A case for transdisciplinary practice in the Art, Science and Technology Research Environment: Michael Naimark's practice in the creation of *See Banff!* and *Be Now Here.*

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Abstract

This research paper looks at the practice of Michael Naimark as an artist during his tenure at some of the foremost Art, Science and Technology Research programmes and assesses the extent to which his practice was transdisciplinary. In order to do this I first look at the definition of transdisciplinarity and expand this to define the characteristics of transdisciplinary practice. I then explore the case for transdisciplinary practice within the context of Art, Science and Technology (AST) specifically, by examining the history of AST programmes and practice. This investigation raises questions as to the validity of transdisciplinarity between these disciplines. However, I explore the case for Art Practice as Research which provides a valid framework for transdisciplinary practice in AST. Having established this context I can now examine Naimark's process in the creation of *See Banff!* and *Be Now Here,* in particular, in order to assess his practice for transdisciplinary characteristics. It is clear from these writings that Naimark does show the characteristics of transdisciplinary practice. This implies that transdisciplinary practice has benefits in the context of AST Research and that transdisciplinary practice should be adopted as a method within these environments.

Declaration

I declare that this Research Report is my own unaided work. It is submitted for the degree of Masters of Digital Arts (In the field of Interactive Media) in the University of the Witwatersrand, Johannesburg. It has not been submitted before in other degree or examination in any other university.

Deborah Ann Rogers

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Chapter 1.1. Introduction

This chapter aims to set up a definition for transdisciplinary practice in general. This will then allow me to explore transdisciplinarity within the context of Art, Science and Technology Research in order to establish a framework from which I can start to assess the work of Michael Naimark and whether or not his practice can be regarded as transdisciplinary.

I will first define transdisciplinarity and look at its historic context. I will then be addressing transdisciplinary practice in particular.

Chapter 1.2. Categories of disciplines

In order to contextualise transdisciplinarity, I must first have an understanding of what is meant by a discipline.

Tony Becher and Paul Trowler in their book Academic Tribes and Territories aim to sort through and map the territory of academic knowledge (Becher and Trowler 2001, Preface to the First Edition). In so doing they note that “the concept of an academic discipline is not altogether straightforward, in that, as is true with many concepts, it allows room for some uncertainties of application” (Becher and Trowler 2001 41). They go on to state:

> Disciplines are thus in part identified by the existence of relevant departments; but it does not follow that every department represents a discipline. International currency is an important criterion as is a general though not sharply defined set of notions of academic credibility, intellectual substance, and appropriateness of subject matter (Becher and Trowler 2001 41)

This analysis of the nature of a discipline leaves itself open to much debate. It also implies that whether or not a certain area of study is in fact considered a discipline, in the strictest sense of the word, is continually changing. For this reason, I will not go into lengthy discussion on whether or not a field of study is a discipline or not as this would be beyond the scope of this paper. I will, however, expand on Becher and Trowler's study somewhat in order to get a better understanding of the types of fields of study that are considered disciplines and how these are characterised.

What is particularly interesting about Becher and Trowler's study is that they do attempt to group disciplines. This grouping and terminology has become a common one in literature about different disciplines and can be viewed in Table 1.

Table 1

Becher and Trowler's Grouping of Disciplines

Disciplinary Groupings	**Nature of knowledge**
Pure Sciences (eg Physics): 'hard-pure'	Cumulative; atomisric (crystalline/tree-like); concerned with universals, quantities, simplification; impersonal, value-free; clear criteria for knowledge verification and obsolescence; consensus over significant questions to address, now and in the future; results in discovery/ explanation.
Humanities (eg history) and pure social sciences (eg anthropology): 'soft-pure'	Reiterative; holistic (organic/river-like); concerned with particulars, qualities, complication; personal, value-laden; dispute over criteria for knowledge verification and obsolescence; lack of consensus over significant questions to address; results in understanding/ interpretation.
Technologies (eg mechanical engineering, clinical medicine): 'hard-applied'	Purposive; pragmatic (know-how via hard knowledge); concerned with mastery of physical environment; applies heuristic approaches; uses both qualitative and quantitative approaches; criteria for judgment are purposive, functional; results in products/techniques.
Applied Social Science (eg education, law, social administration): 'soft-applied'	Functional; utilitarian (know-how via soft knowledge); concerned with enhancement of [semi-] professional practice; uses case studies and case law to a large extent; results in protocols/ procedures.

While this offers an interesting way of grouping disciplines and a useful framework for assessing whether or not a field of study is a discipline, the use of the terms ‘hard’ and ‘soft’ to set the humanities apart from the exact sciences can be problematic as it has loaded connotations. Jill Scott, in her section for the book Educating Artists for the Future: Learning at the intersections of Art, Science, Technology and Culture illustrates these connotations as shown in Table 2.

Table 2

Scott’s Table of Connotations

COLD/HARD/SCIENCE	**WARM/SOFT/ART**
Reliable	Mutable
Well-defined	Ill-defined
Comprehensible	Illusive
Sharp	Flaccid or spongy
Precise	Imprecise
Difficult	Easy

(Scott 2008 130)

For this reason the terms ‘hard’ and ‘soft’ will be avoided as much as possible in this paper even though it may be necessary to refer to Becher and Trowler’s table to some extent in order to justify Art, Science and Technology as disciplines. Scott hopes that, with time, a new common language will evolve that will allow for this type of discussion to take place without reverting to the stereotyped language of ‘hard’ and ‘soft’ disciplines. For this reason ‘hard-pure’ will be referred to as the ‘exact sciences’, ‘hard-applied’ as the ‘technologies’, ‘soft-pure’ as the ‘humanities’ and ‘soft-applied’ as the ‘applied humanities’. It is hoped that this removes some of the connotations of ‘hard’ and ‘soft’ without over-simplifying the categorisation of Becher and Trowler.

Chapter 1.3. Disciplinarity, multidisciplinarity, interdisciplinarity and transdisciplinarity

Disciplinarity sets knowledge into separate, and in many cases, dichotomous disciplines, sub-disciplines and specialisations and as a result fragments knowledge. This way of thinking creates definite divides between disciplines. This means that there is a gap in the system requiring a way to describe research that does not fall clearly into one discipline or was pollinated by other disciplines. This type of research is often classed as either multidisciplinary, interdisciplinary or transdisciplinary research. Although this research paper focusses on transdisciplinary research, providing definitions of interdisciplinarity and multidisciplinarity gives us an important starting point for discussing and exploring transdisciplinarity. It is difficult to discuss any one of the terms without referring to the differences between them because they are so closely related. Basarab Nicolescu, founder and president of the International Center for Transdisciplinary Research and Studies (CIRET), describes this relationship in "*The Transdisciplinary Evolution of Learning*":

> Disciplinarity, multidisciplinarity, interdisciplinarity and transdisciplinarity are like four arrows shot from but a single bow: knowledge. As in the case of disciplinarity, transdisciplinary research is not antagonistic but complementary to multidisciplinary and interdisciplinary research. (1999)

Nicolescu later writes about the differences between inter-, multi- and transdisciplinarity in "*Transdisciplinarity – past, present and future"* as a difference between the goals of the three.

> *Multidisciplinarity* concerns itself with studying a research topic in not just one discipline only, but in several at the same time. Any topic in question will ultimately be enriched by incorporating the perspective of several disciplines. The multidisciplinary approach transgresses disciplinary boundaries while its goal remains limited to within the framework of disciplinary research.
>
> *Interdisciplinarity* has a different goal than multidisciplinarity. It concerns the transfer of methods from one discipline to another. Like multidisciplinarity, interdisciplinarity transgresses the boundaries of disciplines while its goal still remains within the framework of disciplinary research. Interdisciplinarity even has the capacity to generate new disciplines, like quantum cosmology and chaos theory.
>
> *Transdisciplinarity* concerns itself with what is *between* the disciplines, *across* the different disciplines and *beyond* all disciplines. Its goal is the understanding of the present world, of which one of the imperatives is the unity of knowledge. (Nicolescu 2005 143 - 144)

I feel that this is significant because it implies that transdisciplinarity stands apart from multi- and interdisciplinarity as the one practice that values the outcome of the research over the interests of the disciplines involved.

At the colloquium on transdisciplinarity at L'Abbaye de Royaumont, Ansieres sur Oise, May 25-29, 1998, Prof. Gavan McDonell of the School of Science and Technology Studies, Australia, has a different way of describing the three terms. He "expressed the differences among "multi," "inter," and "transdisciplinarity" as associative, connective, and transcendent disciplinary relations."(Thompson Klein 2000 5). In a report for the same colloquium Solomon Benatar seems to mirror McDonell's view. He writes:

> I understand the concept of transdisciplinarity as an integrated approach to complex problems using the methodology and insights from a range of disciplines with differing perspectives on the problem under consideration. Clearly, the term needs to be distinguished from what is meant by multi- and interdisciplinarity, but these three terms can be seen as a continuum, with transdisciplinarity as the most evolved version of an interaction that transcends individual disciplines. (Benatar 2000 171)

These views of inter-, multi- and transdisciplinarity, while not comparing goals of the three approaches as Nicolescu does, again imply that the difference between the three approaches lies in the way that the disciplines involved are of secondary importance to the research itself in transdisciplinarity.

This comparison of the three approaches certainly starts to explain transdisciplinarity but to truly understand transdisciplinarity, and be able to refer to it without having to continuously compare it to other theories, I must explore the definition of transdisciplinarity as a theory with its own definition, practice and context.

Chapter 1.4. Defining Transdisciplinarity

I would like to start to define transdisciplinarity by understanding the history of transdisciplinarity.

According to Nicolescu, the word “transdisciplinarity” was first introduced by Jean Piaget in 1970, at the Organization for Economic Cooperation and Development (OECD) Congress in Nice, France (Volckmann 2007, 76). Considering that disciplinarity has been around for around seven centuries, transdisciplinarity is therefore a very new approach. In the 1970‘s transdisciplinarity was such a new term that Piaget talks more about the possibility of transdisciplinarity and what it *will* be than what he believed it to be at the time.

> transdisciplinarity ‘will not be limited to the interactions or reciprocities between the specialised researchers, but will locate these links inside a total system without stable boundaries between the disciplines’ (cited in Nicolescu 2005 142).

Between 1970 and 1985 there were more thinkers who explored transdisciplinarity, in particular Eric Jantsch and Edgar Morin. Erich Jantsch, Richard Merton Professor at the Technical University, Hanover, Germany and Research Associate at the Massachusetts Institute of Technology (MIT), was particularly focussed on transdisciplinarity within the University and how the structure of the university should change to facilitate transdisciplinarity (Jantsch 1970). Edgar Morin, is a French philosopher and sociologist who believes that transdisciplinarity and complex knowledge are inextricably linked (Morin).

In 1985, quantum physicist, Nicolescu proposed the idea that transdisciplinarity should include the idea of “beyond the disciplines” in order to set it apart from interdisciplinarity.

> Two years later he founded CIRET and recruited 163 members, including Morin, from 26 countries. The CIRET aim was to develop research in a new scientific and cultural approach - the transdisciplinarity - whose aim is to lay bare the nature and characteristics of the flow of information circulating between the various branches of knowledge. The CIRET is a privileged meeting-place for specialists from the different sciences and for those from other domains of activity, especially educators. (CIRET 2005)

This shows that although CIRET claimed to be open to different disciplines, these disciplines were mainly from within the sciences at the time. It would take much longer for the idea of transdisciplinarity to reach beyond the sciences.

CIRET held the first World Congress of Transdisciplinarity in 1994. At this congress a very significant document, The Charter of Transdisciplinarity, was adopted by the participants. (Nicolescu 2005 *Transdisciplinarity – past, present and future* 142) The Charter can be seen as a maturing of the idea of transdisciplinarity to a point where the principles thereof could be agreed upon by a group. The signing did not signify wide acceptance of transdisciplinarity but the same year also saw another view on transdisciplinarity emerging.

In 1994, another significant publication was made which referenced transdisciplinarity. A collection of authors, including Michael Gibbons and Helga Nowotny, published The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies. This publication suggested that transdisciplinarity was an attribute of a new way of thinking about knowledge production: Mode-2. Again the focus of this publication was within the sciences, however, it was widely criticised by the scientific community as being simplistic or banal. Interestingly though, people outside of the sciences embraced this publication. The authors themselves describe the reaction to this publication as follows:

> Those with most to gain from such a thesis espoused it most warmly – politicians and civil servants struggling to create better mechanisms to link science with innovation; researchers in professional disciplines such as management, struggling to wriggle out from under the condescension of more established, and more 'academic', disciplines; and researchers in newer universities, other non-university higher education institutions, or outside the academic, and scientific, systems strictly defined. Those with most to lose were most sceptical – including researchers in established disciplines and institutions, who feared that the quality of Science would be eroded if such levelling ideas gained political currency, and who feared that their own autonomy would be imperiled if more explicit links were established between research and innovation (Nowotny, Scott & Gibbons 2003)

Despite the controversy around this publication, it was perhaps the first step towards transdisciplinarity being explored beyond the sciences.

Since these developments in 1994, these two definitions of transdisciplinarity have developed further. While these two definitions refer to each other often, they look at transdisciplinarity in two ways: theoretically and phenomenologically.

The theoretical definition, which stems from Nicolescu's CIRET, is highly academic and stemmed from his wish to understand why Quantum and Mechanical physics could both be right and yet so contrary to one another. This can mean that the practice of transdisciplinarity is largely ignored within this definition, although we can infer practice from his theory.

The phenomenological definition generally follows the works of Michael Gibbons and Helga Nowotny and focusses almost entirely on application and use of Mode 2 Knowledge Production (of which transdisciplinarity is a trait) rather than academic theory.

Since these two camps approach the definition of transdisciplinarity from such different points of view I believe that there may be value in deriving a definition for transdisciplinarity from both the highly theoretical views of Nicolescu and others who stand by Theoretical transdisciplinarity, and the almost entirely practical views of those who define transdisciplinarity as an attribute of Mode-2 Knowledge production. In this way I will have a more balanced definition for the term.

Chapter 1.4. 1. Theoretical transdisciplinarity

Firstly I will look at Theoretical transdisciplinarity. Basarab Nicolescu was extremely influential in developing this theory and uses three axioms in order to define transdisciplinarity. Axioms are described by Nicolescu in "*Transdisciplinarity – past, present and future"* as follows:

> Axioms cannot be demonstrated: they are not theorems. They have their roots in experimental data and theoretical approaches and their validity is judged by the results of their applications.(Nicolescu 2005 146)

The three axioms laid out by Nicolescu are the Ontological, Logical and Complexity Axioms. By exploring and understanding these three axioms Nicolescu believes that one will be able to develop a more complete definition of transdisciplinarity.

The ontological axiom:

As the name suggests this axiom deals with the nature of being. The axiom says that in Nature and in Knowledge there are many levels of Reality and, correspondingly, different levels of perception. Nicolescu defines Reality as follows:

> By 'level of Reality,' (with a capital R) we intend first of all to designate that which resists our experiences, representations, descriptions, images, or mathematical formulations. (Nicolescu 2005 8)

One way to understand the existence of different levels of reality is to compare the laws of Newtonian physics and Quantum physics. On one level of Reality Newtonian physics is valid. Not only have the principles of Newtonian physics been proven by theories and experiments, but a lay person can understand the principles because they experience the effects everyday. When we begin to look at Quantum physics, however, Newtonian laws no longer apply. Both Newtonian and Quantum physics are equally valid but there must exist another level of Reality for this to be the case. Newtonian physics is valid when considering object's interactions over distances from micrometers to light years, whereas quantum physics applies on a minute scale as in the interactions between electrons in an atom.

Understanding levels of Reality in this way certainly points towards the validity of a transdisciplinary approach because this understanding prevents one from disregarding other disciplines and their viewpoints which may exist on another, equally valid, levels of reality. However, it is not instantly clear how this helps to define transdisciplinarity.

Nicolescu uses the idea of different levels of reality to introduce his second axiom, the logical axiom, by pointing out that if there are different levels of reality, then classical logic cannot govern all of these levels of reality.

The logical axiom:

Classical logic is founded on three axioms:

> *The axiom of identity*: A is A
>
> *The axiom of non-contradiction*: A is not non-A
>
> *The axiom of the excluded middle*: There exists no third term T ('T' for Third), which is at the same time A and non-A. (Nicolescu 2005 150)

This classical logic is not true in quantum physics. For example an electron, when observed under certain conditions, appears to have *both* wave and particle properties, and so the contradictions of these axioms lead to the idea of an *included* middle rather than an *excluded* one. This means that we must change the third axiom so that we now have:

> *The axiom of the included middle*: there exists a third term 'T' which is at the same time A and non-A. (Nicolescu 2005 150)

This third axiom only makes sense when we consider that “levels of Reality” exist. This can be explained using a simple diagram that indicates that a third state T exists on another level of reality:

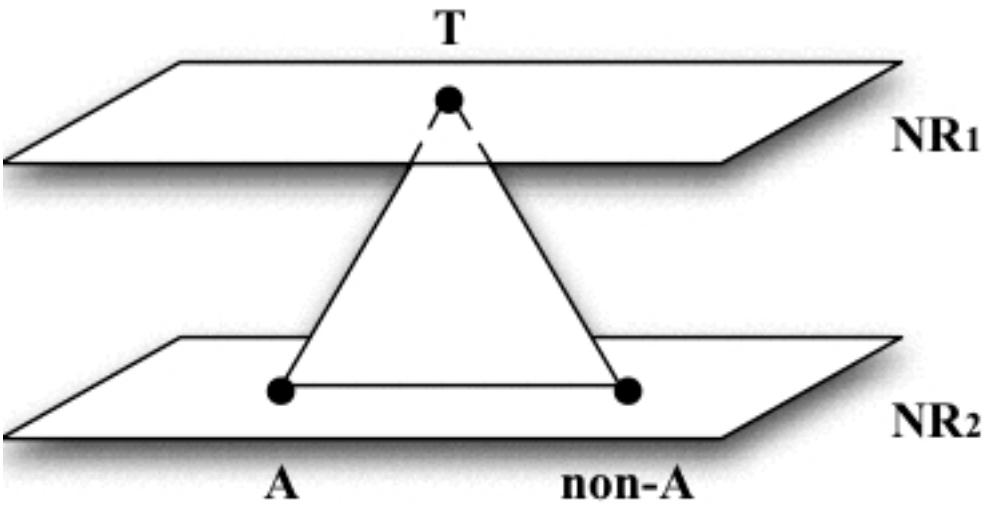

Figure 1: The Included Middle (Volckmann 2007 76)

When we consider this we can see how, from the perspective of Newtonian physics (on one level of Reality), an electron may behave as a particle, while from the perspective of Quantum physics (on another level of Reality), an electron behaves as a wave.

The existence of different levels of Reality has consequences to the theory of knowledge because it implies that if there are different levels of Reality on which different theories hold true, no one theory can be absolutely complete and contained. This implies that transdisciplinarity is not only valid but perhaps essential if we are to try to solve problems where multiple disciplines or fields of knowledge may have a stake.

This still does not define transdisciplinarity fully but again leads to the next axiom: the axiom of complexity.

The axiom of complexity:

The first thing that needs to be made clear in regards to this axiom is that complexity, from a scientific perspective, is not the same as ‘complicated’. Complexity is a scientific theory that deals with non-linear systems. While there are a great number of definitions of complexity that are associated with different scientific disciplines or specialisations, we can explain complexity in a simple way by looking at the similarities between these definitions: complexity comes from the inability to explain phenomena using a reductionist approach.

Descartes was one of the first scientists to take a reductionist approach to scientific studies. Simply put, he, and many classical scientists who followed him, believed that a system and the behaviour of that system under certain conditions could be understood by breaking the system down into small parts, studying each of these parts and then assembling these parts again: the whole is equal to the sum of the parts. This way of thinking worked well for many of the problems associated with classical physics, primarily because they were part of linear systems, but began to present problems in pursuits such as quantum physics where complex, non-linear systems were being analysed. In non-linear, complex systems the whole was not in fact equal to the sum of the parts.

Nicolescu describes the axiom of complexity as follows: “The structure of the totality of levels of Reality or perception is a complex structure: every level is what it is because all the levels exist at the same time”. In other words Reality is complex in structure. In this axiom, Nicolescu seems to be putting forth a case for transdisciplinarity rather than defining it, but this does seem to give us a defining characteristic of transdisciplinarity: that of complexity. This characteristic’s validity is supported by the first two axioms.

Antony McMichael, in his text “*Transdisciplinary Science*”, for the book TRANSDISCIPLINARITY: Recreating Integrated Knowledge, seems to have a similar view to Nicolescu. He describes transdisciplinary Science as one might explain complexity by saying that “In transdisciplinary Science, the whole is not just greater than its derivative disciplinary parts, but it has qualitatively different properties” (McMichael 2000 204).

In the third axiom of transdisciplinarity we are reminded of the idea of transdisciplinarity being beyond the disciplines. If the whole is more that the sum of the parts then transdisciplinarity is not simply a combination of methodologies from different disciplines: it is more than that.

Diana Dominingues and Eliseo Reategui seem to imply that complexity is not only a property of transdisciplinarity but that complexity is a cause of transdisciplinarity when, in their paper “Collaborative and Transdisciplinary practices in Cyberart: from Multimedia to Software Art installations” they state that:

> Nowadays, the science of complexity and emergent proprieties blur the boundaries of isolated disciplines by sharing common investigations to respond to the same concept and context, without any hierarchy, and require reciprocity and collaboration of all experts. (Domininges and Reategui 2005 3)

What is interesting about Domininges and Reategui's view is that they infer that if the whole is greater than the sum of the parts, then no one part can be superior to another. This means that for transdisciplinarity to work, all experts will need to view their collaborators as equal, despite preconceptions that there may be about the validity of one discipline over another. This also means that all experts will need to be equally responsible for the outcomes of the collaboration. Not only does this reference Nicolescu's earlier axioms but this has far reaching consequences in the practice of transdisciplinarity and starts to show some of the challenges that this approach may encounter on a practical level.

The implications of the three axioms

In exploring the three axioms of transdisciplinarity Nicolescu believes that one now has a solid definition of transdisciplinarity. To my mind the three axioms in themselves should rather be used to put a case forward for the validity, and in some cases necessity, of transdisciplinarity. These axioms simply support his idea of transdisciplinarity being "beyond" the disciplines, which in itself has a number of implications. Nicolescu describes the implications of the three axioms as follows:

> If you take these three axioms, which parallel the three axioms of modern science, you get the definition of transdisciplinarity. But this means that we define transdisciplinarity not via a new discipline, but via a new methodology. In other words, we identify transdisciplinarity not with a new discipline, but with a new knowledge—knowledge about what is in between, across and beyond disciplines. For this new knowledge, you need these three axioms... If you take the three axioms, for the first time you can understand these realms of reality which involves the Subject and involves all of the different aspects of us. This means the individual level and also the social level. We talk about knowledge, which is not neutral. Disciplinary and academic knowledge is by definition neutral, with no values. You are not allowed to introduce values into scientific knowledge. However, transdisciplinarity is not neutral, and involves values (Volckmann 2007 82).

The implications of the axioms now start to get us closer to a definition of transdisciplinarity. I see this definition as follows: Transdisciplinarity is a methodology that approaches a complex problem from many multi-referential angles. In taking this approach it is necessary to cast aside previous notions of knowledge structures and to accept that the theories, practices and perceptions of one or many disciplines are not enough to solve a complex problem. This approach also insists that, along with the views of other disciplines, the views of the Subject, or society, must also be taken into account. This puts complexity at the heart of transdisciplinarity because a reductionist approach simply cannot be taken when so many view points, opinions and bodies of knowledge are involved.

While this makes a good argument for the existence of and need for transdisciplinarity and begins to give a definition thereof, it is important that I explore another way of looking at transdisciplinarity in order to incorporate another perspective. I will now look at the definition of transdisciplinarity, from a phenomenological point of view, as an attribute of Mode-2 Knowledge production.

Chapter 1.4. 2. Transdisciplinarity as an attribute of Mode-2 knowledge production

Defining transdisciplinarity from the perspective of those who prescribe to the Mode-2 knowledge production theory requires that we first briefly describe Mode-2 Knowledge production, as transdisciplinarity is viewed as an attribute of Mode-2 knowledge production.

In 1994, The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies proposed that

> The old paradigm of scientific discovery ('Mode 1') – character-ized by the hegemony of theoretical or, at any rate, experimental science; by an internally-driven taxonomy of disciplines; and by the autonomy of scientists and their host institutions, the universities – was being super-seded by a new paradigm of knowledge production ('Mode 2'), which was socially distributed, application-oriented, trans-disciplinary, and subject to multiple accountabilities. (Nowotny, Scott and Gibbons 2003 179)

Mode-2 Knowledge Production has 5 characteristics, one of which is transdisciplinarity. These 5 characteristics are (Nowotny, Scott and Gibbons 2003 186 - 188):

- generated within the context of application
- trans-disciplinarity
- much greater diversity of the sites at which knowledge is produced, and in the types of knowledge produced.
- it is highly reflexive
- seen in novel forms of quality control

Within the context of these 5 characteristics, transdisciplinarity is defined by Nowotny, Scott and Gibbons as:

> the mobilization of a range of theoretical perspectives and practical methodologies to solve problems. But, unlike inter- or multi-disciplinarity, it is not necessarily derived from pre-existing disciplines, nor does it always contribute to the formation of new disciplines. The creative act lies just as much in the capacity to mobilize and manage these perspectives and methodologies, their 'external' orchestration, as in the development of new theories or conceptualisations, or the refinement of research methods, the 'internal' dynamics of scientific creativity.

The phenomenological definition of transdisciplinarity seems more concise than the theoretical definition of transdisciplinarity. This may well be because there seems to be no need to support the validity of transdisciplinarity. It is accepted as a characteristic of Mode-2 Knowledge Production and the authors need only justify the validity of Mode-2 Knowledge production. It may also be the case that at this point in time, 24 years after Piaget and Jantsch began using the term, the validity of transdisciplinarity is no longer in question for the authors.

In this definition I see some similarities and differences between the theoretical and phenomenological definition. Both definitions say that transdisciplinarity is a methodology, or coming together of methodologies, and that the goal thereof is not to create a new discipline. Both talk to the multi-referential nature of transdisciplinarity through the coming together of different perspectives or Levels of Reality. The language of each of these definitions does talk significantly to their audiences, which is perhaps why Mode-2's definition may seem laissez-faire. The phenomenological theory, however, does take quite a practical look at transdisciplinarity by placing as much emphasis on the organisation and mobilisation of a transdisciplinary team as it does in the work the team does. I feel that Nicolescu's definition does tend to skirt around these issues, but he would probably argue that this view is taken into account because of the implication that the Subject plays such a vital role in transdisciplinarity.

Although Mode-2 knowledge production claims to be grounded in practice and this element has some practical references in it, neither the phenomenological, nor the theoretical definitions, give one enough with which to assess whether or not a researcher, such as Michael Naimark, practises a transdisciplinary methodology. In order to do this I must extend the definition of transdisciplinarity by looking at the practice of transdisciplinarity and defining the characteristics of transdisciplinary practice which will allow us to assess a researcher's practice. The theoretical and phenomenological definitions that I have explored will give us the framework with which to gather characteristics of transdisciplinary practice and guide me in synthesising these characteristics into a comprehensive, and yet defined, list of attributes.

Chapter 1.5. Transdisciplinary Practice

I will now draw on various attempts to define the characteristics of transdisciplinary practice in order to synthesise a list of these characteristics. We can then use this list to assess the practice of researchers, such as Michael Naimark, to ascertain whether or not their practices are indeed transdisciplinary in nature.

Chapter 1.5. 1. Characteristics of transdisciplinary practice

There are a number of sources that describe the defining characteristics of transdisciplinarity, especially with a focus on the practice of transdisciplinarity. This chapter will compare the characteristics described by these sources in order to synthesise these ideas.

At the colloquium on transdisciplinarity at L'Abbaye de Royaumont, Ansieres sur Oise, May 25-29, 1998, in an attempt to create a definition for transdisciplinarity, the participants compiled the following list of traits of transdisciplinarity (Thompson Klein and Macdonald 2000 216):

1. Praxis (reconstructive, transforming and integrating)
2. Embrace (inclusive)
3. Reflexive (assumptions and values explicated)
4. Complex (problems, knowledge, and situations)
5. Plural (multiple, diverse and different knowledge and situations)
6. Future (-orientated)
7. Choice (situated and requires agency)
8. Problem (focused) (rather than discipline focused)

They also made the very important observation that

> transdisciplinarity was viewed as a PROCESS more than a specific product or method. Yet, even though it is more than a specific outcome, it is not a procedure. It is a commitment to a way of knowing and a way of being (Thompson Klein and Macdonald 2000 216).

Inherent in the idea that transdisciplinarity is a process is the idea that it is *temporal* in nature and does not follow a specific methodology but rather evolves and adapts over the period of research.

This may seem to be in opposition to the theoretical and phenomenological definitions of transdisciplinarity, but I believe this is born from practice. While a theory describes the ultimate goal, in practice, realising this goal takes time and becomes a process. This is also reflected in the fact that after attempting to create a definition of transdisciplinarity, the participants in the colloquium decided that they would not pursue a definition any further but would rather see their "definition" as a fluid list of characteristics that flowed into a "field of vision" or "a perspective" (Thompson Klein and Macdonald 2000 216 - 217).

In "Transdisciplinary Research: characteristics, quandries and quality" by Wickson, Carew and Russell (2006 1048 – 1052) the authors list the characteristics of Transdisciplinary Research as:

1. Problem Focus
2. Evolving methodologies
3. Collaboration

They also list the challenges of transdisciplinary research as:

1. Integration
2. Reflection
3. Paradox

These characteristics are very similar to those listed at the colloquium, except that the authors divide these characteristics into characteristics and challenges. I find this very interesting as these challenges are seen as characteristics by those at the colloquium. It seems that the challenges of transdisciplinarity are therefore inherent characteristics of transdisciplinarity.

The “Charter of Transdisciplinarity” (De Freitas, Morin and Nicolescu 1994) does not explicitly define characteristics of transdisciplinarity as the quotes above do. However, it does give some clues as to these characteristics. The following extracts from the charter are particularly relevant in identifying characteristics (Nicolescu 2005 *Transdisciplinarity – past, present and future* 142):

> Article 3: Transdisciplinarity complements disciplinary approaches. It occasions the emergence of new data and new interactions from out of the encounter between disciplines. It offers us a new vision of nature and reality. Transdisciplinarity does not strive for mastery of several disciplines but aims to open all disciplines to that which they share and to that which lies beyond them.
>
> Article 4: The keystone of transdisciplinarity is the semantic and practical unification of the meanings that traverse and lay beyond different disciplines. It presupposes an open-minded rationality by re-examining the concepts of ‘definition’ and ‘objectivity’.
>
> Article 5: The transdisciplinary vision is resolutely open insofar as it goes beyond the field of the exact sciences and demands their dialogue and their reconciliation with the humanities and the social sciences as well as with art, literature, poetry and spiritual experience.
>
> Article 6: In comparison with interdisciplinarity and multidisciplinarity, transdisciplinarity is multireferential and multidimensional.
>
> Article 7: Transdisciplinarity constitutes neither a new religion, nor a new philosophy, nor a new metaphysics, nor a science of sciences.

Article 10: No single culture is privileged over any other culture. The transdisciplinary approach is inherently transcultural.

Article 13: The transdisciplinary ethic rejects any attitude that refuses dialogue and discussion, regardless of whether the origin of this attitude is ideological, scientistic, religious, economic, political or philosophical. Shared knowledge should lead to a shared understanding based on an absolute *respect* for the collective and individual Otherness united by our common life on one and the same Earth.

Article 14: *Rigor, openness* and *tolerance* are the fundamental characteristics of the transdisciplinary attitude and vision. *Rigor* in argument, taking into account all existing data, is the best defense against possible distortions. *Openess* involves an acceptance of the unknown, the unexpected and the unforeseeable. *Tolerance* implies acknowledging the right to ideas and truths opposed to our own.

I can summarise the characteristics that are outlined by the charter as such:

1. Complimentary and inclusive (Article 3)
2. Subjective (Article 4)
3. Beyond the sciences (Article 5)
4. Multireferential and multidimensional (Article 6)
5. Nonhierarchical (Article 7)
6. Transcultural (Article 10)
7. Respectful (Article 13)
8. Rigorous, open and tolerant (Article 14)

These characteristics do reference one another and don't seem to be as grounded in practice as the previous lists of characteristics are. However, they are the only set of characteristics found to refer explicitly to disciplines "beyond the sciences". This is significant because transdisciplinarity grew from within the sciences and often only deals with transdisciplinary practice between different scientific disciplines. This does not necessarily mean that the previous two lists of characteristics exclude disciplines beyond the sciences. I believe that characteristics such as "collaboration" and "inclusiveness" imply acceptance of disciplines beyond the sciences even if this was not the author's original intention.

If I look at the lists of characteristics above, within the context of the definitions of transdisciplinarity outlined in Chapter 1.3, I believe we can now synthesise a list of characteristics with which I can assess whether a researcher is following transdisciplinary methodologies in his or her work. I believe that these are as follows:

1. Complex (problems, knowledge and situations)
2. Problem focussed
3. Inclusive, tolerant, open and collaborative (recognises the existence of different levels of reality)
4. Rigorous and reflexive (critique)
5. Temporal and evolving process
6. Praxis (reconstructive, transforming and integrating)

Being the strongest, common characteristics of transdisciplinarity across the various theories, I will be using these characteristics to assess the practice of Michael Naimark, in order to discover whether his practice may be described as transdisciplinary.

Chapter 1.5. 2. A Note on Defining Complexity

The first characteristic of transdisciplinarity, that of complexity, is not a simple thing to analyse. In order to assess whether something is complex, rather than complicated, one must understand how to define complexity. Xu, Chau, Wang and Li note that although there is not a widely accepted definition, they have assessed the work of Funke and Quesada in order to distill the following characteristics for a complex problem:

> defining characteristics of complex problems are a large number of variables (complexity) that interact in a nonlinear fashion (connectivity), changing over time (dynamic and time-dependent), and to achieve multiple goals (polytely). (Xu, Chau, Wang and Li 526)

Interestingly, the characteristic of changing over time is actually the fifth characteristic of transdisciplinarity that we will assess. This indicates some overlap between the different characteristics and for that reason, when assessing practice for transdisciplinary process I may not be able to assess each characteristic in isolation.

Chapter 1.5. 3. Critique of transdisciplinarity

I have spent some time looking at the various theories around transdisciplinarity and have, in the process seen some arguments in favour of transdisciplinarity, or putting forward the validity of this methodology. However, it is equally important to look at the critique of transdisciplinarity in order to get a balanced view of the subject.

Through extensive research there was not very much written that directly critiques transdisciplinarity, challenges the notion of transdisciplinarity or is against transdisciplinarity. One reason for this could be that transdisciplinarity is a reasonably new idea[1] and so has not attracted the attention of critics as yet.

One critique that was found of transdisciplinarity was posed as a question rather than an outright criticism:

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[1] Although the idea itself was first introduced 40 years ago, the uptake of this idea has been very slow and has only seen much activity in the last 15 - 20 years.

> Is it able to deal with thoroughgoing critique, or will it either absorb it into the system or (following Boehme) reject the critique as a product of incomplete discursive reason (*Vernunft*), and thus render itself immune from real conversation about its own position as an epistemological construct? Does the notion of reality that undergirds this project preclude conversation by stipulating the boundaries of that conversation? Is conversation, in the final analysis, made safe by the unexamined assumptions of transdisciplinarity? (Janz 13)

This criticism seems to be more of a musing on transdisciplinarity as a new field but does stand as a caution to those who practise it. The characteristic of Rigour and Reflexivity will need to be expanded to include critique of transdisciplinarity itself if those who practise it are to be truly transdisciplinary.

Another way that opposition to transdisciplinarity was reflected, while it was not necessarily overtly stated, was in that transdisciplinary practitioners have found it extremely hard to find funding for transdisciplinary research (Sommerville and Rapport 2000 Preface). This again hints at the fact that this is a new field which funders may not be willing to fund until the methodology has matured further and been proven to work. This is one of the strange paradox's of seeking funding.

The other form of critique of transdisciplinarity that was found was by those involved in or practising transdisciplinarity. This was in the form of addressing the failures of transdisciplinarity. This was particularly prevalent in Transdisciplinarity: Recreating Integrated Knowledge where each participant in the colloquium on transdisciplinarity in 1998 was asked to submit a paper that chronicled stories of success *and failur*e in transdisciplinarity. Julie Thompson Klein felt that this exercise was necessary in order to lend "insight into the least understood aspects of transdisciplinarity – the process of integration and appropriate criteria of evaluation" (Thompson Klein 2000 7).

Critique from researchers who practise transdisciplinarity is perhaps more valuable than critique from researchers who do not practise transdisciplinarity because this reflects on practice rather than theory. This is also, perhaps, why there is not as much open critique of transdisciplinarity to be found as one might find for other theories, because practitioners themselves are open to critique and being reflexive. It may be more useful to look at this type of critique as addressing the challenges inherent in a transdisciplinary process rather than the problems with it, as the members who wrote about these failures still continue to invest in transdisciplinarity and have learnt a great deal from these challenges.

Chapter 1.5. 4. Challenges of transdisciplinary practice

While Wickson, Carew and Russell (2006 1048 – 1052) directly define the challenges of transdisciplinarity and separate these from the characteristics of transdisciplinarity, I would like to take a different stance. I believe that the challenges of transdisciplinarity are inherent in the characteristics thereof and cannot be seen separately. In order to illustrate this I have taken the characteristics which I defined earlier as the strongest common characteristics of transdisciplinarity and have considered what challenges may come from the characteristics of transdisciplinarity in Table 3.

Table 3

Characteristics of Transdisciplinary Practice and the Corresponding Challenges

Characteristic	**Challenge**
Complex (problems, knowledge and situations)	The reductionist view of systems no longer applies and so all the challenges of complex systems will present themselves at various levels in transdisciplinary processes, from the management of the team involved to the analysis of the problem itself.
Problem focussed	When different people from different disciplines are selecting a problem focus they may not be able to agree on a problem because they may have different world views and areas of concern.
Inclusive, tolerant, open and collaborative (recognises the existence of different levels of reality)	This level of collaboration requires not only a setting aside of egos but also presents challenges when paradox occurs.
Rigorous and reflexive (critique)	This characteristic is necessary in order to ensure that the challenges of collaboration do not result in a poor quality outcome.
Temporal and evolving process	Since transdisciplinarity does not set out a meta-theory or precise methodology, those involved will face the challenge of a continually evolving process that will be influenced by many different and perhaps “foreign” methods and processes.
Praxis	Although many researchers may embrace praxis as a matter of course, the theory and practice of other disciplines will now influence one’s own praxis. This requires “translation across disciplinary languages” (Thompson Klein 2000, 11) so that collaborators may understand each other’s praxis.

Each of these characteristics may well lead to more challenges than have been listed here (which illustrates that transdisciplinarity is in itself a complex system which presents many challenges), however, many researchers believe that these challenges are worth the effort in order to solve many of the complex problems that the world is faced with today.

This is reflected by Antony McMichael in his report for the colloquium at L'Abbaye de Royamont where he notes that although reductionist views have served us well for hundreds of years, there is now a need for a different way of approaching problems:

> in a world increasingly beset by an array of large-scale environmental and social problems, many scientists are becoming uneasy about the imbalance in science's repertoire of conceptual approaches and research methods. There is a need for approaches that can transcend the limited horizons of existing disciplines and can look at wider horizons - thereby accommodating new dimensions of complexity, scale and uncertainty (2000).

This does not, however, mean that transdisciplinarity could be a cure-all and the methodology used for all research going forward. Because of the challenges of transdisciplinarity, this approach will only be used where researchers feel that the challenges will outweigh the rewards of using this methodology.

Chapter 2. Art, Science, Technology and Transdisciplinarity

Chapter 2.1. Introduction

This chapter aims to contextualise transdisciplinarity within AST Research. As mentioned previously transdisciplinarity was initially practised between the scientific disciplines and has now become more prevalent within the humanities. However, the focus of this paper is on transdisciplinarity between Art, Science and Technology. This means that a case needs to be made for this type of transdisciplinarity. In order to achieve this, I will first look at the definitions of these disciplines and then make a case for a common ground on which these disciplines may interact.

An historical framework of integration of AST within the context of research environments will then be explored as an indication that this common ground does in fact exist.

Chapter 2.2. Art, Science and Technology as Disciplines

Chapter 2.2. 1. Art as a Discipline

What Art is, is a hotly contested, continually evolving debate. The scope of this research paper does not allow for entering these debates. However, a broad definition of Art will be given here so that a context can be given for the topic of the thesis.

Stephen Wilson, where he attempts a similar definition, for a similar purpose in Information Arts (2003), notes the following:

> It has become difficult to achieve consensus on definitions of art, the nature of the aesthetic experience, the relative place of communication and expression, or criteria of evaluation. However, there is some agreement on these features: art is intentionally made or assembled by humans, and usually consists of intellectual, symbolic, and sensual components. (Wilson 2003, 15)

Art as a discipline may fall into various disciplinary categories according to Becher and Trowler, depending on the aspect of Art under consideration. Art History for example may fall under the 'humanities' while Art practice may fall under the 'applied humanities'. This does present a strong argument to support that Art can be defined as a discipline, or supra-discipline. This also implies that various sub-disciplines within Art, could be defined as disciplines.

Chapter 2.2. 2. Science as a discipline

An absolute definition of Science is as difficult as one of Art. However, for the purpose of this paper Science will be defined as:

> a branch of knowledge conducted on objective principles involving the systemised observation of and experiment with phenomena, esp. concerned with the material and functions of the physical universe (Allen 1992 1081)

Science will, for the purpose of this discussion, also be seen as a supra-discipline which falls under, or in fact encompasses, the 'exact sciences' category in the Becher and Trowler Table (Table 1).

Chapter 2.2. 3. Technology as a Discipline

Technology will used in the context of this discussion to mean the “the study or use of the mechanical arts and applied sciences” (Allen 1992 1253) and will encompass the Technologies category in the Becher and Trowler Table (Table 1) as a supra-discipline.

Chapter 2.3. Integration of Art, Science and Technology: an historical framework

Over the past forty five years there have been a number of attempts to integrate Art, Science and Technology. These attempts have taken many different forms and have had varied success. These programmes show the rich history of integration of AST and also show the continued support of these types of programmes in various countries and at various institutions from the academy to industry. The interactions between the members of the artistic, technological and scientific disciplines within these organisations/programmes and the roles that they played have also varied greatly between these programmes, however, over time there seems to have been a trend towards closer integration and more importance placed on the mutually beneficial relationships between Artist, Scientist and Engineer researchers.

In 1967, perhaps the best known AST programme was set up in the USA. Experiments in Art and Technology (EAT) was started by Artist Robert Raushenberg and Engineer Billy Klüver with aim to provide Artists with access to Engineers, Technology and materials (Shanken 2005 415). At a time when neither Artists nor Engineers had much access to one another, this groundbreaking programme set up the foundation for many other programmes which would come into being over the next forty five years.

In an academic setting, the Centre for Advanced Visual Studies (CAVS), was founded by Gyorgy Kepes at the Massachusetts Institute of Technology (MIT) in 1972. This centre seemed to have more structured and lofty goals than that of EAT when you consider what Kepes aimed to achieve with this centre:

> With the founding of CAVS he sought to bring about the "absorption of the new technology as an artistic medium; the interaction of artists, scientists, engineers, and industry; the raising of the scale of work to the scale of the urban setting; media geared to all sensory modalities; incorporation of natural processes, such as cloud play, water flow, and the cyclical variations of light and weather; [and] acceptance of the participation of 'spectators' in such a way that art becomes a confluence." (Finch 1)

Perhaps this more integrated approach is why CAVS outlived EAT by many decades.

In the 1980s there were a number of programmes set up within a more industry focussed setting. Some of these include Atari Research Lab (1982), the Apple Multimedia Lab (1987), and Lucasfilm Interactive (now LucasArts, 1989). The subject of this paper, Michael Naimark, worked within all three of these labs (Naimark 2011 Biography). On the academic front, the MIT Media Lab evolved from the Architecture Machine Group in 1985. This lab still exists and is possibly the best known academic programme in AST (Shanken 2005 416).

1992 saw a significant development in the AST field when Microsoft co-owner, Paul Allen, set up Interval Research. Despite this not being in an academic setting, at first the focus of the programme was research. Importantly though, Michael Naimark notes the significant change in attitude at Interval compared to the other labs that he had worked at previously:

> It's charter was to look five to ten years ahead into the future of computing and media, in a most general way. Unlike other tech labs I'd seen, this one seemed to really believe in having artists and other diverse elements as members of the research staff (Naimark 1998 Art (“and” or “versus”) Technology – Some Personal Observations 130).

Unfortunately as Allen pushed for the programme to become sustainable by 2002, the focus shifted away from research and focussed more on production. In Naimark’s opinion this spelled the end for Interval which gradually disappeared in the late 1990s (Naimark 2004 13).

In the late 1990s and 2000s there was a significant geographical change with attention being now gained from AST programmes in Canada and Europe rather than in the USA. In Europe, programmes within the academy such as Zentrum fiir Kunst luid Medientechnologie (ZKM) in Karlsruhe, the Ars Electronica Center in Linz, and the new Artists in Labs programme at the Hochschule fur Cestalttmg und Kunst Ziirich (HCKZ) are all seen as exemplary AST programmes (Shanken 2005 415).

In Canada, The Banff New Media Institute (BNMI) at the Banff Centre for the Arts, rose from many smaller AST programmes such as the Art and Virtual Environments programme. Not only has the BNMI supported AST collaborations, but Edward Shanken also notes the contribution that the Institute has made to the theory of AST in his article “Artists in Industry and the Academy: Collaborative Research, Interdisciplinary Scholarship and the Creation and Interpretation of Hybrid Forms”, For LEONARDO magazine.

> [BNMI] has played a leadership role in promoting metacritical research into the field through the Beauty of Collaboration symposium (2003) and the BRIDGES consortium and conferences (in collaboration with the University of Southern California Annenberg Center for Communication, 2001 and 2002), resulting in informative and insightful reports (2005 416)

This again is a significant development in the AST field. Although many of the AST initiatives and programmes have developed interesting results and seen new collaborations, if these initiatives are to become sustainable, fundable and recognised academically, I believe that there will be a need for more publications around the methodologies and frameworks that these programmes are taking and the successes and failures of these. This opinion is reflected by Shanken when he writes:

> On a philosophical level, if the fruits of hybrid research are not strictly science, or engineering, or art, then one must wonder about the epistemological and ontological status of these hybrid forms: What exactly are they? What new knowledge do they produce or enable? What is their function in the world? On a practical level, the future sustainability of hybrid research depends on answering these questions, because the academic careers of scholars whose work fuses disciplines will be cut short if their contributions are not recognized and rewarded within the university (2005 418).

It is hoped that if this paper can put forward a case for the practice of Michael Naimark, who has been involved in so many of the AST programmes listed above, being transdisciplinary in nature, then this will, in a small way, contribute to answering some of these important questions.

Chapter 2.4. Transdisciplinarity within AST

The concept of transdisciplinarity was born out of a need to solve complex scientific problems using the perspectives of many of the scientific disciplines or sub-disciplines. For this reason much of the writing on the subject is specific to the sciences. This is certainly not a characteristic of transdisciplinarity, however, as was shown in chapter 1.5.1.

Despite its origins in the exact sciences, transdisciplinarity is increasingly being seen as a valid process in many other fields, such as in the humanities. This is reflected by Julie Thompson Klein:

> In the past, the term was not used often in humanities, but it has been appearing increasingly as a label for new knowledge formations rooted in cultural critique (in women's studies, cultural studies, and a variety of other fields that bridge humanities and social sciences) (Thompson Klein 2003 1)

While this sets a precedent for transdisciplinary practice within the humanities as a whole, there is very little written about transdisciplinary practice within the Visual Arts and within AST research.

One AST research programme which does make reference to transdisciplinary practice is the Artecno Research group facilitated by The University of Caxias do Sul in Brazil as part of the Laboratory of New Technologies in Visual Arts (Shanken 2005). It is actively attempting a transdisciplinary approach to research. The programme involves Artists, Engineers, Scientists and Programmers. The coordinator of the programme, Diana Dominingues, describes herself as an Artist-Engineer and believes that a transdisciplinary approach to research into cybernetic systems is a necessity for Technological Art (Dominingues and Reategui 2005 18).

This suggests that there is a place for transdisciplinary practice within AST and also suggests that transdisciplinarity has a place within the Visual Arts. The problem with this is that transdisciplinarity is a research methodology and while technological and scientific research is common-place, practice as research within the Arts, and particularly within the Visual Arts, is not. In order to argue that there is a place for transdisciplinary methodology within AST labs, I will first need to establish a case for Visual Arts practice as a valid research field.

Chapter 2.5. Visual Arts Practice as Research

If I am to argue effectively that transdisciplinarity is a valid research practice in AST, I must establish whether or not practice within the Visual Arts can be seen as research.

Peter Weibel raises the problem of convergence of the disciplines of Art and Science in his chapter for the book Art@Science called “The Unreasonable Effectivenss of the Methodological Convergence of Art and Science”. Here he writes:

> Is it actually reasonable to compare these different disciplines? Can convergence of art and science even be defined on the level of similar disciplines? (Weibel 1998 167)

He raises a very valid point here because the common perception is that these disciplines are in no way similar and so cannot converge. Weibel names many instances where Art has influenced Science or Science has influenced Art but notes that this idea of influence further emphasises the difference between the two disciplines because otherwise the word “influence” would not be used (Weibel 1998 169). This idea of influence is also contrary to the concept of transdisciplinarity so if I am to justify transdisciplinarity within Art, Science and Technology, we cannot simply try to find similarities between the disciplines themselves.

Weibel proposes that the best way to compare Art and Science is therefore one of methodological comparison: “Therefore we have to compare Science and Art as methods. That means not only to accept for Science to be a method …, but also for art to be a method” (Weibel 1998 170)

Much has been written on Science as a method and so for the purposes of this paper I can assume that it is indeed a method. However, the idea of Art as a method is a relatively new one and will require some more investigation.

The idea of Art as a method is thoroughly explored by Graeme Sullivan in the book Art Practice as Research. This book argues that the practice of Artists is in fact a valid form of research (2005 xi).

This book differs from most attempts to justify research within the Arts in that it argues for the practice of Art itself to be seen as a valid research methodology and not just Art Theory, Art History, Social Anthropology and other, more theory based, sub disciplines within the Arts.

In this book Sullivan argues that Art Practice is research by undertaking a detailed analysis “that explores the theoretical basis of artistic practice to position it within the discourse of research” (2005 xi) This is obviously a large undertaking and cannot be summarized in this paper in a way that would do this book justice. However, Sullivan does present a robust and defensible theoretical framework for positioning Art Practice as a form of research (2005 95). He expresses the need for this framework as follows:

> a framework for theorizing offers the possibility that visual arts practice can be readily translated into other forms of research language if the purpose demands it. In this way research culture remains grounded in the theories and practices of the visual arts, yet the outcomes can be communicated across disciplines (2005 93).

If I can indeed use this (or another similar) framework to not only explain, but defend, Art Practice as research to other disciplines, I could then justify a transdisciplinary methodology in AST.

Chapter 2.5. 1. Framework for Visual Arts Research

We will now take a closer look at the Visual Arts Research Framework set out by Sullivan in order to assess whether this framework could be used to justify transdisciplinary Art research.

Figure 2: Framework of Visual Arts Research (Sullivan 2005 94)

Sullivan places Art practice as the central strand in his framework. He describes why this is by saying:

> The center strand is *Art Practice*, which is the site where research problems, issues and contexts originate. This placement is not meant to be self serving. Rather it captures the reality that the visual arts are grounded in the studio experience, yet practitioners move eclectically across boundaries in their intellectual and imaginative states (2005 94)

The areas that border on this central strand are domains of inquiry. Within these domains Sullivan has situated different research methods and traditions.

Within each domain, Sullivan has indicated whether the methods in that domain are “discipline-based”, “inter-discipline” or “trans-discipline”. The diagram can be read as follows:

> there is a *discipline-based* position that is embedded within the empiricist tradition of research. Within the interpretivist paradigm, it is through an *interdisciplinary* investigation of cultural texts that theories and practices are teased apart and meanings disclosed. Inquiry from the critical perspective, on the other hand, is more of an incursion as existing systems, structures, and practices are interrogated and changes enacted – this approach can be described as *transdisciplinary* (2005 102)

This is obviously a very interesting reading of the framework for the purpose of this paper. However, Sullivan’s description of transdisciplinary should be looked at critically to assess whether his description could fall under the definitions of transdisciplinarity that I have already addressed. In pages 188 and 189 of his book, Sullivan discusses his idea of transdisciplinarity further. I have summarised some of the traits of transdisciplinarity which he mentions in this text:

1. The inquiry is purpose driven.

2. There is a need to explore new domains for critiquing and creating knowledge.

3. Much of this research is driven by public need or issues driven.

4. Complexity necessitates transdisciplinarity.

5. This practice is driven by “individuals who see structures that define traditional discipline areas not as boundaries or barriers, but as bridges that can link in new ways.” (Sullivan 2005 188)

These points certainly seem to mirror the transdisciplinary practice characteristics enough that I can assume that Sullivan’s understanding of transdisciplinarity is similar to what I have already deduced from primarily scientific papers, books and authors. This not only lends validity to the idea that Art Practice can be a form of research but also points to the fact that transdisciplinarity is no longer restricted to the domain of the sciences.

Chapter 3. Michael Naimark's practice while developing the works "See Banff!" and "Be Now Here"

Chapter 3.1. Introduction

Chapter 1 and 2 of this report took a very theoretical look at transdisciplinarity and transdisciplinary practice. I put forward a more complete definition of transdisciplinarity and the characteristics of transdisciplinary practice. Additionally, in Chapter 2 we established a case for transdisciplinary practice in Art, Science and Technology research from a theoretical perspective.

In this chapter I will now take a more practical look at collaborative practice in the AST context through the work of Michael Naimark and, in particular, his process while creating the works *See Banff!* and *Be Now Here*. Assessing this case study against the definition and characteristics of transdisciplinarity set up in Chapter 1 will establish to what extent this practice was transdisciplinary.

Chapter 3.2. Who is Michael Naimark?

Some of Michael Naimark's involvement in past AST initiatives was mentioned in Chapter 2, however, this was not the only reason that Michael Naimark was chosen for the case study of this report. Naimark is an Artist and a Researcher who not only has over thirty five years of experience in some of the foremost AST research environments in the history of AST research, but the work that he has produced over this time has been well received by both the research and artistic communities and Naimark has invested much of his time documenting his practice and his experience within these AST settings. This experience, critical acclaim and wealth of documentation makes Michael Naimark an ideal candidate for a case study in this report.

I will now further expand on the experience, work and writings of Michael Naimark based on Naimark's Biography and CV (Naimark 2011), which he has published on his website, in order to expand on the reasons for choosing Naimark as the Artist whose work would be used for the case study in this report.

It is important for us to note that in his biography, Naimark describes himself as an Artist *and* Researcher. If Naimark did not see himself as a researcher or his artistic practice as being research then I would not be able to assess his work as transdisciplinary as established in Chapter 2.

Naimark's belief in Art Practice as research is also reflected when looking at the institutions at which he has been a member over the past thirty five years. After completing his undergraduate degree in Cybernetic Systems at The University of Michigan in 1974, Naimark moved to the Massachusetts Institute of Technology (MIT) where he completed his masters in Visual Studies and Environmental Art in 1979 at the MIT Center for Advanced Visual Studies, USA (1976-1980). Thereafter Naimark was a founding member of Atari Research Lab, USA (1982-1984), Apple Multimedia Lab, USA (1988-1990) and LucasFilm Interactive, USA (1986-90). Naimark also worked at Paul Allen's Interval Research Corporation, USA (1992-2001), San Fransisco Art Institute, USA (1989-1990), Banff Center for the Arts, Canada (1991-1993), and the Institute of Advanced Media Arts and Sciences (IAMAS), Japan (2001-2002). Very few Artists can claim this kind of experience in this range of AST environments and programmes. This puts Naimark in a unique position when understanding best practice for research in the AST domain and an ideal candidate for this study.

It is not just his experience which is of interest, however. If Naimark's experience is to be seen as valuable, I should also establish if the outcomes of his work at these institutions have added value to the artistic and research communities.

From an artistic perspective, Naimark has exhibited works in more than 37 group exhibitions and 9 solo exhibitions to date, including a show of 20 years of his work, in 2005, organised by the Art Center College of Design in Pasadena, at the Alyce de Roulet Williamson Gallery. Naimark's work is currently in three permanent collections: the American Museum of the Moving Image, NY, USA (*See Banff*), the Zentrum fur Kunst und Medientechnologie (ZKM), Karlsruhe, Germany (*Karlsruhe Moviemap*) and the Exploratorium, San Francisco, USA (*Golden Gate Flyover*). He was also the guest curator for the "The World in 25 Years", Ars Electronica 25th Anniversary Symposium, Austria, in 2004.

His work has also been recognised by the technological and research communities, as is evidenced by the fact that his work has been awarded 9 patents to date and his being awarded the World Technology Award[2] for the Arts in 2002 and the Google Research Award[3] for "Collective Photo Mapping" in 2007 (together with Paul Debevec).

As with many researchers, Naimark is a respected academic who has been invited to give over 200 presentations at various universities, colleges, exhibitions and conferences all over the world. He has occupied academic positions at the University of Southern California, University of Michigan, New York University, San Francisco Art Institute, San Francisco State University, California Institute of the Arts and the Massachusetts Institute of Technology. Naimark is currently employed as an associate research professor in the Interactive Media Division of the University of Southern California School of Cinematic Arts, USA.

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[2] "The World Technology Awards have been presented annually since 2000 to the outstanding innovators from each sector within the science and technology arena for innovative work of the greatest likely long-term significance" (http://www.wtn.net/awards.html)

[3] "The purpose of this program is to facilitate more interaction between Google and academia and also nurture stronger relations and partnerships with universities. The intent of the awards is to support academic research aimed at improving information access" (http://research.google.com/university/relations/research_awards.html)

As testament to his contribution to AST research, Naimark also holds a number of positions at institutes that actively pursue research in the fields of Art, Science and Technology: Naimark is on the Board of Advisors for the International Society of Arts, Science & Technology (ISAST)[4], the board of directors for the ZeroOne Network[5], a member of the Scientific Council of the Ludwig Boltzmann Institute for Media Art Research[6], Austria and on the Editorial Advisory Board for the Leonardo Electronic Almanac.

This all speaks to the fact that Naimark is well respected for his Art, Research and Academic ability. However, it is still important for this case study that I should be able to look into Naimark's practice. This is well facilitated by the fact that Naimark is a prolific writer and is published in a variety of media as well as on his website.

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[4] "Leonardo/ISAST serves the international arts community by promoting and documenting work at the intersection of the arts, sciences, and technology, and by encouraging and stimulating collaboration between artists, scientists, and technologists." (http://www.leonardo.info/isast/isastinfo.html)

[5] "Our Mission Inspiring creativity at the intersection of art, technology, and digital culture" (http://zero1.org/about/)

[6] "The mission of the Ludwig Boltzmann Institute Media.Art.Research. is the scholarly treatment, mediation, archiving and publication of works of media art and media theory. Bringing together science, art, technology and cultural mediation in a single facility" (http://media.lbg.ac.at/en/index.php)

Some of Naimark's writings appear in books (sections by Naimark have appeared in titles such as Art@Science[7], Design Research: Methods and Perspectives[8] and Immersed in Technology[9] among others), in technical and Fine Art journals (including Presence[10], Leonardo Electronic Almanac[11], FineArtForum and EMERGEncy), exhibition catalogues (including Ars Electronica[12] and Tomorrow's Realities, SIGGRAPH[13]) and conference proceedings for a range of conferences (including SPIE[14], ISEA 2002[15], Consciousness Reframed[16] and VSMM '98[17]).

This makes Naimark's writing very accessible and also talks to the validity of what he has written because it has been published in well respected and diverse publications. This again strengthens the validity of the work of Michael Naimark as a case study in the context of transdisciplinarity in the AST research environment.

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[7] Springer Press, 1997

[8] MIT Press, 2003

[9] MIT Press, 1996

[10] "The first academic journal for serious investigators of teleoperators and virtual environments…Presence appeals to a wide audience - particularly mechanical and electrical engineers … computer scientists, high-tech artists, and media people; and psychologists" (http://www.mitpressjournals.org/loi/pres)

[11] "a monthly web journal which is also distributed via e-mail. It is produced by Leonardo…and includes: profiles of media arts facilities and projects; profiles of artists using new media; feature articles comprised of theoretical and technical perspectives; the LEA Gallery exhibiting new media art work by international artists; reviews of publications, events and exhibitions" (http://www.leonardo.info/isast/faq.html)

[12] "For nearly three decades now, this world-renowned event has provided an annual setting for artistic and scientific encounters with social and cultural phenomena that are the upshot of technological change." (http://www.aec.at/festival_about_en.php)

[13] "SIGGRAPH celebrates and fosters the fusion and mutual inspiration of science, art, and technology." (http://arts.siggraph.org/)

[14] "SPIE is an international society advancing an interdisciplinary approach to the science and application of light." (http://spie.org/x13.xml)

[15] "The Inter-Society for the Electronic Arts (ISEA) is an international nonprofit organization fostering interdisciplinary academic discourse and exchange among culturally diverse organizations and individuals working with art, science and emerging technologies" (http://www.isea-web.org/eng/about.html)

[16] "a forum for transdisciplinary inquiry into art, technology and consciousness, drawing upon the expertise and insights of artists, architects, performers, musicians, writers, scientists, and scholars "(http://portal.unesco.org/culture/en/ev.phpURL_ID=30590&URL_DO=DO_TOPIC&URL_SECTION=201.html)

[17] "exploring the fusion between engineering, art and commerce in virtual reality and multimedia technologies" (http://www.iospress.nl/loadtop/load.php?isbn=9789051994704)

Chapter 3.3. Naimark's Work leading up to *See Banff!* and *Be Now Here*

Michael Naimark has produced many works over the past thirty five years, at a number of different AST institutions, many of which were of interest when choosing a case study for this paper. Figure 3 below shows a chronological summary of the works which are particularly relevant to transdisciplinarity within the AST environment due to the fact that they were well documented, developed while Naimark was at world renowned AST institutions, were often completed with many diverse collaborators and had well recognised technological and artistic outcomes.

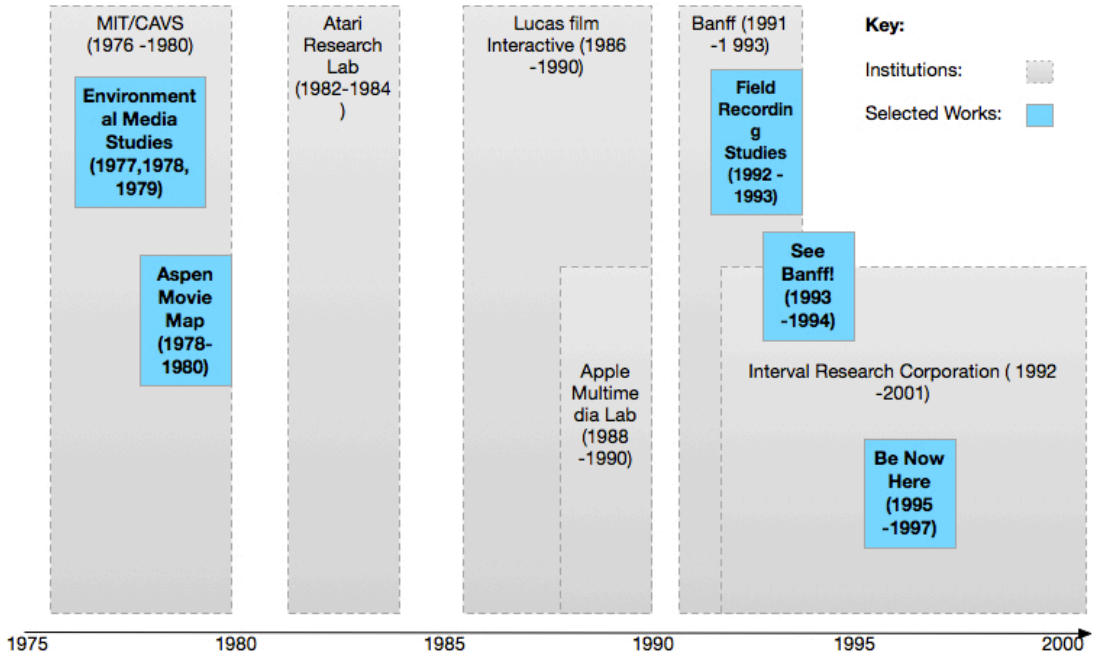

Figure 3: Selected works and Institutions of Naimark 1975 - 2000

These selected works also represent two major trajectories of Naimark's work - namely "Moving Movies" and "Movie Maps". When looking at these works it is clear to see the evolution of these two principles as well as the evolution of Naimark's practice over twenty years of exploration and collaboration. This trajectory lead to some of, arguably, his most well known and successful works - *See Banff!* and *Be Now Here.*

Since transdisciplinarity has a temporal aspect, it is tempting to look at all of the above selected works as case studies in this paper and thus follow the trajectories of both "Moving Movies" and "Movie Maps". However, the scope simply does not allow for this and I feel that it will be sufficient to give a brief overview of each of the works leading up to *See Banff!* and *Be Now Here,* only so that I can provide a context to these two works and briefly show the evolution of the "Movie Maps" and "Moving Movies" as well as the evolution of Naimark's practice leading up to the main case studies for this paper.

Chapter 3.3. 1. Environmental Media Studies

Naimark was a graduate, and later a fellow, at the MIT Center for Advanced Visual Studies (CAVS). Here he developed his interest in "Moving movies" and "Movie Maps". "Moving Movies" began as three experiments or *Environmental Media Studies* in moving a projector to mimic camera movement (Naimark 1998 124) namely, *Moving movie #1* (1977), *Dome Projections* (1978), and *Moving Movie #2* (1979).

Moving Movie #1 addressed Naimark's obsession with why cameras moved but projectors did not, by both filming and projecting a landscape on a slowly rotating turntable. *Dome Projections* spoke mainly to the perspective of the viewer by attempting to give viewers the perspective of viewing a landscape from the outside in, rather than the inside out. *Moving Movie #2* expanded on Naimark's *Moving Movie #1* by not only moving a projector and the camera in one direction but rather in any direction depending on the camera motion.

Unlike much of his later work, Naimark worked on these projects alone. He does, however, note that his process involved much discussion with other Artists and researchers at CAVS:

> These began as small artist "provocations" which also interested the researchers around MIT. "What would happen when a movie projector moves like the camera?" " What would an 'inside-out' dome projection look like?" They were small enough that I could work on my own, but did indeed involve much lively discussion with both artists and researchers (Naimark 2009).

This work seemed to interest researchers beyond CAVS too, because Naimark published his processes and findings from these experiments in Sensory Anomalies[18] and Spatial Correspondence in Motion Picture Display [19]. These publications were particularly focused towards the research and engineering communities rather than the Art community which would suggest that perhaps Naimark was starting to successfully walk the divide between Art and Research very successfully. However, this focus on Research in these works actually left Naimark feeling like he was neglecting his Art Practice. In “Art (“and” or “vs”) Technology” Naimark notes that, at the time, he felt he was forced to make a choice between Art and Technology Research in his work:

> I built various camera and projector contraptions to move the image with better control, but then felt like I had to decide: was I interested in building a new projector or in making an art statement? I opted for the latter, and over the next four years produced a series of installations reverting back to a simple turntable, but where I could concentrate more on the imagery itself (Naimark 1998 124).

This need to choose between Art or Technology Research seems to indicate a lack of transdisciplinary thinking at the time and that, although institutions were starting to investigate the influence between the two fields, work was still defined as either Art or Research and could not comfortably exist between the two. This could at best be described as multidisciplinary practice.

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[18] Published in Design Research: Methods and Perspectives, Brenda Laurel, Editor, Cambridge, MA: The MIT Press, 2003

[19] published in SPIE Vol. 462 Optics in Entertainment /I (1984)

Chapter 3.3. 2. Aspen Moviemap

While at MIT CAVS, Naimark also became involved in “Movie Maps”. “Movie Maps” allowed the viewer to take a virtual tour of a space in their own time and in any direction they chose by controlling the playback of a movie recorded on laserdisc. The experience was much like that of Google Streetview today and was first developed as an experiment by undergraduate, Peter Clay, with graduates Robert Mohl and Naimark.

Aspen Moviemap was an ambitious project, with Andrew Lippman as the Principal Investigator, and involved over fourteen collaborators at various stages of the project with diverse backgrounds from engineering to film and production. Also ambitious was the technology involved. The playback system involved several laserdisc players, a computer and a touch screen display. This technology was the absolute cutting edge at the time. The complex team structure certainly talks to at least an interdisciplinary, if not transdisciplinary practice for this project. However, Technology and Research again took precedence and this project was never intended as, or exhibited, as an Art project even though Naimark felt that the project dealt with classic issues of visual representation (Naimark 1998 124). This again suggests that the practice in this project was not transdisciplinary, even if a transdisciplinary practice may have benefitted a project of this magnitude and complexity.

Figure 4: The Aspen Moviemap experienced in the “Media Room” at the Architecture Machine Group, MIT, c1980. The “traveler,” seated in an instrumented armchair, controls speed and direction of travel. Touch screens displaying map and aerial views allow access to additional multimedia material (Photo: Bob Mohl) (Naimark 2006).

Chapter 3.3. 3. Further Movie Maps

Naimark was clearly not deterred by the lack of interest in the Art aspect of *Aspen Moviemap*, as he went on to be involved in a number of other “Movie Maps” which, while using sophisticated technology to deliver playback, also explored cultural and artistic issues and were exhibited in a number of diverse spaces including galleries and museums. Among these were:

- *Paris VideoPlan (1986)* which was exhibited in the Paris Metro Madeleine Station, Paris

- *Golden Gate Flyover* (1987) which was exhibited in Art Center College of Design (Pasadena), Kanagawa International Art and Science Exhibition (Japan), Kennedy Center for the Performing Arts, (Washington, D.C.) and The Exploratorium (San Francisco), among others.
- *Karlsruhe Moviemap* (1991) which was exhibited in six spaces before returning to the Zentrum fur Kunst und Medientechnologie, Karlsruhe, Germany to be part of the permanent collection there.

The fact that these “Movie Maps” were displayed in such a variety of sites certainly suggests that the works or outcomes of Naimark’s practice could not be defined as either Art or Technology or Research but perhaps existed somewhere between the fields and therefore may be at least interdisciplinary in nature, if not transdisciplinary.

These “Movie Maps” were not developed by Naimark alone, but did not involve teams of the size of that involved in *Aspen Moviemap* either. Most teams consisted of Naimark (Concept and Direction), a producer, and one or two engineers for software and interface design. These types of teams have become a pattern in much of Naimark’s work and he notes, in a personal interview, why he works like this:

> First, I’m not an engineer so need help. That said, I’ve been fortunate to have been in research environments with people from different disciplines and have had the opportunity to get to know many of them. These acquaintances have often fueled my own creativity. The challenge, of course, is “walking the walk and talking the talk” of others not in your field, and it’s this “cultural translation skill” which is where the value lies. (Naimark 2009)

This observation certainly indicates that Naimark has started, in these projects, to adopt the transdisciplinary characteristic of being Inclusive, Tolerant, Open and Collaborative.

Chapter 3.3. 4. Field Recording Studies

In 1991, Naimark began a residency at the Banff Center for the Arts, Canada, in the Art and Virtual Environments programme. Here Naimark produced two *Field Recording Studies* which were intended as experiments in place representation using 3D computer modeling.

Field Recording Study #1 was produced in 2 weeks and consisted of stills of a scene captured from video camera footage. These were then meticulously (and by hand) tiled together to form a three dimensional dome using software developed by John Harrison (Figure 5).

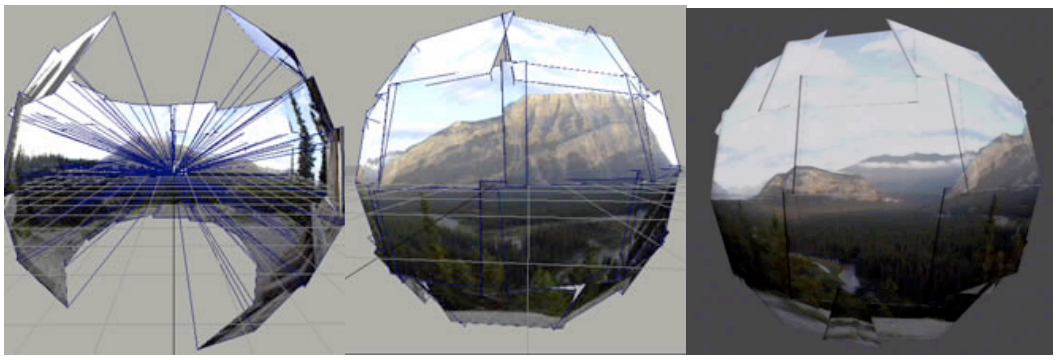

Figure 5: Field recording Study #1 showing wireframe construction (Naimark 2011 “Field Recording Studies”)

This collaboration with Harrison certainly seemed to be one that was inclusive, open and tolerant if I look at Naimark's comments on John and his working relationship from a personal interview: "John was a great collaborator. There was less methodology than there was building a sincere and respectful relationship." (Naimark 2009)

This study was exhibited at the SIGGRAPH Guerrilla Technology Show (now known as the Emerging Technologies[20]), Chicago, 1992 where interdisciplinary research in emerging technologies was displayed to tens of thousands of attendees from various backgrounds who were interested in computer graphics and interactive techniques.

Although *Field Recording Study #1* created a 3D panorama using 2D images, *Field Recording Study #2* was an attempt to turn 2D images into 3D images by moulding these images onto a 3-dimensional wireframe or to texture map an image onto a wireframe.

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[20] "Emerging Technologies seeks creative and innovative technologies and applications in many fields, including displays, robotics, input devices, interaction techniques, gaming, computer vision, sensors, audio, speech, biometrics, wearable computing, data and scientific visualization, biotechnology, graphics, collaborative environments, design, and medicine" http://s2013.siggraph.org/submitters/emerging-technologies

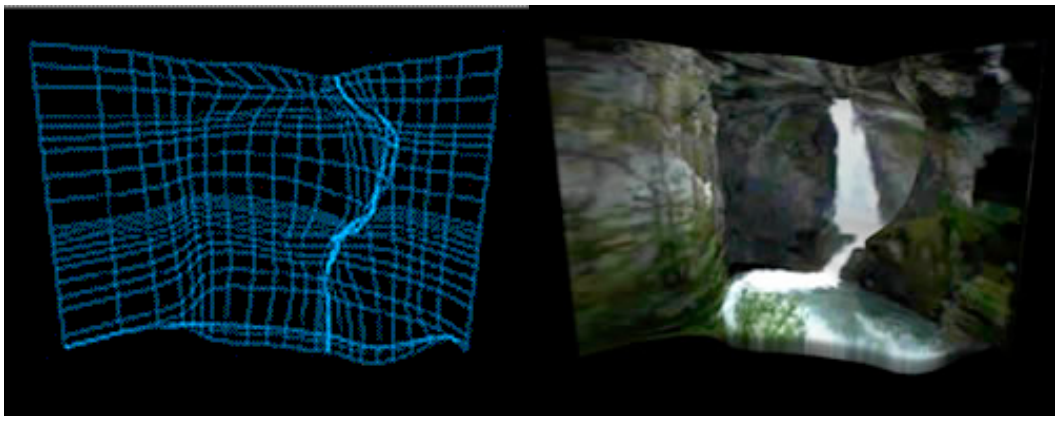

Figure 6: Field recording Study #2 showing wireframe construction (Naimark, “Field Recording Studies”)

Again, Naimark collaborated with John Harrison, but in this case he also collaborated with his two colleagues from Interval Research Corporation, Brenda Laurel and Rachel Strickland. This study formed part of their work *Placeholder.* These, and other collaborations at Banff, made quite an impression on Naimark as is evidenced by his comment on the centre:

> The Banff Centre was, in my opinion, the perfect place for art and technology work, particularly because of its international multi-cultural diversity (Naimark 1998 128).

This comment implies that the collaborations taking place here may well have been tending towards transdisciplinarity, even if this was not intentionally the practice, because it speaks to the complexity of the teams involved as well as the Tolerant, Collaborative practice.

In terms of Reflection and Rigour, Naimark again published his reflections on these studies and the process of creation thereof. This time his article “Field Recording Studies” appeared in Immersed in Technology : Art and Virtual Environments, edited by Mary Anne Moser and Douglas MacLeod, MIT Press, 1996

Chapter 3.3. 5. An Evolving Practice

Looking back over Naimark’s works from 1978 - 1991, I think that one can clearly see a pattern of Collaboration, Reflection and Complexity. This becomes more and more evident as Naimark’s practice matures over time and he begins to explore collaborative relationships and Research as well as Art outcomes in his work. I would not go as far as to say that Naimark’s practice was transdisciplinary over this period of time but I certainly believe that his work moves from being multidisciplinary, to interdisciplinary at least and that in his later “Movie Maps” and *Field Recording Studies* he starts to show transdisciplinary characteristics in his practice.

Chapter 3.4. Case Studies

I have seen in Naimark’s works leading up to now, that he has started to display some transdisciplinary characteristics in his practice but we will now assess his practice while producing the pieces *See Banff!* and *Be Now Here* in order to determine whether he used a transdisciplinary practice in the creation of these pieces.

Since a large portion of the analysis of Naimark's projects will focus on process, Naimark's writings about his process will be the primary resources for analysis. However, at times it will be necessary to analyse the outcomes of the projects themselves. Since all primary examples of this work are in the USA, Canada and Europe it will not be possible for me to access the works directly. Analysis of these outcomes will therefore be primarily from documentation of the works including descriptions, images, reviews and videos of the work. I understand that this does mediate the experience of the project and this may not give an entirely accurate representation of the experience of interacting with Naimark's pieces. However, since the focus of this paper is on process and not outcome and the funds are not available for me to travel in order to view the work, this is deemed a necessary compromise.

In order to be able to assess the case studies *See Banff!* and *Be Now Here* for transdisciplinary practice I will first give a short description of the works in order to give context to the study and will then examine Naimark's practice during the creation of these works against the 6 characteristics of transdisciplinary practice as outlined in Chapter 1.5.

Chapter 3.4. 1. Case Study - *See Banff!*

See Banff! began life as the third study in Naimark's *Field Recording Studies* while Naimark was completing his residency at the Banff Center for the Arts. This study started to explore stereoscopic imagery in "Movie Maps". However, Naimark began work at the Interval Research Corporation in 1992 on the *Immersion Project* and here he decided to continue his work with the *Field Recording Study #3* and create something "exhibitable" (Naimark 1998). This work has been chosen as the first case study because it showed a shift in Naimark's work from technological experimentation to artistic statement.

> See Banff was perhaps a turning point in my work, working as much to understand the politics of place as to simply capture it photographically (Naimark 2009).

For *Field Recording Studies #3,* Naimark worked with performance Artist Mark Pauline of Survival Research Labs to rig a "Super Jogger" baby carriage with two 16 mm film cameras. This device was used to film stereoscopic imagery of the Banff surrounds triggered either by an encoder on the wheel which produced imagery used for a "Movie Map" or triggered at determined time intervals for time-lapse photography (Figure 7).

Figure 7: The "Super-Jogger" baby carriage rig used to film *See Banff!* footage

Figure 8: Stereogram from *See Banff!* footage. Stereoscopic view can be seen if you cross your eyes.

The “Movie Map” footage (Figure 8) was transferred to laser disk and used by Naimark to create *See Banff!*. This “Movie Map” was housed in a walnut cabinet designed to reference the Edison Kinetoscope of 1894. A lever on the cabinet selected different scenes and the crank on the side of the cabinet allowed the user to move forward and backward through the footage at their own pace (Figure 9).

Figure 9: The *See Banff!* kinetoscope installation

Should you wish to view a video of the piece, which shows the piece from the user's perspective, this is available at http://www.naimark.net/projects/banff/banff_v1.html .

Naimark's Process in the creation of See Banff!

As mentioned in Chapter 1.5.2, it may not be possible to analyse Naimark's process for each characteristic of transdisciplinary practice in isolation of the others and so this chapter will take a narrative rather than reductive approach.

One of the most interesting things about the *See Banff!* process was that Naimark did not set out originally to make a piece of Art, but rather to explore a concept through his *Field Recording Studies.* As Naimark recorded footage, and was exposed to different environments and different collaborators, *Field Recording Studies #3* evolved into *See Banff!*.

For *Field Recording Studies #3,* Naimark set out with his “Super Jogger” to film footage around the Banff area. While filming the footage, Naimark was struck by a number of observations that changed how he thought about the study and prompted him to conceive the idea for *See Banff!.*

Naimark observed that despite the beauty of the region, most tourists were not engaging with the beautiful surroundings but were rather being bussed in and bussed out thirty minutes later. This raised some interesting questions for Naimark surrounding place representation. After conducting research into the origins of the tourist industry in the Banff region he discovered that there were some controversies around this industry, particularly around the period of 1904 -1917 when a ban was placed on automobiles in the area. This time also happened to be an exciting time for visual representation technology as Stereoscopes were extremely popular. These observations and historical facts first sparked the idea for *See Banff!* in Naimark’s mind (Naimark 1995).

The evolution of Naimark’s work over time points very definitely towards the fifth characteristic of transdisciplinary practice, a Temporal and Evolving Process, but also hints at the characteristics of being Problem Focussed (2) and Praxis (6). In order to assess Naimark’s practice for Praxis it may be necessary to look at some smaller and more intricate parts of his process than the overall change from Field Recording Study to ‘exhibitable’ piece.

In “A 3D Moviemap and a 3D Panorama”, Naimark goes into some detail about the practical considerations which he had while filming the footage that would be used for this piece. His first observation is about building the “Super Jogger”:

> After much theoretical debate about optimal interocular distance between cameras, the minimum practical distance the cameras could be mounted apart was about 8 inches due to the size of the stop-frame motors. After reviewing several hundred turn-of-the-century landscape stereograms, it became clear that the exaggerated depth resulting from abnormally large interocular distances was the rule more than the exception, so no sleep was lost over our rig design (Naimark 1997).

This suggests that while theory framed his research, Praxis drove the process and therefore influenced the outcomes of his work. Another quote which reflects Praxis in Naimark’s process relates to how Naimark handled filming in difficult terrain:

> Stability ranged from finding smooth paved wheelchair trails to carrying the rig over rocky terrain. Frame rates were determined on-the-spot as a function of stability of the surface and distance of nearest objects, and ranged from 1 frame every centimeter to 1 frame every meter (Naimark 1997).

These situations and Naimark's process in dealing with them surely show that Praxis forms a major part of his process. This also shows that he tackled many problems while creating *See Banff!,* but does not necessarily show whether his work as a whole was Problem Focussed. The problem that Naimark wanted to solve was set out clearly when he began his 3rd Field Study: he wanted to explore Stereoscopic imagery in place representation. It may appear that this became less of a focus when he began to produce an Art work, but I believe that this was more a change in outcome than in Problem Focus. This change in outcome could well have come from an observation Naimark made while at Interval Research lab around proof of concept:

> Another connection has brought together tech-based art and research: the proof of concept. Traditionally, artists make exhibits and researchers write papers. But much of the new tech-based art today is incomplete, unstable and temporary, while much of research, particularly if it's media related, must be experienced as much as described.
>
> The convergence comes from opposite poles. In research labs, proofs of concept make physical something otherwise left to words alone. At places like the MIT Media Lab "the demo" is the currency for success, often in terms of funding as well as coolness among peers. In the arts, proofs of concept represent the end of an investigation that, for many tech-based artists, is enough. Any further work would be considered productization, not as interesting as exploring something else. This convergence helps to blur the line between artist and researcher (Naimark 2004 11).

I believe that this shows that Naimark had started to see the the role he could play in a space between Art and Tech Research and that his decision to create an exhibition piece from his field study showed not a change in problem focus, but simply a shift in how he would show proof of concept. But, did this shift to showing proof of concept in an Art space mean that the outcome of his process only spoke to the Art world or had only one goal?

See Banff! has been exhibited in eight separate exhibitions between 1994 and 2005 and is in the permanent collection at the American Museum of Moving Image in New York. By most standards that would seem to have achieved well within the Art world, however, Naimark and his collaborators have also been awarded two patents from their work on this piece. This starts to show the complexity of Naimark's practice by showing polytely. The second characteristic of Complexity, that of being dynamic and time dependent has been shown, but we have not yet shown whether there were a large number of connected variables in his process. The fact that this work started as a field study at Banff and then evolved to See Banff at Interval Research already hints at complexity but when one looks at the collaborators involved in the project, we get a better idea of the complexity of the situation. Naimark credits eight principal collaborators from a variety of backgrounds from film to software development and design. He also credits a further twenty five individuals and a number of organisations as collaborators from both Canada and the USA. This is certainly a complex situation and also talks to the third characteristic of transdisciplinarity, that of being Inclusive, Tolerant, Open and Collaborative.

The Openness and Collaborative nature of Naimark's practice is clear, but critics of transdisciplinarity may argue that this does not ensure an outcome that is not diluted. Key to preventing this is the fourth characteristic of transdisciplinarity: being Rigorous and Reflexive. When I asked Naimark what he felt the role of critique was in his work he had the following to say:

> Required, especially for anything interactive. I've often been wrong about audience expectation when it comes to user interface (Naimark 2009).

This certainly shows that Naimark feels that critique is critical to his work, but does this result in being Rigorous and Reflexive? The first indication of this trait is that Naimark has written extensively about his work, his process in creating this work and also about what he learned working in AST research environments. One need only look back through this chapter to get an idea of this. His reflections on his work were published for a number of audiences and these reflections documented not only the success of the project but also the processes involved and the challenges faced. One of the quotes that I think best shows both the Reflexive and Rigorous nature of Naimark's process was published in a chapter written by Naimark for the book Design Research: Methods and Perspectives (Ed Brenda Laurel). This quote also shows so many of the other characteristics of transdisciplinarity that I believe it best summarises our analysis of Naimark's practice:

> Since the moviemap sequences were all of finite length, the question arose of what to do with the crank when the scenes came to an end. One solution was for the image to simply go black, but this was unsatisfying. A better solution, it seemed, was for the crank to automatically freeze. A force-feedback brake was attached to the crank. When the first or last image of a sequence was viewed, the brake would switch on and the crank would lock up.

The effect was so effective that when the force-feedback was disengaged, something felt wrong. Obviously, a mental model of film mechanically transported through the device, with a beginning and end, was strong, and it was amplified when the eye and hand received consistent signals. But there was a small problem. The force-feedback brake was only so strong and could be over-ridden. An engineer colleague, Bob Alkire, had a curious suggestion: he said add an audio "pop" in sync with the brake engaging. Easy enough, so we did. The wooden cabinet was resonant, so the pop could be felt as well as heard. Magic! The result, based purely on adding an additional parallel sense, was that people actually thought we installed a more powerful brake.

But the problem didn't entirely disappear. Anyone (big males in particular) could still force the crank to move when the brake was engaged. An even more curious solution was proposed by Joe Ansel, former exhibit director for San Francisco's Exploratorium. He noticed that a mechanical bearing coupled the wooden handle to the crankshaft, allowing participants to grip the handle while turning it. He said "take it out." Everyone was puzzled. Joe explained that without the freely rotating bearing, participants would have to hold the handle lightly, to let it rotate under their grip. Joe's solution worked like a charm. The "light-handedness" made the brake feel even stronger. And the cost was, well, a negative number.

So in the end, the least anomalous interface required a force-feedback brake added, and an audio "pop" added, and a mechanical bearing subtracted. Who knew? (Naimark 2003)

This piece of writing clearly shows what I believe to be the transdisciplinary nature of Naimark's practice while working on *See Banff!*. Not only have I seen through this and many other quotes that Naimark's practice follows the characteristics of transdisciplinary practice but Naimark's work between the fields of Art and Science and his belief in being an Artist *and* Researcher clearly places him in a space where transdisciplinary practice would be advantageous.

This does only show, however, that Naimark showed transdisciplinary characteristics in his process in one instance. We will now look at what is arguably Naimark's best known and most successful work, *Be Now Here,* in order to ascertain whether he continued to show transdisciplinary characteristics in his practice.

Chapter 3.4. 2. Case Study - *Be Now Here*

After the completion of the *See Banff!* 'Moviemap', Naimark began work on the stereoscopic "Moving Movie" *Be Now Here*. For this piece, Naimark filmed stereoscopic panoramas at four "endangered sites" on the UNESCO World Heritage Sites list: Jerusalem, Dubrovnik, Timbuktu, and Angkor. This was done using a custom designed rotating tripod which housed two cameras placed eight inches apart (Figure 10). The rig was also highly portable since it needed to be transported between all of these sites around the world.

Figure 10: The *Be Now Here* production equipment

To view these panoramas, the audience was given stereoscopic glasses, entered a black, cylindrical room and stood on a slowly rotating, sixteen foot diameter floor.

Figure 11: The *Be Now Here* installation

This floor rotated in sync with the panning panoramic scene on the projection screen and gave the illusion that the screen was rotating, rather than the floor. The audience could move between scenes shot in the different locations using a very simple input panel on a pedestal (Figure 11).

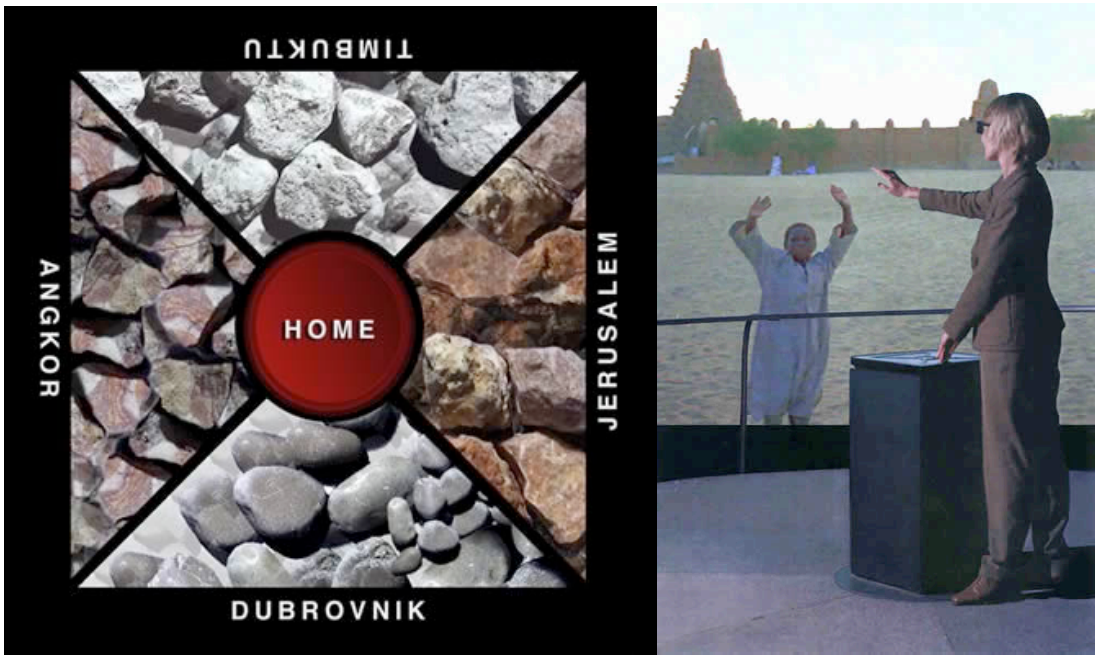

Figure 12: The *Be Now Here* Input panel and image of user interacting with the installation.

Four-channel location sound completed the illusion and gave the audience a strong feeling of being within these spaces (Figure 12).

Should you wish to view a video of this piece please visit http://naimark.net/projects/benowhere/benowhere_v1.html

***Naimark's process in the creation of* Be Now Here.**

Unlike *See Banff!* which started as an exploration and grew into and 'exhibitable' piece, *Be Now Here* was far more deliberate and focussed from conception to production and exhibition. Naimark notes that this work felt like a culmination of all his work into place representation so far, but that he also wanted to make a statement with this work:

> It seemed as if the last unchecked box of an invisible matrix was to make a stereoscopic motion picture panorama filmed in outdoor landscapes. I had also become increasingly politicized regarding content. The innocence and safety of filming along the Charles River across the street from MIT faded as I filmed more and more in other places, particularly in other countries. It became increasingly clear that whoever controls representation, controls everything (Naimark 2005).

Be Now Here was created with these two goals of "place representation" and political statement in mind, which clearly shows polytely and Problem Focus. These two goals would also lead Naimark to feel that he was walking the line between "presence" and "abstraction" or between Art and Science which he wrote about extensively in his article "What's Wrong with this Picture? Presence and Abstraction in the Age of Cyberspace". This piece gives us the most insight into how Naimark thought about working between these two disciplines and gives us a number of insights into his practice.

After 2 exhibitions of *Be Now Here* Naimark realised that a number of people in the audience were complaining of dizziness. He decided to do some experiments to determine the effect of reducing the speed of the rotation of the floor on both dizziness and the strength of the illusion created by the rotating floor. He discovered that by reducing the rotation of the floor (and therefore the speed of the footage so that they remained in sync) from 1 rpm to 0,5 rpm he could reduce the number of people who suffered from dizziness significantly without sacrificing too much of the strength of the illusion. To him this was the perfect example of how people who work with Art and Technology have to walk the line between the two fields. Figure 13 shows how he believes this balance is seen by others and where the two versions of *Be Now Here (BNH)* sat in relation to this view.

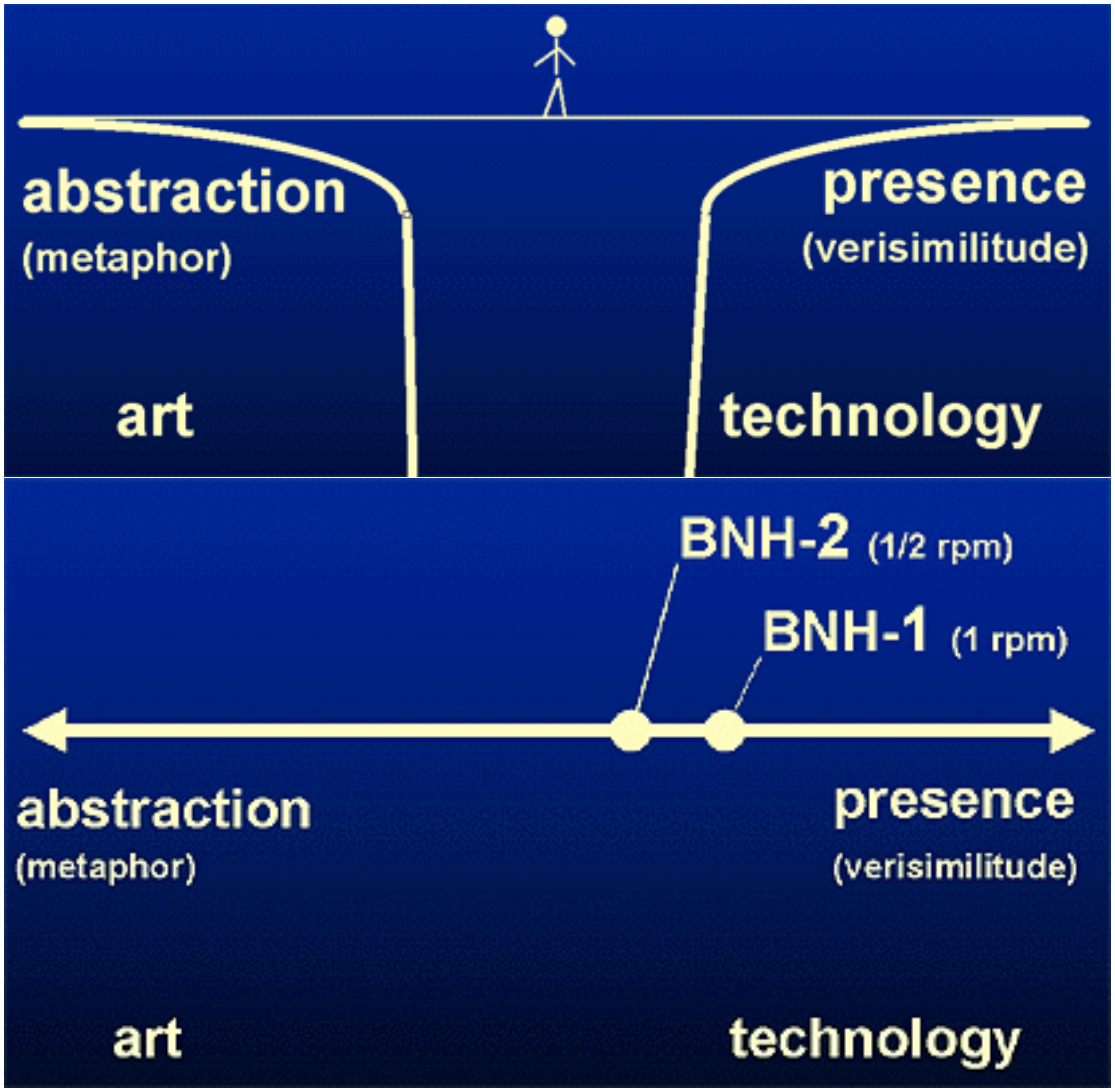

Figure 13: Presence and Abstraction/ Art and Technology

However, this perception concerned Naimark because he felt that simply saying that moving between abstraction and presence (or between Art and Technology) made something better or worse was too simplistic. He therefore decided that quality (which some may call Art) in fact lay on an orthogonal axis to presence and abstraction. Using this idea, he created a diagram that showed where the two versions of *Be Now Here* would now sit.

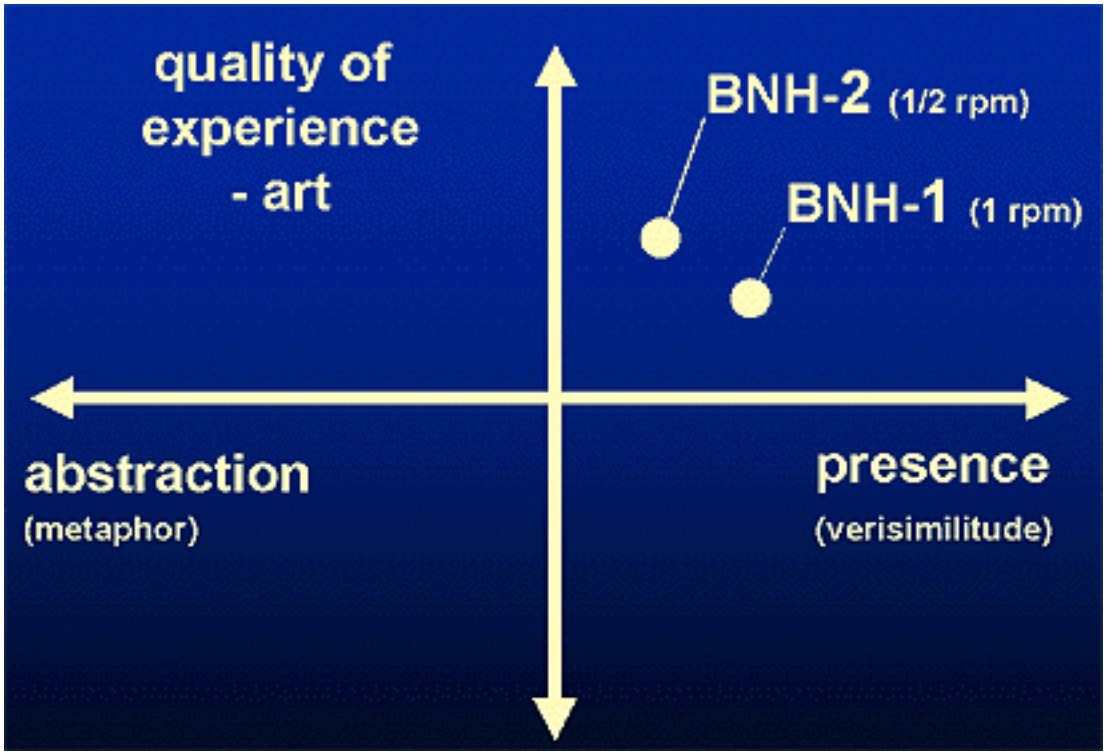

Figure 14: Presence and Abstraction vs quality of experience

This example of Naimark's practice as well as his analysis and critique thereof shows many characteristics of transdisciplinarity. It shows that he is Reflexive and Rigorous in his practice, has a Temporal and Evolving process and shows Praxis. The characteristic of Praxis is supported by his comment in a personal interview where he was asked about the roles of theory and practice in research:

> I'm more comfortable when practice drives theory rather than the other way (though I also believe that some strong inner sense, dare I say something spiritual, needs to drive practice.) (Naimark 2009).

I have already touched on the fact that Naimark's work has both polytely and a Temporal Process, however, in order to say that it was Complex I need to have these characteristics as well as the large number of connected variables. Firstly, let us look again at the outcomes of the project. As with *See Banff!* I can again see Complexity and, particularly, polytely when I see that *Be Now Here* has been exhibited nine times but also received a patent. This is just *Be Now Here* in it's original form. The footage from *Be Now Here* was also used extensively not only by other researchers and interns at Interval Research Corporation, such as Paul Debevec and Romy Achituv, but also by students at MIT and UNC to run various experiments. In the creation of *Be Now Here,* Naimark again collaborated with eight principal collaborators from varying fields and numerous additional collaborators, this time from five different countries. Naimark had often worked with researchers, however, in *Be Now Here* there were additional collaborations and relationships to consider:

> BNH required several years of cultivating a relationship with the UNESCO World Heritage Centre.... On the other side, it required cultivating relationships with various researchers at Interval (Naimark 2009).

Naimark noted that his collaboration with Interval Researchers was a particularly prolific one:

> One particularly fruitful collaboration that came out of the Interval community was with the computer vision researchers. I learned they were also interested in basic elements of visual perception, perspective, and presence, and together we nurtured a symbiosis. The footage I produced for See Banff was also made with them in mind. They were amused, I think, to have an artist-type supplying them with material which they felt was unique and valuable. The fact that it was not simply "views of the parking lot" was gravy. (Naimark 1998)

However, in *Be Now Here,* there were additional complexities to do with the locations in which he shot his footage and the relationships around these as Naimark observes in “Field Recording Techniques for Virtual Reality Applications”.

> Working with local collaborators was a critical element in ensuring the quality of imagery. The selection of the sites was heavily informed by local knowledge. More important, filming in the middle of public plazas is a conspicuous activity, and the fact that local collaborators knew many of the people in the plaza helped to make everyone feel comfortable (Naimark, 1998).

Naimark’s comments on his collaborations not only speak to the complexity of the process but also how Naimark’s practice was Open, Inclusive, Tolerant and Collaborative. Perhaps the best measure of both the characteristics of Complexity and Being Open, Inclusive, Tolerant and Collaborative is in Naimark’s response to my question about complexity in his work:

> At its best, my work strives to be complex, with extra credit points if it’s difficult to describe to others in words (e.g., try explaining the experience of Be Now Here to someone, why the rotating floor?). But it’s also important if kids and non-tech-savvy people “get it” as well (Naimark, 2009).

As we can see, Naimark's process in *Be Now Here,* displays all of the characteristics of transdisciplinary practice. However, I believe that there is another trait in his work, but also particularly in the way that he writes about his process, that is significant. Naimark is becoming increasingly aware of the space that his work occupies between Art and Technology Research and he is beginning to be more critical and reflexive about what this means for his practice. I believe that this above anything else shows that Naimark is employing transdisciplinary practice in the creation of *Be Now Here*. This is clear in his writing about presence and abstraction but also in his assessment of the success of *Be Now Here:*

> The closest guiding principles of my practice may be Gregory Bateson's assertion that almost all meaningful human interaction happens on a non-verbal level; Gyorgy Kepes' philosophy that an interdisciplinary approach to the arts builds bridges between people, their environments, and themselves; and Stewart Brand's statement about art as "at guerrilla war with artifice, employing and subverting the artificial to reawaken the real." (I've had the fortune of having had several conversations with Bateson, Kepes as a longtime mentor, and Brand as an ongoing colleague and collaborator.)
>
> In this light, a major external metric for success in my work is whether it attracts members of the arts community, the technology community, and (for lack of a better word) the activist, ideally in equal doses. The closest I've come is with my installation "Be Now Here," which attracted arts people because of its venues (San Francisco Center for the Arts, the Anchorage, Kiasma), tech people because of its unique stereo-panoramic immersion, and people interested in the Middle East, the Balkans, West Africa, and Southeast Asia because of its content (Naimark 2004).

This level of Reflexiveness and awareness about the space that his work and processes inhabit, in my opinion, makes his process even more transdisciplinary in nature than it was when he created *See Banff!* and shows a clear evolution of his process towards transdisciplinary practice.

Chapter 3.5. Does Naimark claim to follow transdisciplinary practice?

While this chapter has successfully assessed Naimark's practice and found that he displayed all the traits of transdisciplinary practice, Naimark himself does not claim to have a transdisciplinary practice. This may go against the argument that Naimark's practice is transdisciplinary because some may argue that you cannot have a transdisciplinary practice unless you actively make the choice to do so. I believe that this is untrue for two reasons. Firstly, at the time of these case studies, transdisciplinarity as a theory was in its infancy and was very much restricted to the sciences. Naimark may not have been aware of the idea of transdisciplinarity at all. Secondly, as we can see from the progression of Naimark's practice over the thirty five years, Naimark's practice evolved over time to becoming more and more transdisciplinary in nature. This was a natural progression as Naimark learned more and more about working in these AST environments. This progression suggests that not only is transdisciplinary practice useful for Naimark, but also suggests that it is a framework that works particularly well within the AST research environment.

Chapter 4. Learning from Naimark's Transdisciplinary Practice in the Art, Science and Technology Research Environment

Chapter 4.1. Introduction

In Chapter 3 I showed that Michael Naimark developed a transdisciplinary practice in the creation of his work *See Banff!* and *Be Now Here* while at the Banff Center for The Arts and Interval Research Corporation. In this chapter I explore the idea that transdisciplinary practice should be implemented at AST research environments to ensure that the outcomes from these environments are more successful in multiple fields.

Chapter 4.2. The Value of AST research

As outlined in Chapter 2, working between disciplines is not without it's challenges. Naimark himself noted a number of challenges when working in the AST environment and said that in many cases it felt that "the "art" and the "technology" forces were in opposition". (Naimark 1998 123) However, this has not stopped Naimark from working in the AST environment. In fact Naimark believes strongly that Artists should be involved in technological development and research:

> It is my observation and belief that technology, particularly computer and media technology, is having an increasingly profound effect on everyone on the planet. And that if artists don't jump in and pro-actively help shape these powerful new tools, it will be left by default to advertisers, the military, organized religion, and sex peddlers. Some of us believe the stakes are high (Naimark 1998 123).

This is certainly a strong view, but it is mirrored by a number of Artists, including Stephen Wilson, author of Information Arts and long time Artist and Researcher, and Gyorgy Kepes, founder of MIT Media Lab.

> It is a critical error to conceive of contemporary research as merely a technical enterprise; it has profound practical and philosophical implications for the culture. The shaping of research and development agendas could benefit from the involvement of a wider range of participants including artists (Wilson 1996).

> The images and symbols which can truly domesticate the newly revealed aspects of nature will be developed only if we use all our faculties to the full—assimilating with the scientist's brain, the poet's heart and the painter's eyes. It is an integrated vision that we need; but our awareness and understanding of the world and its realities are divided into the rational—the knowledge frozen in words and quantities—and the emotional—the knowledge vested in sensory image and feeling (Kepes 1956 19-20).

These comments certainly make a strong point for Artists to be involved in AST, however, in order for AST research to truly flourish, it must benefit scientists and researchers to be involved in these environments too.

Naimark made some crucial observations about Artists' roles in research while he was working at Interval Research Corporation:

> I noted six reasons why art projects in a research lab have significant value to the research lab :

1) art projects provide stimulation and provocation to our research community, adding meaning, entertainment, and emotional resonance to our work;

2) these projects often act as magnets to bring together unconventional combinations of skills and talents;

3) they can provide content to test tools (and even tools to test content);

4) some of these projects are means for collecting data about human behavior, both through explicit query as well as through observation;

5) these projects may lead researchers down unforeseen paths and result in new discoveries and intellectual property;

6) external deadlines and public scrutiny serve as forcing functions for decision making, Rigor, and completion. They keep us street-smart. “Putting on a show” is a test bed for new ideas, a simulation of the real world.

If one swaps the words “art” and “research,” the same reasons are valid for why tech-based research has value in arts centers (2004 10).

Stephen Wilson talks to the role that an Artist can play in research in his book Information Arts.

> Free from the demands of the market and the socialization of particular disciplines, artists can explore and extend principles and technologies in unanticipated ways. They can pursue “unprofitable” lines of inquiry or research outside of disciplinary priorities. They can integrate disciplines and create events that expose the cultural implications, costs, and possibilities of the new knowledge and technologies (2003 28).

The advantages of research within AST have not just been noted in writings however, there is also evidence of these advantages in the sheer fact that so many AST environments have been, and are, in existence today. In fact MIT began a new Center for Art, Science & Technology (CAST) in April 2012. (MIT, 2012) MIT has run a number of AST initiatives in the past thirty years and would not have launched this new initiative if it had not been sure to produce excellent results.

Of course setting up of AST Research environments is not without its challenges. One of these is funding, which Naimark has written about extensively in Truth, Beauty, Freedom and Money: Technology-Based Art and the Dynamics of Sustainability. Here he proposes a hybrid model of Donor Funding, Research Grants, Sales of the Outcomes of Research, Consultation Fees and PR fundraising to sustain such a environment (2004).

The other major challenge is measuring the outcomes of the research environment. Let me revisit a quote from Edward Shanken that was introduced in Chapter 2:

> On a philosophical level, if the fruits of hybrid research are not strictly science, or engineering, or art, then one must wonder about the epistemological and ontological status of these hybrid forms: What exactly are they? What new knowledge do they produce or enable? What is their function in the world? On a practical level, the future sustainability of hybrid research depends on answering these questions, because the academic careers of scholars whose work fuses disciplines will be cut short if their contributions are not recognized and rewarded within the university (2005 418).

It is my belief that transdisciplinarity provides the answers to these questions. Transdisciplinarity provides a theoretical and epistemological framework for work *between* the disciplines of Art, Science and Technology.

Chapter 4.3. The benefits of Transdisciplinarity practice within AST Research Environments

As mentioned in Chapter 2, there are very few examples of transdisciplinary practice within AST. However, after assessing Naimark's practice for transdisciplinary traits and finding that his process has evolved to become progressively more transdisciplinary over time, I would like to propose that transdisciplinary practice offers many advantages in an AST research environment. Naimark's practice in these environments naturally evolved into a transdisciplinary one, which suggests that there are benefits to this practice in these environments.

In many cases transdisciplinary practice is seen not as a benefit but rather a necessity. Julie Thompson Klein in her article Prospects for Transdisciplinarity notes the following about problems faced by society today:

> The problems of society are increasingly complex and interdependent. Hence,they are not isolated to particular sectors or disciplines, and they are not predictable. They are emergent phenomena with non-linear dynamics, uncertainties, and high political stakes in decision making. They center, as Bruce and colleagues explained in their report on the Fifth Framework Programme of the European Commission (EC), on complex heterogeneous domains. The need for transdisciplinarity is ubiquitous (2004 517).

She then goes on to say that “transdisciplinary approaches have exposed the limits of segmented thinking and problem solving” (2004 517). In talking about areas in which transdisciplinary thinking is particularly called for she mentions “fields of major technical development”, in particular, and also “fields where social, technical, and economic developments interact with elements of value and culture” (2004 517).

I believe that this shows clearly that there is a need for transdisciplinary thinking in the AST research environment. The types of complex problems faced by the world today could surely benefit from the transdisciplinary thinking from Artists, Engineers, Technologists and Researchers.

Transdisciplinary practice does not represent a panacea, however, and is not always a better choice than inter- or multi- disciplinary practice. It is different. As shown above, transdisciplinarity has particular benefit when assessing a complex, real world problem. This makes transdisciplinary practice an ideal framework for an AST research environment. Transdisciplinarity as a core principle for an AST research environment would give a framework for the selection of research problems in the programme, would frame the way in which research was conducted and would give a way in which outcomes of the programme should be evaluated. Of course it would also present all the challenges associated with transdisciplinarity, but in many cases these challenges are similar to those experienced in inter- and multi-disciplinary environments and so, in this context, the benefits would be seen to outweigh the challenges. As Naimark says, the stakes are high, and I believe that a transdisciplinary AST environment's time has come: one with real world, complex technological and social problems as the focus.

Chapter 4.4. Implementing Transdisciplinary practice within the AST environment

While Naimark's evolving practice indicates that transdisciplinary practice is valuable within the AST environment, it does also speak to the implementation of transdisciplinary practice within these environments. It suggests that the theory of transdisciplinarity cannot simply be implemented in it's idealistic form or be enforced in an environment as a set method. In practice, transdisciplinarity is temporal in nature and continually evolving. This is mirrored in the characteristics of transdisciplinary practice but also in the practice of Naimark and how this evolved over time. While an understanding of transdisciplinary theory is essential, an understanding of the characteristics of transdisciplinary practice and its temporal nature will be essential in implementing transdisciplinarity in any real world environment such as an AST research environment.

Afterward: A Case for a transdisciplinary AST research environment in South Africa

Although the purpose of this research paper was not necessarily to create a case for transdisciplinary research environments in South Africa, my context and environment has driven me to add this afterward with the intention of exploring this idea. To my knowledge, there is no initiative in South Africa that attempts to explore research between Art, Science and Technology in a transdisciplinary manner. There are programmes in a number of South African Universities which explore Technology in Art Practice, including the Masters in Interactive Media Design at the University of the Witwatersrand School of Digital Arts in Johannesburg which accepts students from a variety of undergraduate degrees including Fine Art and Engineering.

> The Interactive Digital Media program focuses on interactive digital media and creative practice. The program is designed for students from an arts and design background who wish to engage with the creative possibilities of interactive digital media technologies; AND for students from engineering, science and technology backgrounds who wish to develop their creativity in these areas. The aim of the Masters Program is to bring together passionate individuals from diverse creative and technology/science backgrounds to creatively explore and develop new and exciting interactive media. (University of the Witwatersrand 2013).

Programmes like this certainly talk to an acceptance of Art using Technology as a medium, however, they do not have an Art Practice as Research focus and do not attempt to work between disciplines, but rather fall fairly firmly within the academic discipline of Art. While it accepts students from different disciplines are accepted into the University of the Witwatersrand programme, the outcome of the masters programme is a Masters in Art, and the faculty of the programme comprises mainly of Artists who practise in the Tech-based Art but not of Technology or Science Researchers.

This is one of the challenges of any kind of transdisciplinary programme within the university context. In many cases the departmental and discipline structures of the university are too firmly entrenched to accommodate work *between* disciplines.

The University of Stellenbosh is attempting to break down these boundaries and forge, what to my knowledge, is the only outwardly transdisciplinary programme in South Africa. This programme, called the Transdisciplinary, Sustainability, Analysis and Modeling Assessment HUB (Tsama HUB) is described as follows:

> The TsamaHUB acts as a coordinating mechanism that utilizes the transdisciplinary potential that exists among various faculties and departments of the University that have interests and expertise in sustainability, sustainable development and complexity. In this regard, collaboration with existing Centres, such as the Centre for Renewable and Sustainable Energy Studies (CRSES) led by Prof Wikus van Niekerk (Mechanical Engineering) as well as the Centre for Studies in Complexity, (CSC), initiated by Profs Jannie Hofmeyr (Biochemistry) and Paul Cilliers (Philosophy), are of particular importance (Tsama 2013).

This programme is, however, largely limited to transdisciplinary research within the sciences, although it does not exclude students from the humanities in it's summer school courses.

Of course programmes of this type do not need to be limited to academic institutions. In fact in his paper Truth, Beauty, Freedom, Money: Technology-Based Art and the Dynamics of sustainability, Naimark notes the following about the types of programmes that run AST research:

> Tech-based art is largely supported by two different kinds of institutions: art centers with an interest in new technology and research labs with an interest in art. Some are university based. Some are corporate based. Some are government funded. And because of the ubiquitousness of technology, many tech-based artists are happy to exist entirely outside of any institutional environment (2004 12).

Naimark does, however, also note that examples that he found of AST programmes while researching this paper were "despairingly First World". Perhaps this is due to the fact that developing nations and companies offering funding and grants in developing nations are less likely to provide money for research in such an "obscure" field when there are so many pressing problems such as poverty and inequality. Perhaps this is due to a lack of inter- and transdisciplinary thinking within academic institutions. Whatever the reasons, and they are many and complex I am sure, emerging markets are starting to become hotbeds for technological innovation. Naimark notes that "Things will change as the tools become cheaper and internet access widens. Stay tuned to the margins: Newer, bolder exemplars will emerge from there." (2004 12)

Naimark is certainly correct and I believe one just needs to look at the technology “hubs” that have sprung up all over Africa in the last five years[21] to see that Africa is reaching a new era in technology innovation. Perhaps this market is still too young for a full AST focussed research environment, but certainly I hope that technology hubs such as the JoziHub[22], which aims to have a Technology and Culture stream, will start to show the value of AST which will eventually lead to more focussed AST initiatives and programmes.

It is my hope that when these more focussed initiatives start to form, that at least some will undertake a transdisciplinary practice as, particularly in the context of the developing world, the types of problems that can be solved by these initiatives could greatly benefit from a transdisciplinary approach.

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[21] https://africahubs.crowdmap.com/

[22] Jozihub is a network of tech innovators in Johannesburg, South Africa, dedicated to harnessing the power of technology to create sustainable change in Africa. http://www.jozihub.org/

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