, Vienna: Books on Demand GmbH, Norderstedt, pp. 25-3, <http://curating.cont3xt.net/>
- Sedek G., (2006) 'Extracts from Kurator Source Code', In *Curating Immateriality: The Work of the Curator In the Age of Network Systems*, edited by Joasia Krysa, DATA Browser series (vol 3), New York: Autonomedia, pp. 63-69, <http://www.data-browser.net/03/>.
- Krysa J., 'Curating Immateriality' (2006), Introduction to *Curating Immateriality: The Work of the Curator In The Age of Network Systems*, DATA browser series, vol. 3, New York: Autonomedia.

[all web sites last accessed 16/01/08].

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8.3 Conference Papers

Research towards development of the *kurator* project led to a number of related conference papers, presentations, panels and external roles during the registration period between 2002–2008 as follows (listed in order from the most recent).

Related Conference Papers and Panels

- ISEA 2008 (International Symposium on Electronic Art), 'Open Systems Curating', panel and paper as part of 'wiki wiki' symposium, Singapore (forthcoming 25 July – 3 August 2008), <http://www.isea2008.org/page/1/>
- Computer Art Congress [CAC 2008], 'Software Curating: programming and curating for networks', conference paper, Mexico City (26–28 March 2008), organised by The Paragraphe Lab, University of Paris VIII (France), the Monterrey Tech Campus Toluca and Campus Estado de México (Mexico), and Europla Productions, <http://europla.org/CAC2/>
- Curating Media/Net/Art, 'The Politics of Online Curating: kurator software version beta 1.0', presentation (with Duncan Shingleton), Vienna, October 2007, <http://curating.cont3xt.net/>
- WRO Biennale 07: 12th International Media Art Biennale, 'Curating – Archiving: online repositories, curatorial platforms and curatorial software systems', symposium presentation, Wroclaw, Poland, May 2007, <http://wrocenter.pl/wro07symposium/>
- Piet Zwart Institute, Software Studies workshop, 'Source Code', presentation (with Grzesiek Sedek), Rotterdam, February 2006, <http://pzwart.wdka.hro.nl/mdr/Seminars2/softstudworkshop/>
- Tate Britain, Open Congress, 'Software Kurating', symposium presentation, (with Grzesiek Sedek), London, October 2005, <http://opencongress.omweb.org/modules/wakka/HomePage/:Open Congress/>
- Centro Cultural de Belém / Atmosferas – Centro de Artes Digitais, 'Software Kurating – Kurating as Software', conference presentation (with Grzesiek Sedek), in conjunction with the launch of exhibition *Online Portuguese Net Art 1997 – 2004* (curated by Luis Silva), Lisbon, Portugal, June 2005, http://www.atmosferas.net/netart/conferencia_en.htm

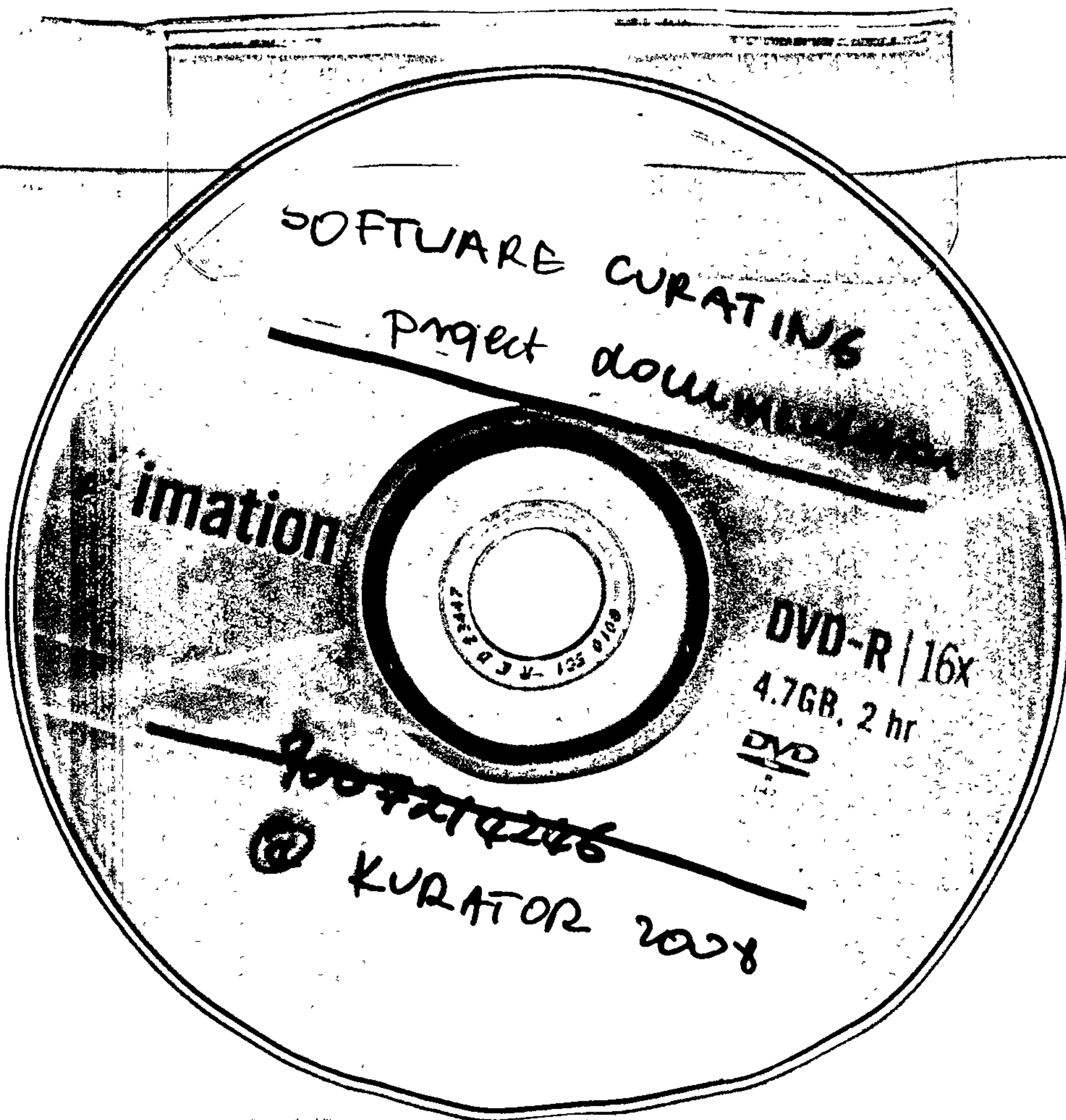
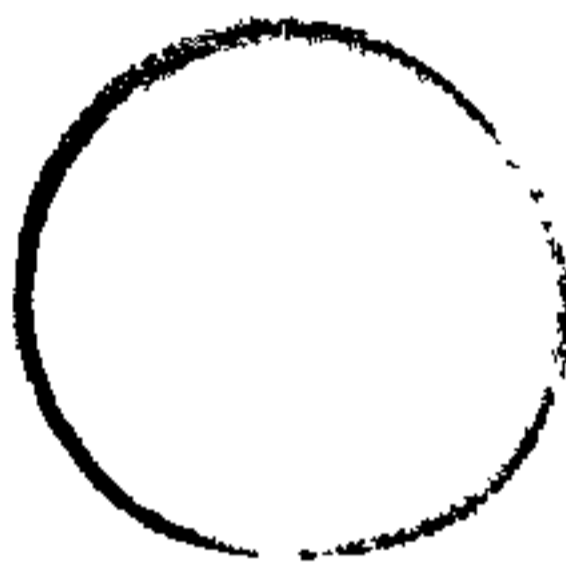
- Tate Modern, *Curating Immateriality Systems*, presentation of kurator project in conjunction with the conference, London, June 2005, <http://www.tate.org.uk/onlineevents/archive/CuratingImmaterialitySystems/>

Related External Roles

- Jury Member, ARTE 2.0 VOCENTO competition 2008, ARCO International Art Fair, Madrid, Spain, <http://www.vocento.com/English/acclon-cultural/arte-web.html/>
- Jury Member, ARCO /Beep New Media Art Awards 2007, ARCO International Art Fair, Madrid, Spain, <http://www.arco.beep.es/>
- Jury Member, Share Award 2007, Share Festival, Torino, Italy, <http://www.toshare.it/>
- Curatorial Network, curatorial board, with Arts Council England, UK (since 2005-ongoing), <http://www.curatorial.net/>
- FACE (Free Artist Concepts Exchange) project, curatorial advisory board, (2007-ongoing), <http://freeconcept.pl/>

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