Extending Spatial Boundaries Through Sculpture Practice: An Exploratory Study of the Influence of a 3D Digital and Technological Context on Sculpture Installation Art

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ABSTRACT

Extending Spatial Boundaries Through Sculpture Practice: An Exploratory Study of the Influence of a 3D Digital and Technological Context on Sculpture Installation Art

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In sculpture practice, artists are challenged by a 3D digital medium within which digital data intangibility also embeds a tangible form. The focus of this study is to understand how a 3D technological context extends spatial and medium boundaries in sculpture practice and affects artists' conceptual and practical approaches to the creative process. The study explores the sculptors' relation to space, time, and the medium inside a gravity-free spatial context, which proposes a re-defined concept-process relationship. The research methods include a Research Creation experiential mode of inquiry and a case study interview approach. The Research Creation project documents the artist-researcher as sculptor's conceptual investigations (which are focused on environmental concepts). The main sculpture installation work, *Vulnerable: The Salmon Project*, conveys a concept of memory and proposes a visual metaphor of the vulnerability of the living condition. The data collection method is informed by the artist-researcher's creative exploration guided by an experiential learning of 3D scanning, in-depth investigations into the structure of digital objects, and applied knowledge of 3D modelling and rapid prototyping processes. The case study focuses on three professional sculptors: Kiki Smith, Evan Penny, and Trevor Gould. The artist-researcher presents an interpretation of how the artists' conceptual explorations, professional backgrounds, and experience play a role in the way they approach 3D technology in their creative process.

This research examines how artists engage with a digital medium and the ways in which it influences their visual language and artwork aesthetics. The research outcomes indicate that explorative and innovative perspectives lead to a convergence of digital mediums. Artists experience a medium that encourages the crossing over from 2D to 3D. Collaboration, or a shared knowledge approach, stimulates creative freedom inside a 3D software environment. This research contributes to a deeper understanding of artists' interactions with extended spatial dimensions and a digital medium through which technology becomes a way of engaging, perceiving, sensing, and experiencing creativity.

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Within this Research Creation Ph.D., the main sculpture installation project and other works supporting the dissertation were shown in Montreal at the POPOP Espace

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INTRODUCTION

Extending Spatial Boundaries Through Sculpture Practice is an exploratory study that scrutinizes the ways in which artists experience a 3D digital and technological context in a hypermodern[2] epoch, where space-time and materiality are greatly affected by digital mediums. The Research Creation project develops through a concept of time,[3] and a digital medium guides the artist-researcher's[4] creative investigations. The study questions the influence of a technological context on sculpture installation artists' creative process. The research outcomes are presented from an interpretive understanding of how artists' interactions with a digital medium and a 3D software spatial context affect their sensibility, their creativity, and their artwork production strategies. Interpretations of how a 3D digital and technological context extends sculptors' spatial boundaries in sculpture practice are also presented.

Today, artists are confronted with an expanded concept of space-time, from which creative explorations address two distinct but complementary dimensions. A traditional approach to sculpture practice proposes an analogue approach to a spatial-temporal environment. When the materiality conveyed through a sculptural concept is challenged by the immaterial nature of a digital and technological context, the artists' creative process is affected. Both, the sculptors'[5] relationships with objects in space and the means of their production are questioned. The concept of sculpture itself is challenged by 3D digital processes that broaden sculptors' interactions with the medium from analogue to digital experiences that reflect on the aesthetics of their artwork.

This study explores how creative possibilities are influenced by the relationship

between analogue and digital approaches to artistic exploration in the field of sculpture installation art. The tangible and the intangible conditions characterizing the creation process of sculpture inside a 3D digital and technological context are explored. The study looks into how these conditions affect a creative activity experienced inside a 3D software interface environment that broadens artists' spatial-temporal and material boundaries. The research examines the extent to which the creative process is influenced by artists' interactions with a technological context and a digital medium. This research makes an important contribution to the field of sculpture by presenting how traditional modes of experiences are broadened by sculptors interactions with a digital medium and how the creative conditions artists experience when exposed to a digital and technological context influence their perception of spatial environments. A Research Creation project is supported by a case study interview method of inquiry to identify how the artists' creative process and the artworks' production modes are affected by these extended spatial boundaries from analogue to digital. The research more specifically focuses on artists' creative experiences of distinct artistic approaches to figurative works that are influenced by a sensory experience of forms perceived through a computer software perspectival frame. The digital sculpture representation is generated through creative applications of technology, such as 3D modelling, 2D and 3D scanning, and rapid prototyping (RP). The study also identifies the ways in which the artists' visual language is influenced by their interactions with a digital medium.

From an analogue viewpoint, artistic knowledge is transposed into tangible forms inside a spatial environment. Sculpture production comprises a sense of materiality in relation to a tangible space. As the artist engages with an artwork, a spatial and temporal

interaction with the environment is experienced. This study presents a perspective on the ways digital technology affects artists' creative experiences. The research brings to sculpture practice a 3D digital and technological perspective that builds on existing analogue knowledge. The study looks into artists' interactions with and perceptions of the sculptural object mutation from matter to bits, or data information. The digital medium exposes artists to a computerized spatial dimension and automated fabrication, through which they experience simulated modes of production. The research contextualizes the ways in which digital technology incites the venue of artwork aesthetics engaging with a digital medium. This digital medium is intrinsically linked to the notion of simulation, as defined by Baudrillard (1983) or that of disappearance developed by Virilio (2009). Art has become transmittable and therefore has become converted into information of all nature and content (Berger, 1972). The digital medium brings to sculpture installation artists an extended approach to conceptualizing and perceiving objects in space. The exploratory and innovative perspectives that digital mediums present foster a plurality in the arts from which the specificity of each medium is embedded in its encoded data.[6]

Moreover, this research opens onto the endless creative perspectives of digital means to create and it encourages innovative approaches to a digital spatial context. The research extends artistic experience with a simulated medium, a digital medium or, as proposed by Krauss, a *postmedium*: "a medium as such" (Krauss, 1999, p. 296). Different from all other artistic mediums, the digital medium is dependent on its computerized environment and technological support—a medium within which artistic representations are embedded in a code and whose coded mutable nature encourages a plurality in the arts.

This dissertation develops over six chapters: a literature review; a statement of the research focus addressing the research questions; the methodology and research procedures, which include a section on the data collection methods for the Research Creation project; the data analysis from the case study interviews; a discussion and interpretation of the research results; and, in the last chapter, a broad perspective on the Research Creation project, addressing the themes of the interviews and providing a description of the research creation concepts leading to the exhibition of artworks supporting the dissertation; followed by the conclusion.

Chapter 1 presents the theoretical framework from historical, philosophical, and cultural frames of reference. First, the 3D software graphic interface perspectival configuration is contextualized through an overview of the development of the perspectival plane through time. The study retrospectively looks into Alberti's (2004) research on perspective and Lambert's (1759) interest in finding ways to free up artists' minds from perspectival versus mathematical constraints. This situates the research within a space-time context. Second, arguments in support of the research direction are presented; the study explores the correlation between artists, art and media theorists, and philosophers and their position on digital media and a digital medium's influence on the arts and society. Third, the literature situates how, in the field of sculpture installation art, computer technology influences traditional approaches to sculpture practice and influences spatial-temporal and artist-medium relationships. Theories that build on digital mediums are addressed. This theoretical framework supports the Research Creation project, which presents ecological perspectives through a technological creative context. The literature that inquires into the fragmented nature of digital mediums from theoretical,

aesthetic, philosophical, and artistic perspectives informs the Research Creation mode of inquiry. Finally, the literature review guides the research focus.

Chapter 2 introduces the two central questions that guide this research. The first question addresses the influence of a 3D digital and technological context on sculptors' relation to spatial environments and on their creative process: in sculpture practice, how does a 3D digital and technological context extend sculptors' spatial boundaries and influence artists' conceptual and practical approaches to the creative process? A 3D digital and technological context includes working with technology such as 3D software, 3D scanning, and RP processes, which expose artists to a different spatial-temporal dimension and affect the artists' creative process.

The second central question addresses the influence of a digital medium on the artwork aesthetics and inquires: How do sculptors' interactions with a digital medium influence the aesthetics of their artwork? The research presents ways in which creative explorations of a digital medium, from 3D scanning analogue sculpture forms or found objects to 3D modelling a sculpture concept, influence the artist-medium relationship. The artists' spatial-temporal-material interactions, which affect artwork production modes and reflect on the artwork aesthetics, are also presented. The study brings to light the ways artists' sensory experiences are influenced by a digital spatial context.

In Chapter 3, the research procedures and methodology are described. The research is positioned inside a hypermodern viewpoint, which proposes looking at a present that builds from modernist and postmodernist perspectives. Hypermodernity addresses the technological era and the influence of digital media, and digital mediums,

on the arts and on contemporary society. Case studies and the Research Creation project are the means of data collection. The case studies and the Research Creation provide a broad perspective on the influence of a 3D digital and technological context on artistic creation. The interview structure and procedure for the analysis are described. In section 3.6, the Research Creation data collection methods are presented, which include a description of the ways the artist-researcher engaged with technology. A description of the artists' interactions with the digital medium and how this influenced the artwork aesthetics is also presented. A selection of images of artworks from all the participants illustrates the artist-researcher's interpretation of how the artists' creative process is influenced by a 3D digital and technological context.

Chapter 4 presents an analysis of the data from the case study interviews. Contextual backgrounds situate the profile of each artist-participant. Most of the interview questions focus on the artists' current use of 3D digital technology. Chapter 5 presents a discussion and interpretation of the research findings, which include the Research Creation and case study interview outcomes, gathered through the Research Creation project and the case study interview themes.[7] The artist-researcher's experiences and the case study participants shared experiences present a lens on how a 3D digital and technological context influences artists' conceptual and practical approaches to the creative process. Each artist-participant's creative mode of production—including that of the artist-researcher—is discussed. Comparisons are made between the data collected. Artworks reflecting the sculptors' interactions with a digital medium, which support the research findings, are discussed.

Chapter 6 presents the conceptual framework of the artist-researcher's sculpture installation project. This chapter also addresses the themes explored in the interviews and situates the researcher and her motivation for this research project. A discussion of the influence of 3D technology on the artist-researcher's creative process is presented. The researcher's sensorial and perceptual experience of a digital and technological creative context is discussed. The chapter focuses on a description and illustrations of the artist-researcher's Research Creation works. The Research Creation project explores creative interactions with natural and technological environments. The Research Creation body of works includes a main sculpture installation project and additional work explored through a print edition and digital print images. Reflecting a concept addressing the condition of the natural environment, the work's aesthetics indicate the artist-researcher's technological investigations.

The conclusion presents the outcomes of this research project. It offers insights into the ways a 3D digital and technological context extends artists' spatial boundaries in sculpture practice and can broaden the creative possibilities for future generations of artists. From the theoretical framework to the methodology that guides the research and more particularly the Research Creation exploration, the conclusion points out how artists' relationship to space, time, and materiality—while interacting with a digital medium—is changed. A case study inquiry brought an understanding of how, from an analogue to digital to analogue modes, digital inquiry extends artists' spatial and medium explorations and their relations with sculpture fabrication processes.

A critical reflection on the overall research project is also presented. The artist-researcher questions what could have been done differently and identifies some of the weaknesses of this project. Future perspectives, ideas, directions, and projects are also presented. New questions addressing the future of objects in sculpture installation art practice and ideas about the artist-researcher's upcoming project directions conclude the study.

CHAPTER 1

THEORETICAL FRAMEWORK

1.0 Introduction

In line with the ongoing relationship between art and technology, this research contributes to an understanding of the influence of a digital and technological context on sculpture practice. As an attempt to better situate the context of this research within the existing wide range of digital media works, the study focuses on a 3D technological context from which creative explorations are shaped from an analogue to digital to analogue medium output. The research explores artists' conceptual investigations led through interactions with a digital medium. A Research Creation project, whose concept is an ecological discourse, explores a space-time concept and is challenged by technological explorations that influence artists' perceptions of spatial boundaries and the tangibility of artistic mediums.

Today, the tangibility of the medium has broadened to give rise to a less tangible form of art, a work of art that has opened out from a socio-cultural and historical referential context onto an endless concept of being other than itself, and, as the French philosopher Lipovetsky (2005) stated, "the second kind of presentism that now rules our lives is no longer either postmodern or self-sufficient: it never ceases to open out on to something other than itself" (p. 41).

This chapter presents a review of concepts from art historians, media theorists, literary theorists, philosophers, computer science theorists, and artists. It presents the theoretical framework on which the study is grounded. First, a look back into history

situates how perspectival concepts, from that of Alberti to those related to digital technology, have influenced the arts. Today, the perspectival views presented on a 3D software interface influence the ways in which sculptors interact with the spatial environment. Digital mediums and technological advances reflect on the arts and on society from many angles. The following sections examine the subject from various theoretical standpoints.

1.1 Representation of Objects: From Perspectival Representation to CAD

From Alberti's perspectival representation to 3D modelling software coordinate systems, technological developments influence spatial representations and the way we perceive and interact with spatial environments. These developments have influenced artistic manifestations in fine arts, design, and architecture. Representations of objects on a plane have shifted through time, influenced by technology growth from Lambert's *Freye Perspektive*[8] (free perspective) in 1759 to the computer in the 1940s, proposing a digital context leading to visual appearance or simulation of object in space. Moreover, the development of computer-aided design (CAD) and computer-aided manufacturing (CAM) in the 1960s led to rapid prototyping (RP), computer numerical control (CNC), and 3D printing technology in the 1980s, where the concept of immateriality, linked to the digital medium, influences artistic modes of production and artists' interactions with objects in space.

Such extensions of spatial boundaries historically experienced by the arts are meant to release artists from physical or mathematical constraints. Looking back at Lambert's research on free perspective,[9] which indicates a strong interest in painting, Kirsti Andersen (2007) stated, "Lambert's concern for the practice of perspective

manifested itself in, among other things, a lengthy discourse on how to choose the parameters of a painting—a theme most authors avoided or only touch upon briefly" (p. 682). Lambert's research objective remained a constant desire to free up artists' minds. This affirmation is supported by media theorist Friedrich Kittler (2010), who stated:

> Lambert's free perspective wanted to relieve painters of precisely this toil . . . . Lambert applied Euler's mathematical trick to painting. He no longer determined perspectival geometry as relationships or proportions between lines, like Euclid and Pythagoras, but rather as transcendental functions of an angle of vision. (p. 94)

As proposed by Kittler, Lambert's research removed the burden of "mathematically untrained painters" by developing measuring instruments; he invented a ruler

> . . . that would have simply appalled Euclid or Dürer. . . . A painter who had obtained Lambert's ruler could cast an eye over the landscape, slide the ruler over the drawing, and an image emerged in perspective entirely without a ground plan or site elevation. (Kittler, 2010, p. 95)

Lambert's research in the field of mathematics or trigonometry, as presented by Kittler (2010), "made it possible to calculate a subjective appearance" (p. 95). This dissertation studies artists' interactions with a 3D software context and technological modes of production that convey a so-called "subjective appearance" (Kittler, 2010).

1.1.1 Creative Freedom

Lambert's preoccupation with encouraging creative freedom through the invention of a measuring instrument also exists in the present day, where software advances evolve towards a similar objective of providing and increasing user-friendly interface environments, including tools and applications. In the early 1990s, artists indicated an interest in the production of sculptural work and explorations of 3D digital

technologies, such as 3D modelling software, 3D scanning, and rapid prototyping (RP) modes of production. Today, sculpture studio production, such as the Digital Atelier,[10] focuses on the mandate of "bring[ing] technology into the hands of artists" (Lash, 2013). The Digital Atelier's objective is to propose and bring new approaches to sculpture practices, reducing and facilitating production modes through the use of emerging 3D technologies. While computerization has influenced concepts and productivity and brought new methods of prototyping and new ways of improving project development in architecture and design since the late 1980s, 3D digital technology's implementation in the sculpture field started in the 1990s, when "digital sculpture officially began to exist, even if it had its roots in earlier experiments" (Paul, 2013, p. 8).

While most obvious in contemporary architecture, 3D digital means influence a visual language and formal vocabulary of concept design within all artistic domains. Evidence of the influence of 3D modelling software applications is primarily significant in architecture. Take, for example, the architecture of the Guggenheim Museum in Bilbao, Spain, or the new AGO wing in Toronto, two projects designed by the Canadian architect Frank Gehry. In *Frank Gehry Architect*, Cohen & Gehry (2001) address the architecture of the Guggenheim Museum Bilbao, where evidences of the influence of 3D digital technology on the architectural concept are acknowledged:

> With this building, the gestural quality of Gehry's sketches was captured in built form for the first time. While CATIA software had been in use at his office since the firm worked on the Fish Sculpture at the Vila Olimpia (1989-92), the Guggenheim Museum Bilbao was the first major project in which the full potential of the program was realized. CATIA has enormous significance from both aesthetic and technical points of view, for not only did it afford greater freedom in the design of Gehry's distinctively organic forms, but it also simplified construction, providing digital data that could be employed in

> the manufacturing process, thus controlling the costs. (Cohen & Gehry, 2001, p. 161)

Focusing on sculpture installation art practice, this research concerns an artistic field subject to technological growth that has not yet been thoroughly investigated. Moreover, current studies described in the literature fail to address the impact of technology in visual art from multiple standpoints. In the artistic domain, the influence of the digital medium on photography and video art was primarily addressed, followed by drawing and painting or printmaking. But the application and consequences of the technology on sculpture installation practice need to be further explored.

1.2 Formal, Spatial, and Temporal Creative Explorations

Sculpture installation[11] art is not medium specific. Artists engage with formal, spatial, and temporal explorations where a dialogue between the artist and the medium can be initiated from multiple perspectives. But what does art do? Contemporary thinker Jean Luc Nancy would answer that art captures the artist's sensory experience of being in the world. Addressing the question of the role art plays in our society, Nancy (1996) stated, "it touches on the trans-immanence of being-in-the-world. Art does not deal with the 'world' understood as simple exteriority, milieu, or nature. It deals with being-in-the-world in its very springing forth" (p. 18).[12]

From the premise that a 3D digital and technological context extends sculptors' spatial boundaries and influences artists' concepts, the study questions how does this context "touch on" (Nancy, 1996) sculpture installation art practitioners. How does it influence, disturb, destabilize, or deconstruct artists' creative process? How does it provoke a shift from pre-established analogue approaches to objects in space or hands-on

modes of production? How does digital sculpture "open up new dimensions for relations between form and space" (Paul, 2013, p. 14)? How do artists build a new formal knowledge inside a computerized or mathematically formatted spatial-temporal context? And, how does artists' creative thinking experience a computer-controlled process, such as 3D modelling, 3D scanning, and RP modes of production?

Looking for answers from a Research Creation standpoint implies a perspective based on artists' sensory and perceptional experience. A phenomenological approach, as stressed by the German school of *Gestalttheorie*, aims to demonstrate that (contrary to the criticism doctrine) perception is not an intellectual operation and it takes form through sensory knowledge (Merleau-Ponty, 1998, p. 12).

1.2.1 Phenomenology: Philosophy of Sensation

Phenomenologist Maurice Merleau-Ponty suggested that the philosophy of sensation could be considered the psychological application of the theme of "L'intentionalité de la conscience" as presented by Husserl (2012). Merleau-Ponty (1998) stipulated that the phenomenology, and the psychology inspired by it, may bring about a need to revise notions of consciousness and sensation:

> *La phénoménologie et la psychologie qu'elle inspire méritent donc la plus grande attention en ce qu'elles peuvent nous aider à réviser les notions mêmes de conscience et de sensation, à concevoir autrement le "clivage" de la conscience*. (p. 24)

Psychologist Margaret Boden's position is that rules and constraints are relevant to artistic creativity. Boden (2004) stated:

> People often claim that talk of "rules" and "constraints"—especially in the context of computer programs—must be irrelevant to creativity, which is the

> expression of creative freedom. But far from being the antithesis of creativity, constraints on thinking are what make it possible. This is true even for combinational creativity, but it applies even more to exploration-based originality. (p. 95)

Boden used Dickens's creative writing as an example to argue that constraints stimulate artists, as they are meant to be pushed further, and stated,

> Constraints map out a territory of structural possibilities which can then be explored, and perhaps transformed to give another one. Dickens could not have created his luxuriant description of Scrooge without accepting the grammatical rule about adjectives, and pushing it towards its limits. (Boden, 2004, p. 95)

Due to the complexity of 3D digitizing methods, it is inevitable that artists are continuously confronted with unexpected technological constraints, but, as Boden (2004) stated, "In short, to drop all current constraints and refrain from providing new ones is to invite not creativity but confusion" (p. 95).

1.3 From Benjamin to Manovich: From Individualism to Perspectivism

In this section, art theorists' and philosophers' standpoints on the impact of a digital medium and computational technology on the arts and on society are introduced. To present perspectivism from the viewpoint of a social theorist facilitates the comprehension of its use in the context of this research, where perspectivism is rooted in the ways artists interact with a 3D digital spatial dimension. As described by David Harvey (1990):

> Perspectivism conceives of the world from the standpoint of the "'seeing eye"' of the individual. It emphasizes the science of optics and the ability of the individual to represent what he or she sees as in some sense "'truthful,"' compared to superimposed truths of mythology or religion. The connection between individualism and perspectivism is important. It provided an effective material foundation for the Cartesian principles of rationality that

> became integrated into the Enlightenment project. It signalled a break in artistic and architectural practice from artisan and vernacular traditions towards intellectual activity and the "'aura"' of the artist, scientist, or entrepreneur as a creative individual. (p. 248)

Building on traditional ways of seeing and interacting with objects in space, sculpture practice inside a 3D software environment is subjected to a visual perspective that affects the artists' perceptions of objects; their structure; or the way objects are formed, positioned or moved, and scaled. Influenced by mechanical reproduction, this technological context proposes an interaction with simulated forms encompassing physicality through their modes of production.

Looking at the influence of industrialization on the viewer's relationship to a work of art, Walter Benjamin (1968) proposed that mechanical reproduction changes the way works of art are perceived and questions the concept of authenticity or "aura" of an artwork subjected to technological means. He argued that technological development expands the concept of distance and influences the viewer's spatial-temporal interaction.[13] Benjamin's writings on the influence of technological growth on the arts primarily speak to the medium of photography, therefore addressing analogue image capture reproduction modes. Today, the concept of the authenticity of an original or the aura of an artwork affects not only 2D but 3D works that are computer generated, where an original can travel through the Internet and sculptural forms materialize anywhere through RP service labs. From this digital perspective, the aura of the work of art is contained within the digital file format. In Benjamin's time, a traditional approach to painting or sculpting excluded technological advancements that bring forth computer ubiquity. Today, the expanded perspectival frame proposed by the software platform

affects conventional ways of seeing and interacting with forms from 2D images to 3D objects.

1.3.1 From Berger to Virilio: The Visible World

In the early 1970s, the writer and art critic John Berger (1972) claimed that, "The process of seeing painting or seeing anything else is less spontaneous and natural than we tend to believe" and largely depends on habit and convention. With reference to European conventions of perspective, Berger (1972) stated that, "perspective makes the eye the centre of the visible world, but the human eye can only be in one place at one time, and it takes the visible world with it as it walks."

Technological innovation modifies our perception of the "visible world." First, in the late 1800s and early 1900s, the invention of photography and cinema presented a mechanical eye's ability to record or capture scenes and movements. Second, the beginning of this century experienced an expanded concept of appearance, or a 21st century aesthetics of disappearance as proposed by Paul Virilio, when addressing computerized environments such as virtual reality (VR).

From a technological perspective, this study supports John Berger's (1972) claim that the invention of the camera changed everything, as people can see things that are not in front of them and appearance can travel around the world. Moreover, the notion of appearance, the simulated environment conveyed by a digital medium, is progressively invading the visual culture. As proposed by Virilio (2009), this is affecting the concept of synchronicity, which is shifting to that of a de-synchronized and fractured experience of perceptual duration. A diachronic perception is experienced wherein the notions of

distance, time, and space are rapidly expanding—"producing a patchwork of various contingent worlds" (Virilio, 2009, p. 11), and accelerating all means of visual communication.

Digital media expand ways of seeing and communicating. From Benjamin's (1968) writings on mechanical reproducibility connecting the viewer's experience of a work of art directly with others' experiences and shifting the viewer's mode of perception from a passive to an active position, contemporary viewers' interactions with artwork have opened to various forms of social media. The visionary media ecologist Marshall McLuhan indicated a significant change in our relation to an expanding media environment, while describing it as a "final phase of the extensions of man." McLuhan stated (2001):

> Rapidly, we approach the final phase of the extensions of man—the technological simulation of consciousness, when the creative process of knowing will be collectively and corporately extended to the whole of human society, much as we have already extended our senses and our nerves by the various media. (p. 3)

This quotation stresses the main focus of this research, which scrutinizes the ways in which technology influences an artistic practice subject to socio-cultural contexts and influenced by digital means. The following section presents the concepts of production and reproduction addressed through artistic practice and digital technology.

1.4 Production and Reproduction: Praxis and Poiésis

The digital medium is linked to the concept of production and, more specifically, to the concept of artistic production in which reproduction becomes the means of encoding information in this technological environment, which in turn influences artists'

production modes. Artistic practice is influenced by and subject to artists' interactions with a social environment. From the perspective of Aristotelian philosophy, *poiésis* is translated into production, which is perfected by artistic virtue, or *tecknè*, a material production. In addition, *praxis* is translated into action or the individual practice in terms of an action addressing the condition of a community within a social environment. Praxis addresses man's intellect, where thought (or *la pensée*) becomes the object of intellectual virtue. It implies the transformation of something *other* within an artistic production.

Today, the "something other" includes both aspects of artistic production: something is made or fabricated and a thought is expressed through a creative action addressing artist's social, political, and ecological engagement. However, Aristotle (1959) claimed that production and action are distinct. This distinction is better understood through architecture practice, where the context of production is accompanied by rules that are not a production mode but are the relevant action to be taken to make the building socially viable. Therefore, action is not production. Aristotle also claimed that the principle of existing lies in the artist not in the art object. However, today, the notion of art object has expanded to that of an artistic concept or idea, as proposed in the early 20th century by Marcel Duchamp's *ready-made* object. Moreover, French philosopher Nicolas Bourriaud (1999) argued that modern art conveys the idea that *praxis égale poiésis*: that artworks, when compared with industrial products, are inseparable from their creator's life. When artistic practice is influenced by a technological environment, the product is less dissociated from its producer's life and social or media interactions. Within a computerized environment in which automated fabrication technology or information transmission processes are interconnected and through which the concept of

distance collapses, the philosophical distance that Aristotle described between praxis and poiésis, production and action, theoretically collapses. As if influenced by technological advancement, action and production become inseparable: *la pensée et le faire ne font qu'un*. An action accomplished (or *la pensée artistique*) and an artwork (produced) as artistic manifestation (or *objet d'art*) may still be perceived as distinct as in Aristotle's time, but, today, the change in our relation to time and space has narrowed this distinction to the point of hybridization.

Technological growth is transforming the way that humans perceive and interact with the environment. From the mechanical eye to the encoding of visual data or the digitization of images or forms leading to automated fabrication (CAD and RP), digital technology influences the status of the work of art, which is subject to the constant technological changes impacting our society. Emerging scientific discoveries provoke a metamorphosis in our perception of, and relation to, artistic modes of production.

1.5 Digital Media: Digital Medium

This section on the digital medium addresses the discrete and fragmented nature of a coded medium from theoretical, aesthetic, philosophical, and artistic perspectives. The ways in which, in the field of sculpture and installation art, computer technology influences the traditional artist-medium relationship and affects how artists perceive and interact with a digital medium is also addressed.

The definition of *medium* and the influence of industrialization on art (Benjamin, 2008), culture, and the advancement of knowledge is central to the history of modernism and, as art theorist Mark Hansen (2006) pointed out, "the problematic of the medium,

which, although central to the now contested history of modernism in all the arts, is given a specifically technological inflection by Benjamin—an inflection particularly resonant in today's cultural climate" (p. 1).

From Walter Benjamin (1968) to Lev Manovich (2001), references to digital media imply fundamental changes in artists' interactions with time, space, and the tangibility of artistic mediums. Artists are confronted today with a computerized environment linked to the concept of mutability, volatility, and impalpability. Artists experience extended spatial-temporal boundaries within all artistic disciplines. Openness to a concept of plurality in the arts is also provoked by the coded nature of the digital medium. Art theorist Rosalind Krauss (1999) proposed the term "reinventing the medium" in reference to the digital medium, explaining:

> The medium in question here is not any of the traditional media—painting, sculpture, drawing, architecture—that include photography. So the reinvention in question does not imply the restoration of any of those earlier forms of support that the "age of mechanical reproduction" had rendered thoroughly dysfunctional through their own assimilation to the commodity form. Rather, it concerns the idea of a medium as such, a medium as a set of conventions derived from (but not identical with) the material conditions of a given technical support, conventions out of which to develop a form of expressiveness that can be both projective and mnemonic. . . .
>
> But to grasp Benjamin's theorization of the outmoded, itself triggered by specific works of surrealism, and to interrogate its possible relation to the postmedium condition I've been sketching, one must follow Benjamin's example by addressing particular instances in which the obsolescent could be said to have a redemptive role in relation to the very idea of the medium. (p. 296)

The obsolescence of a medium, as presented by Krauss, is bonded to a social context influenced by digital technology. It is also linked to a theoretical framework addressing a concept of postmodernism that further opens onto that of a hypermodernism reflecting on

the concept of the here and now (Lipovetsky, 2005). Hypermodernism proposes a culture of the immediacy and situates the research context within the ways in which new media not only affect our societal values but also impact the spatial-temporal context. In fact, time has become an essential point of reference in our lives (Charles, 2005). Referencing the philosophy of the Enlightenment and the scientism of 19th century optimism in creating the conditions for peace, equity, and justice, Charles (2005) stated:

> Past and future have been discredited and there is now a tendency to think that the present has become the essential point of reference for democratic individuals, since these people have definitively broken with the traditions that modernity has swept away, and turned their backs on a future that was far from rosy. (p. 2)

Finally, Charles called for the analysis of Gilles Lipovetsky's concept of hypermodernity, the time of the here and now, which is important to the development of the research methodology in Chapter 3. It contextualizes the study within the socio-cultural changes that digital media and technological advancements bring to society. Although Lipovetsky (2005) did not support the relevance of the postmodern era, he envisioned that societal values are changing to a different mode of being that he associated with hypermodern times:

> But at the same time, the expression "'postmodern"' was ambiguous, clumsy not to say loose. It was, of course, a modernity of a new kind that was taking shape, not any surpassing of modernity. Hence the legitimate hesitation that people showed with regard to the prefix "'post"'. . . . Now that genetic technologies, liberal globalization and human rights are triumphing the label "'postmodern"' is starting to look old; it has exhausted its capacities to express the world now coming into being. . . . It all happened very quickly: the owl of Minerva was announcing the birth of the postmodern just as the hypermodernization of the world was already coming into being. (Lipovetsky, 2005, pp. 30-31)

1.5.1 Medium Specificity or Plurality

In sculpture practice, when addressing medium specificity and objectification, there is a shift in the artist's approach from analogue to digital sculpture, where a simulated medium and object appearance is influenced by the "vector" structure of its geometric coordinates. This geometry within the 3D software spatial configuration not only triggers artists' relations to objects in space but forces artists to interact differently with the medium itself. Inside a gravity-free spatial setting, the immaterial coded nature of the data object influences a more traditional analogue approach linked to medium specificity and the production mode of sculptural forms. The specificity of the mediums attributed to distinct artistic practices today finds a common ground through a digital media language based on coded information. The digital object is therefore not medium specific. Whatever the digital representation is addressing bi-dimensional or tri-dimensional art forms—the data created do not theoretically represent any medium in particular: photography, cinema, video, painting, or sculpture. As the medium specificity is embedded into a code, artists can play with multiple interpretations of that code. The mutability of a digital medium is possible because of the malleability of its code, which conveys a concept of plurality in the arts.

1.5.2 Medium Convergence

From another perspective, the specificity or the essence of each artistic medium remains but can potentially converge into other media through the concept of *plurality of mediums* embedded in its code. As Mark Hansen (2006) pointed out, in reference to Kittler's concept of digital convergence:

> Applied to the domain of digital art, Kittler's concept of digital convergence yields a theory of the *obsolescence of the image*—a radical suspension of the image's (traditional) function to interface the real (information) with the human sensory apparatus. In the terminology of my argument, Kittler configures the digital image as an autonomous *technical* image—one that carries out its work without any necessary or intrinsic correlation whatsoever to human perceptual ratios. If the digital image can be said to replace photographic, cinematic, and televisual images with a wholly new technical image, that is because it fundamentally reconfigures the very concept of "image," stripping it of a correlation-by-analogy with the human body and thus rendering it a purely arbitrary construct. This reconfiguration is precisely what is at stake in Kittler's recent account of the radical flexibility and total addressability of computer graphics. . . . (p. 72)

Hansen (2006) further developed Kittler's premise that the medium is pertinent only where there are plurality of media and wrote,

> This epoch of media differentiation is precisely what is now coming to an end in the context of digitization; with the possibility for universal convergence of media, i.e., translation of all media into each other through a digital universality, the concept of the medium is becoming obsolete. This, we should stress, is a very different understanding of the "post-medium condition" than that offered by Krauss. (p. 275)

To investigate this phenomenon further, the following question on the notion of the medium is asked: How does the term *medium* become intangible and immaterial through digital means? As French philosopher Jean Baudrillard enunciated, an inevitable change in the nature of the medium that the coded structure of the digital data engenders, which allows for multiple interpretations of the data source, is experienced. Baudrillard (1983) stated:

> The medium itself is no longer identifiable as such, and the merging of the medium and the message (McLuhan) is the first great formula of this new age. There is no longer any medium in the literal sense: it is now intangible, diffuse and diffracted in the real, and it can no longer even be said that the latter is distorted by it. (p. 54)

1.5.3 From Krauss to Nancy

The digital medium is experienced by artists through a spatial context where the notion of materiality and therefore the medium itself belong to a technologized space—a space that leads to the venue of a "postmedium," as suggested by Krauss (1999, p. 296). In an article entitled "Reinventing the Medium," Krauss addresses a notion of plurality of the arts that the "postmedium" encourages. She referred to Walter Benjamin's work,[14] stating:

> At the moment, now, of its obsolescence, photography can remind us of this promise: not as a revival of itself or indeed of any of the former mediums of art, but of what Benjamin had earlier spoken of as the necessary *plurality* of the arts (represented by the plurality of the Muses), a plural condition that stands apart from any philosophically unified idea of Art. This is another way of stating the need for the idea of the medium as such to reclaim the specific from the deadening embrace of the general. (Krauss, 1999, p. 305)

The concept of the plurality of the Muses, proposed by Krauss in reference to Benjamin's writings, is also addressed by French philosopher Jean Luc Nancy in *Why Are There Several Arts and Not Just One?* (Nancy, 1996, p. 1). Nancy questioned the concept of plurality and looks at the subject from different perspectives. He first suggested the following observation: "plurality is a given of the arts" (Nancy, 1996, p. 2), but he also added,

> . . . one may suspect, in a general manner, that if the ontological question of the *singular plural* of the Muses is dodged, this is because it is understood *a priori* that we are in the register not of ontology but of technology. Whether technology can make an ontology, or can imply it—that question is not posed. (Nancy, 1996, p. 3)

Furthermore, Nancy (1996) interrogated traditional assumptions that there are several forms of art, stating,

> Are there really several arts? Is what we apprehend as a plurality not in the final analysis the set of manifestations or the moments of a unique reality (of a unique Idea, substance, or subject), or does it not form the expressive profusion of a unique gesture, of a selfsame drive? (p. 3)

This debate opens a philosophical discourse on the very nature of art, or the arts, which today is influenced by technological growth and, furthermore, by the presence of a digital medium. Nancy (1996) took us back to Heidegger, quoting,

> Thus Heidegger can declare, in the 1956 Addendum to *The Origin of the Work of Art*, that in this essay "art is considered neither an area of cultural achievement nor an appearance of spirit; it belongs to the *disclosure of appropriation* by way of which the 'meaning of Being' can alone be defined" (Heidegger, 1971, p. 86). (pp. 3-4)

Heidegger's concept of the "disclosure of appropriation" brings the conversation back to that of plurality but one does understand that within this concept are embedded the various aspects of medium specificity and approaches to the arts as "thing."[15] One also does not neglect to consider as art political, environmental, and many other artistic manifestations through social engagement or in reference to Heidegger as various approaches to the "meaning of Being."

In the contemporary technological era, these extrapolations of the notion of medium affect traditional understandings of art, the specificity of its medium (sculpture, painting, cinema, dance), and the relationship between artistic practices. Previous understandings of what is a medium have changed; this change is provoked by impalpable, intangible computerized and digitized art forms. A medium found within a data environment—a technological environment, which induces an engagement with technique, but which also re-defines the concept of technique itself, as Nancy (1996) stated, "technique means knowing how to go about producing what does not produce

itself by itself" (p. 25).[16]

1.6 Artistic Freedom and Technological Knowledge

When creating art through computer-aided design and RP technology, an artist's visual proposition or representation of a concept does "produce itself by itself," as the concept embedded in the digital file is further produced through a computer-automated fabrication or 3D printing process. However, the artist chooses the file content in which the selection and functionality of the software interface tools play a role in the digital artwork output. The artwork aesthetics is influenced by the artists' interactions with the digital medium. Nancy's (1996) explanation of technique and artistic production, which also includes a quote from Marcel Duchamp's concept of creative making, supports this claim:

> Technique is a—perhaps infinite—space and delay between the producer and the produced, and thus between the producer and him- or herself. It is production in an exteriority to self and in the discreteness of its operations and its objects. In this regard, the singular plural of art extends to the endless multiplying of the artist's technical decisions: "To make art is to judge art, to decide, to choose. 'To make something,' says Duchamp 'is to choose. . . it is always to choose.'" (Duve, 1989, p. 38). (Nancy, 1996, p. 25)

From the perspective of this research, decision making that addresses a digital medium or digital sculpture located inside a 3D software interface environment confronts artists with a spatial-temporal context that simultaneously embeds and discards technique and in which, as proposed by Nancy (1996), "Technique is the obsolescence of the origin and the end" (p. 26).

1.7 When the Medium Becomes a Technology

Looking at traditional artistic mediums as being obsolete within the condition of a

technological context and analyzing artists' interactions with a digital medium contribute to the advancement of a better understanding of a sensory knowledge and a human condition influenced by a simulated environment, an environment where the medium becomes a technology that belongs to a media ecology (Postman & Godard, 2000). In a keynote entitled "The Humanism of Media Ecology," Neil Postman and Paulette Godard (2000) state the origin of the term media *ecology*:

> You may be surprised to know that our first thinking about the subject was guided by a biological metaphor. You will remember . . . that a medium was defined as a substance within which a culture grows. If you replace the word "substance" with the word "technology," the definition would stand as a fundamental principle of media ecology: A medium is a technology within which a culture grows; that is to say, it gives form to a culture's politics, social organization, and habitual ways of thinking . . . We put the word "media" in the front of the word "ecology" to suggest that we were not simply interested in media, but in the ways in which the interaction between media and human beings give a culture its character. . . . If we wish to connect the ancient meaning with the modern, we might say that the word suggests that we need to keep our planetary household in order. (p. 10)

Postman and Godard (2000) explain that at first the term *media ecology* was not well received in social studies; to support their position, they add:

> But from our point of view, we had chosen the right phrase, since we wanted to make people more conscious of the fact that human beings live in two different kinds of environments. One is the natural environment and consists of things like air, trees, rivers, and caterpillars. The other is the media environment, which consists of language, numbers, images, holograms, and all of the other symbols, techniques, and machinery that make us what we are. (p. 10)

There is a context that is defined by the natural environment (comprised of air, water, animals, and plants) and the media environment (comprised of language, images, symbols, and technologies), both of which influence the human condition. The Research Creation project proposes looking at both as being part of two environments that interact

with each other and the artist-researcher suggests looking at ways they can influence more sustainable perspectives about the future. This study addresses an approach to sculpture practice from the perspective of a digital medium that brings to the practice sustainable approaches to material consumption. The technological directions conveyed through an artistic concept are a means to address a future condition.

1.8 Creativity and Technology

Throughout history, artistic movements have indicated an opening to social changes. Between conceptual art ideology (where the idea makes the art, as suggested by Sol Lewitt (1967) in an article entitled "Paragraphs on Conceptual Art") and contemporary technological advancement, the influence of computer-automated technology on artistic practice can be interpreted in many ways. Lewitt (1967) proposed that, "When an artist uses a conceptual form of art, it means that all of the planning and decisions are made beforehand and the execution is a perfunctory affair. The idea becomes a machine that makes the art" (p. 80). A few decades later, the artist's creative process is assisted by a computer-automated technology (CAD), a "machine that makes the art." With CAD, a visual representation of an artistic concept may be sent to a machine that fabricates the art object.[17] Today, automated fabrication influences not only the artist's creative process and artworks' modes of production but all spheres of society, such as is described in the following article on recession and technology:

> Year after year, the software that runs computers and an array of other machines and devices becomes more sophisticated and powerful, and capable of doing more efficiently tasks that humans have always done. For decades, science fiction warned of a future when we would be architects of our own obsolescence, replaced by our machines . . . (Condon & Wiseman, 2013, p. 9)

Within the framework of this research, sculpture practice is influenced by a digital medium linked to a spatial context and a computer-automated mode of fabrication. Whereas artists' creative drives could never be obsolete and they cannot even be envisioned as being replaced by a machine, the machine can enhance artists' creative freedom—so long as artists are open to experiencing a spatial interaction with objects within a technological context. Creativity is influenced by knowledge and observation. As presented by Boden (2004), educational psychologist David Perkins (1981), "sees, creativity as grounded in universally-shared psychological capacities such as perception, memory and the ability to notice interesting things and to recognize analogies" (p. 35). Boden (2004) identifies that, "What makes a difference between an outstanding creative person and a less creative one is not any special power, but greater knowledge (in the form of practised expertise) and the motivation to acquire and use it" (p. 35).

1.8.1 McLuhan's Message

Two important concepts from Marshall McLuhan's writings on the impact of technology on society are identified through examining the many ways in which technology influences sculpture practice: "the extension of man" and "the medium is the message" (McLuhan, 2001), and are re-contextualized and adjusted to the context of this study. Leading to an augmented concept-percept-effect creative experience, technology becomes an extension of man. As discussed previously, this frees up artists from sculpture production mode constraints. In addition, it reduces time-consuming sculpting physical labour. By extending artists' spatial explorations (3D software) and sculpture concept modes of production (CAD and RP), technology frees up artists' minds and time and moves the focus of the practice primarily to imagining and communicating ideas.

McLuhan's (2001) concept of technology as an extension of man specifically addresses communication media; in the context of this research, what is common is the way in which technology moves artists' ideas by freeing their communication means from physical constraints and inviting them into an extended concept in sculpture practice, that of the immaterial: a digital sculpture that can travel through the web.

From a different perspective, freedom also incites artists to explore, to experience a state of being as described by Walter Benjamin (1999) in the concept of the *flâneur*.[18] Originally proposed by French poet Baudelaire, this concept is associated with the act of strolling, which plays an essential role in the complex phenomenon of creative activity (Benjamin, 1999, p. 10). Strolling allows time for conceptual exploration by liberating the mind from practical constraints.

McLuhan (2001) proposed the concept that the medium is the message, meaning that within this era of new media of communication, the medium not only conveys a message but is the message. A symbiosis between concept and process is experienced. Ideas are expressed and sent simultaneously to travel through various media modes. In opposition to McLuhan's concept, Nicholas Negroponte[19] argued that the medium is not the message and asks: "to what degree can the notion of formless data be extended to less prosaic material."[20] Negroponte (2008) explains "when bits are bits . . . the medium is no longer the message" (p. 61).

While the concept of bits being bits was not conceivable in his time, McLuhan would certainly have considered a possible symbiosis of medium and message through the transmission of "bits received as bits," as presented by Negroponte. Moreover, in the

context of this study, the so-called bits environment implies that inside a digital context, bits address a digital medium that conveys information on a sculptural object. Not only can a sculptural object move from its to bits but in many disciplines and from different perspectives data move from analogue to digital. Furthermore, physicist John Wheeler (1990) proposed that the entire world of physics moves from *its* to *bits*.[21] Today, when artists use a 3D scanner to digitize an analogue sculpture form, its become bits: the digital medium contains a message that is in fact the artist's idea. From a digital medium perspective, a formless representation embeds a physical object through which bits can return to its again through RP technologies.

1.9 From Ready-Made to Coded Information

By looking back at Marcel Duchamp's impact on sculpture and his ready-made period, one can see the relevance of Krauss's writing on the aesthetics of his work *The Fountain* when she describes it as an artwork that provokes and incites the viewer to decode a message, or that it is an "aesthetic transformation itself" (Krauss, 1981, p. 80). In *The Fountain*, the art object leads to a question in opposition to an established art system where the viewer is expected to decode feelings through forms. As proposed by Krauss (1981), "Clearly, one answer suggested by the ready-made is that a work might not be a physical object but rather a question, and the making of art might, therefore, be reconsidered as taking a perfectly legitimate form in the speculative act of posing questions" (p. 73).

Based on Krauss's (1981) premise, a parallel can be established between Duchamp's new proposition on what is a work of art through ready-made work, where a sculptural object becomes an act of posing questions, and the digital medium as a digital

object that embeds coded information. The intrinsic value of the digital object rests in its code. The encoded information is presented on the computer screen as a representation of a digital sculpture form. The sculpture proposition may claim political, social, or environmental positions and aim to provoke a questioning—therefore in parallel with the ready-made work, it becomes an act of encoding information. Furthermore, the digital medium coded nature confronts artists with an extremely malleable object able to transform into other digital mediums and coming from all disciplines.

1.9.1 Objects Encoding Information

Peter Lunenfeld (2000) suggested that, "material objects are interpreted with information patterns" (p. 94). Lunenfeld (2000) insists on the idea that, "When information is privilege over materiality, the pattern/randomness dialectic associated with information is perceived as dominant over the presence/absence associated with materiality" (p. 78). The concept of materiality or tangibility in sculpture has progressively moved to that of immateriality or intangibility, from Duchamp's ready-made work or objects embedding questions to what is known today as a digital object, an object embedding information.

This research indicates a growth in artistic research focused on an openness to exploring an intangible medium. The digital medium is located inside a spatial dimension where the merging of space and time is experienced through artistic production modes—a spatial-temporal context that also addresses the malleability of data information and provokes a change in artists' relations with artistic mediums. From Krauss' perspective, this phenomenon opens the venue for a "postmedium," a medium that contains all artistic mediums within its digitality, a medium ready for something "other" than itself. This

medium is subject to a plurality in the arts based on the sharing of a common syntactic element, a digital language or code. The digital medium or digital object inhabits a spatial dimension, a simulated environment inside which it translates into bits of information.

From Duchamp's art objects[22] to digital objects, artists' intention or act of posing questions has moved from ready-mades to what is known today as digital objects or digital sculpture, hence *bits* of information where the presence/absence associated with materiality has become a tangible/intangible concept linked to a computer software interface or digital spatial context.

1.10 Arts, Artists, and Creativity

For the purpose of understanding how 3D technology influences artistic concepts and the production of sculpture projects, literature associated with several contemporary sculptors' works was explored. In the work entitled *Snow Sculpture for Chicago*, artist Tony Tasset used 3D scanning and computer numerical control technology to digitize and reproduce a life-sized pile of snow. Digital technology brings a hyper-realistic quality to the work. His work expresses a confrontation between natural elements and human behaviour in an urban environment. As described by the Museum Without Walls, the work is now a permanent sculpture installation defined through a permanent public art proposition:

> Chicago artist Tony Tasset created this conceptual sculpture, a pile of snow, as a site-specific installation for the west window of the Goldblatt's building facade. This window is the only remaining display window of the former department store. To create a hyper-realistic replica of a typical Chicago snow pile, Tasset included pieces of handcrafted debris such as coffee cups and matchbooks. In his assessment "these piles of snow are sublime; both ugly and beautiful, like life." (CultureNOW, 2004)

From a different perspective, artist Brian Tolle's work is in relation with the natural environment but also explores technological approaches to sculpture practice. In the work titled *Eureka*, Tolle used a 3D environment scanner to digitize a building façade and CNC milled it in Styrofoam. The project, presented in Ghent, Belgium, was a collaborative work and, as Tolle explained, the concept was a technological challenge:

> The idea was to try to do something that hadn't been done before. So there I am, in Belgium—I had been speaking with people about various software packages . . . I was interested in software that simulates real wave algorithms to test the hulls of ships. So I found a building, a 17th-century canal house, and we digitally mapped its façade. Then we created a virtual water plane and tour boats modeled after those that cruise the canal . . . We then reflected the building's data onto this modeled surface. The computer model was then output in full-scale 3D using a CNC milling machine—that model was sculpted using Styrofoam, coated with urethane and painted by hand. The result is a collision between water and architecture, creating something between the two. The ripples that disturb the façade in *Eureka* are actual waves cutting through the building. I wanted to express something that technology enabled me to bring into real time, real space and integrate it into a landscape rather than onto a picture plane. (Museum Without Walls, 2014)

Tolle's artwork reflects how 3D digital technology influences the artist's creative process from concept to production. Combining simulated water wave images with 3D data, the *Eureka* project was enlarged and CNC milled. It is interesting to see how the artist combines software technology, to simulate the movement of water, with 3D scanning processes, to digitize a life-sized building façade. The artist appropriates the building form data to further merge both data sets and create a 3D sculptural project. Hence, as experienced by Tolle, digital technology exposes artists to a spatial-temporal dimension that affects the mode of the artwork production and influences the artwork aesthetics. Technology also lends itself to collaborative works.

From a different perspective, artist Paula Hayes proposed works such as *sustainable cities*, a bio art concept that combines nature, living plants, and a technological mode of production. The work entitled *Nocturne of the Limax maximus* (MOMA, 2010), for example, offers a combined hands-on traditional approach through glass blown vessels and a technological mode of production as the work's realization was done at the Digital Atelier. Hayes's concept addresses questions of sustainability and conservation through living sculpture representations:

> Since the 1990s, New York–based artist and landscape designer Paula Hayes (b. 1958) has produced botanical sculptures—organically shaped vessels made from blown glass, silicone, or acrylic and filled with a rich variety of plant life—that expand upon the classic terrarium, both through their imaginative containers and the microcosmic universes within. Hayes has conceived an installation for the Museum lobby that includes a fifteen-foot-long, wall-mounted horizontal sculpture for the west wall, and a free-standing, egg-shaped, floor-to-ceiling structure nearby. Organic in form and containing a variety of living plants. . . . (MOMA, 2010)

Canadian artist David Rokeby's (2012) work titled *Plot Against Time #4 (Atlantic Baroque)* proposes a study of movement through the filming of seabirds diving for small fish on the coast of Newfoundland. As the work explores patterns of movement over time, the subject used in the study proposes a view of the living addressing the concept of duration linked to present, past, and future perception:

> *Plot Against Time* is a series of works that explore patterns of movement over time. They are attempts to visualize the extended present which French philosopher Henri Bergson called "duration". . . the present pregnant with the past (and future). The works effectively stretch the viewer's eye across time to offer a perceptual experience of duration. (Rokeby, 2012)

While Rokeby's work does not include objectification of the subject studied, American artist Geoffrey Mann (2005-2010) uses rapid prototyping combined with

cinematic technology to express through sculptural form how he is "fascinated with transposing the ephemeral nature of time and motion." Mann explores nature, time, and movement and transposes it through technology to create a palpable object in space. In his work titled *Attracted to Light*, Mann studies the flight of moths as they interact with light and, using selective laser sintering (SLS) (an additive 3D printing process), he materializes time and motion:

> *Attracted to Light* narrates the erratic behavior of a moth upon the stimulus of light. The trajectory is captured through cinematic technology and the echo of the path, materialized through rapid prototyping . . . The Long Exposure series materialising the ephemerality of time and motion. . . . deciphering the trace of the unseen form. The extruded apparitions within the Long Exposure series narrate the rationale of the movement. (Mann, 2005-2010)

For more than a decade, Mann's creative exploration has led to a 3D digital technology mode of production. In his work, a deep understanding of the ways in which digital technology opens new ways of perceiving, interacting, and conceptualizing through different spatial-temporal sensory experiences. In Mann's works, the concept of materiality has expanded to the point of capturing and materializing the distance between objects, freezing their movement in space. Therefore the travel of forms or the trace of a frozen moment in space is objectified. Using digital photographic processes to capture movement and 3D modelling software to manipulate data, forms can now behold an action and the digitally formatted object is 3D printed with RP technology. An immaterial concept, such as the distance travelled by a given subject, can now become a sculptural object. In this way, creative approaches to 3D digital technology influence artists' spatial-temporal interaction and their artwork aesthetics.

1.11 From Theory to Research Questions

In this chapter, diverse perspectives on an ongoing dialogue on contemporary art and philosophical issues have been presented. The theoretical framework of the research is relevant to the ways in which digital technology influences artists' creativity and situates the study within a broad socio-cultural and artistic context. Creativity remains foremost an intuitive phenomenon, through which artistic concepts are manifested in a number of ways. Whatever the approach, analogue through manual production or digital using 3D modelling, 3D scanning, and RP, concepts or ideas seem influenced by artists' ability to be creative within sculpture modes of production. The adages of *praxis* and *poiésis* are relevant to artistic creation where the application of knowledge is subject to a reconciliation of "thought with matter and time, and a person with the world" ("Poiesis," n.d.).

The presented literature provides a framework to shed light on the ways in which a 3D digital and technological context influences artists' conceptual and practical approaches to the creative process. The next chapter introduces the questions leading to the focus of the research through a Research Creation project and interviews case study.

CHAPTER 2

FOCUS

2.0 Introduction

To study the influence of a 3D digital and technological context in sculpture practice, the artist-researcher investigated artistic production using two approaches: a Research Creation project, which comprised a body of works with a central focus on a sculpture installation project, and an interview case study of three sculptors who shared their creative experiences. From each perspective, artistic creation is experienced from analogue to digital modes and the artist's creative process is described, observed, and explored. The ways in which the computerized environment extended sculptors' spatial boundaries and affected their artistic concepts and artwork production are investigated. The study questioned and interpreted sculptors' interactions with a technological context as they described their relationships with sculpture forms inside a digital spatial environment. The researcher also questioned the sculptors' interactions with the medium and the ways various levels of interactions influenced the aesthetics of their artwork.

While the Research Creation project addressed environmental issues, from which analogue to digital perspectives are explored, the case study participants explored the notion of figuration in sculpture from visual representations shaped by a 3D software perspectival frame or shaped by a computer-generated fabrication mode. Looking at an overview of more traditional hands-on approaches and actualizing the influence of a 3D software interface, 3D laser scanner digitizer, and automated mode of production (RP) on artists' creative process, the research explores new relationship with form and space. The

study investigates the sculptors' interactions with a digital medium from which they experience creative activity differently.

2.1 Research Focus

The two central research questions that guide the study address the research focus (see Appendix A.1 for the template used to develop the research focus). **The first question is: In sculpture practice, how does a 3D digital and technological context extend sculptors' spatial boundaries and influence artists' conceptual and practical approaches to the creative process?**

Digital and technological contexts influence artists' spatial-temporal and material interactions in a number of ways. Artists experience a shift in their relationships with objects in space as they interact with digitized data—a simulated representation of a form inside a 3D software environment. More traditional sculpting approaches are challenged when the artists' creative process moves a tangible sculpture form into a digital medium. This implies that when a sculpture moves from a material to an immaterial medium its vector construction inside a simulated spatial context becomes the digital sculpture structure geometry. Objects move from its to bits (Wheeler, 1990), which represents a new paradigm for sculpture practice that affects artists' interactions with objects in space. Artists re-consider their creative strategies and approaches to problem solving, as the medium's immateriality and the gravity-free context increase the sculptures' data malleability. Decision-making is influenced by computerised and technological support linked to RP processes (3D printing and CNC milling), through which the digital sculpture is able to regain an analogue form.

The second central question is: How do sculptors' interactions with a digital medium influence the aesthetics of their artwork?

Artists' interactions with a digital medium influence their sculpture production mode. These changes affect different aspects of their practice and in some instances they have a significant impact on the aesthetics of their artwork. In other instances, digital technology facilitates the scaling and duplicating of forms created for sculpture installation projects. Each artist engages creatively with the digital medium from a unique standpoint; however the study questions the similarities and distinctions between their approaches to technology in their creative process. Understandings of the artists' socio-cultural contexts and techno-culture backgrounds are implied in these questionings. In other words, life experiences are considered. Artists' conceptual thinking brings about a questioning that is also influenced by a 3D digital and technological context. Artists' ideas are shaped through a 3D software spatial configuration, inside which the interrelationship between artistic mediums affects creative explorations.

2.2 Research Perspectives

From a research creation approach, artist-researchers experience knowledge through artistic means and inquire into the "sensory side of human experience" (Eisner, 2008, p. 4). Artistic sensibility is dependent on the context in which the artist experiences the world. Based on this premise, as the artists engage creatively with ideas addressing social, environmental, perceptional, or mythological concepts for sculpture installation projects, the study looks at artistic creation from a digital and technological perspective. The research strategy consists of looking at the ways digital technology affects the artists' relationships to space, time, and materiality. What are the ways in which 3D technology

influences the relation between the artists' conceptual investigation and their practical approaches to the creative process? As suggested by Eisner (2008), "knowing is always about relationship" (p. 5). The research questions are investigated from a sensory exploratory approach in line with Shaun McNiff's (2008) perspective that "rather than trying to fix problems with our points of view, we might focus more on knowing them in creative ways . . ." (p. 38).

The different aspects in which a technological context and digital medium influence artists' creative process include the concept of *reproduction*, linked to encoding information (digitization), and that of *production*, associated with the many artistic media forms the digitized data can take.[23] Digital objects are mutable and volatile, and able to transform into other digital mediums. In addition, through computer-automated fabrication, they are capable of materializing at any given time and place. Digital technology thus inevitably forces the venue of a new aesthetics.[24] But what exactly influences sculptors' visual language and artwork aesthetics?

2.3 Research Questions and Theory

Situating Wheeler's concept of space-time (1990) within this research will facilitate an understanding of how and why the technological context extends sculptors' spatial boundaries and assist in answering the research questions:

> No space, no time. Heaven did not hand down the word "time." Man invented it, perhaps positing hopefully as he did that "Time is Nature's way to keep everything from happening all at once" [79][25]. If there are problems with the concept of time, they are of our own creation! As Leibniz tells us, [80][26] " . . . time and space are not things, but orders of things . . .;" or as Einstein put it, [81][27] "Time and space are modes by which we think, and not conditions in which we live." (p. 488)

Time is a human invention (Wheeler, 1990), as is 3D digital technology. The technological context influences the mode by which artists think by affecting their interactions with time, space, and the medium. In what ways does it re-position artistic modes of production and add to sculpture production strategies carried by analogue processes?

In sculpture practice, 3D digital technology challenges the artists' interactions with the spatial environment, which means from analogue to digital to analogue perspectives. From an analogue spatial context to a digital immaterial dimension, sculpture modes of production incite artists to think differently about concept and process strategies. Within the field of sculpture, the relevance of objects in contemporary art from a 3D digital and technological perspective brings to play the concept of "objectness" (Herbrechter, 2005), which conveys an immaterial dimension inside a spatial context within which materiality and immateriality are embedded in the object representation. The immaterial qualities of digital sculpture include greater malleability of the data. The immediacy within which the sculpture transformation or data malleability is experienced inside the 3D software spatial context influences artists' sensory experiences. In what ways does the geometry of digital objects force artists to interact differently with their medium?

Artists become familiar with the vector construction of digital objects through experiencing their malleability and engaging creatively with the medium. As artists explore the porosity of the digital sculpture data, they access the space inside the object geometry. This space inside a digital sculpture form, as easily accessible, expands artists' interactions with spatial environments. In addition, there is also the negative space

defined by the space outside the object's contour itself. In what ways does 3D digital technology enhance creative explorations of object and space?

The ways in which technology affects artists' relations to objects and space are understood as allowing different ways to appropriate, manipulate, transform, or duplicate the sculpture form. Objects can also be created using more abstract data sources, such as sound waves digital data transposed into a digital sculpture formal representation. The sound wave digital data form, like many other digital mediums, can gain physicality through RP processes. From this perspective suggesting that data sources from all disciplines can objectify, linked to Krauss's (1999) concept of the plurality of the arts that the digital medium engenders, does affect artists' creative process. Artists' relation to this medium *as such* (Krauss, 1999) is influenced by the coded nature of all digital mediums.

As immateriality inhabits the coded data of a digital sculpture concept, a phenomenon of plurality in the arts affects the specificity of the sculpture medium. Medium-specific disciplines now converge through the medium code. The digital medium's intangibility linked to Kittler's (2010) concept of digital convergence also embeds the materiality of the digital sculpture form—a vector or point cloud[28] construction of the digital medium data geometry.

2.3.1 Digital Convergence and Plurality in the Arts

The influence of a "coded" digital medium on the arts is better understood through Kittler's (2010) concept of digital convergence or obsolescence of the image.[29] Kittler defines the digital image as a technical image, an image that turns into coded information through digitization. Therefore, Kittler's premise of digital convergence implies a

"plurality of media" (Hansen, 2006, p. 275), moreover, a plurality in the arts. The mutability, volatility, and modularity of digital data are common to all artistic mediums.

From a different viewpoint, the plurality in the arts[30] is rooted in Benjamin's (1968) concept of the Muse, which stresses the specificity of artistic mediums within the idea of a common ideal or source of inspiration: the Muse. Artists can share the same Muse, but the Muse's visual representation is specific to one medium, a painting, a sculpture, a print, a piece of poetry, etc. Today, this common element—which in Benjamin's writing was associated with the Muse—has become linked to a shared digital medium or a data source represented as a code. Krauss (1999) identifies it as "a medium as such" (p. 296), a postmedium. In what ways does the concept of plurality influence artistic practice and artwork aesthetics?

The concept of plurality in the arts, conveyed by a digital medium, influences artists' conceptual and practical approaches to creative activity. It encourages the passage from one medium to the next, which is presented in the study through the artists' transposition of a 2D digital image into a 3D digital object inside a computerized environment. This passageway between 2D to 3D allows artists to digitize a drawing and move the data to a 3D sculptural concept, encouraging creative interactions between a 2D image and a 3D digital object.

From a Research Creation approach, the artist-researcher experienced a 3D digital medium as the mutability of the data source triggered her imagination. This was a two-way effect in which, through an explorative and heuristic approach to technology, artistic concepts developed. The artist-researcher engaged creatively with what comes forth from

the data manipulation on the computer screen and her sensory modes of creation encouraged digital sculpture exploration. This Research Creation experiential approach encouraged computational knowledge and acquaintance with 3D software interface elements. Through creative exploration, artists become familiar with the spatial environment, thus, with time, they enjoy higher sensory experiences. In what ways do artists' interactions with a digital creative context influence their visual language?

The artwork aesthetics reflects a visual language essentially influenced by artists' conceptual investigations from various data sources. Within a computerized spatial environment, this is guided by the medium's malleability. Visual qualities explored through 2D digital mediums, which include the moving image, can creatively take 3D attributes. The visual language and creative explorations that engage with the flexibility of the numerical image are affected by the level of freedom artists experience when transforming the digital data.

2.3.2 Questioning the Numerical Image Influence from 2D to 3D

The numerical image or digital medium leads sculptors' creative approaches through processes of transformation in line with the flexibility of its numerical basis. In "Image Puissance Image," French engineer and media artist Edmond Couchot (1984) proposed the following definition of a numerical image:

> A numerical image is an image composed of small "discrete" fragments or elementary points, to each of which can be attributed whole numerical values that position each of them in a system of special coordinates (in general of the Cartesian sort), in two or three dimensions. These numerical values render each fragment an entirely discontinuous and quantified element, distinct from other elements, on which is exercised a total command. The numerical image manifests as a matrix of numbers (a table composed of columns and rows) contained in the memory of a computer and capable of being translated through the form of a video or print image. One can from this point on,

> integrally synthesize an image by furnishing the computer with the matrix of values adequate to each of these points. (p. 124)

The numerical image influences the interrelation between linear data or bi-dimensional and tri-dimensional mediums. Today, visual art practitioners develop ideas through the manipulation of digital images or objects, interconnecting the data to create artworks of different natures using various input and output materials. Moreover, as suggested by Couchot, the digital image is "capable of being translated through" different forms. In sculpture practice, production modes (such as automated technology, 3D printing additive or CNC milling subtractive) allow artists to objectify visual representations from multiple coded forms. This observation raises the following question: In what ways are artistic propositions influenced by the flexibility of the numerical image or data medium capacity to move from 2D to 3D?

The way the numerical image is presented inside a 3D software spatial context in which bi-dimensionality and tri-dimensionality co-exist influences the artists' interactions with images and forms. The trajectory of a subject visible through a slow motion image sequence can shape into a material form—inside a 3D software interface environment. The numerical image source, either a 2D or 3D analogue input, is subject to the software spatial configuration but also to RP modes of production. Therefore, how does automated technology force artists to rethink creative methods and re-address traditional artistic production modes?

The materialization of a moving image through RP technology forces artists to question the intrinsic nature of objects in relation to the spatial environment. The ways in which a digital representation of a form inside a computer environment can materialize at

any given time and place through automated fabrication technology influences the artists' relationships not only to spatiality but also to materiality and temporality.

2.3.3 Questioning the Human-Machine Relation to Artistic Production

One significant influence of digital technology on sculpture practice is in relation to a spatial-temporal and physical context that affects the human-machine relationship. The digital space in itself excludes a physical context but gives access to a computer numerical control technology that modifies the artists' relationships to the fabrication process. As presented in Chapter 3,[31] media art theorist Peter Lunenfeld (2000) characterizes this expanded artist-medium relationship as a form of hybridization between humans and machines. How does automated fabrication influence artists' production modes and fabrication process time frames?

The human-machine relationship is key to 3D digital technology. Not only does the latter influence artwork production modes by allowing the printing of digital data and prototypes, but it also affects the artists' production strategies. The research further investigates RP influences on artists' creative process in relation to concepts and processes in sculpture practice through the case study interviews, questioning how artists' interactions with RP automated fabrication technology influence their artwork.

Working inside a gravity-free context implies that artists' relation to objects in space is absolute—objects are not qualified by their dimension, material, or mass. As artist, writer, and musician Bruce Wands (2006) stipulated, digitizing frees up the artist's mind "from the natural constraints of weight, size or gravity" (p. 76). How does working on a sculpture concept inside a gravity-free context influence artists' creative process?

The impact of a gravity-free spatial context is very important. Artists can manipulate the digital data from all directions and viewpoints rapidly and easily. It also allows artists to freely duplicate and change the artwork scale without weight, size, or time constraints. The study explores the ways in which artists' perceptions of objects in space and production strategies addressing a sculptural concept are influenced by a digitizing mode, through which technology becomes inseparable from their creative process. The study questions how the influence of a 3D digital and technological context can be understood through the lens of the artists' conceptual investigations.

The next chapter presents the research methodology, which draws on a hypermodern viewpoint from which the immediacy of life is subject to a technological growth. The research methods used to comprehend the ways in which a technologized environment influences artistic concepts and processes in sculpture practice as well as the method used to identify the elements that affect artists' interactions with a digital medium are presented. Research procedures for data collection are described and the case study interview design is also presented.

CHAPTER 3

METHODOLOGY AND RESEARCH PROCEDURES

3.0 Introduction

This chapter addresses the methodology and research procedures or methods used to conduct the study.[32] Whereas Chapter 1 presented the theoretical framework surrounding the subject of the inquiry, here the hypermodern standpoint of the research is emphasized. This chapter has two sections. The first section presents the ground on which the research methodology was developed. The second part explains the methods for data collection and analysis, which include the presentation of the Research Creation project and the method of inquiry for the case study interviews.

The research methodology drew on the ways in which a digital and technological context affects artists' socio-cultural points of reference and influences their artistic activities. From an artistic position, the contemporary concept of knowing has its own way of perceiving and interpreting social contexts through sensory experiences. The research studied the tension within the mode in which a technological context affects sculptors' sensory knowledge and interactions with space, time, and materiality. The methods of investigation included a Research Creation project and an interview case study of three sculptors. The study situated a 3D digital and technological context within a digital era that affects our society and our daily lives. The present is an essential point of reference, a time centred on living in the present, and as suggested by Lipovetsky (2005):

> The enthusiastic visions of historical progress were succeeded by narrower horizons, a temporality dominated by precariousness and ephemerality.

> Inseparably associated with the collapse of earlier heroic constructions of the future and the concomitant triumph of consumerist norms centred on living in the present, the postmodern period indicated the advent of an unprecedented social temporality marked by the primacy of the here-and-now. (p. 29)

3.1 Hypermodernity

The time in which we live, the time of the "here and now" (Lipovetsky, 2005), brought a hypermodern worldview to this research. Lipovetsky's concept of hypermodernity is representative of the social and cultural changes that have influenced modernity. More specifically, the combination of science and technology is constantly reshaping everyone's lives through an accelerating concept of a space-time framed by digital media. It is interesting to see how, through hypermodernity, the concept of time also encompasses a relationship to historical referents or artefacts as a way to counterbalance the "culture of immediacy" (Lipovetsky, 2005). As a consequence of an accelerated speed of life affecting the daily environment, a state of destabilization provoked by a hypermodern culture emphasizes individuality and causes a "decline in the individual's inner strength" (Lipovetsky, 2005, p. 56). As Lipovetsky (2005) explained, "Hence the individual appears more and more opened up and mobile, fluid and socially independent. But this volatility signifies much more a destabilization of the self than a triumphant affirmation of a subject endowed with self-mastery" (p. 55).

This concept of "ultra modernity" (Lipovetsky, 2005) also reflects on an economic context, which emphasizes the value we bring to tradition as a need to safeguard our heritage. Historical referents become a way to help individuals regain self-balance or equilibrium (Lipovetsky, 2005). This need to reference the past, to establish a temporal relationship with historical means within the context of the speed of life in

which we live, is described by Lipovetsky (2005) as "the hypermodernization of our relationship to historical time" (p. 42). This hypermodernization, which emphasizes time as a main societal value, has an impact on artistic manifestations that engage with sensory knowledge. Lipovetsky described that in today's society, cultural heritage reflects as a temporal referent; he claimed that as a consequence of the unrestrained expansion of the ways people engage with recollection, the "nostalgic society" paradoxically conveys a concept of the here and now. It is as though an excess of the present and a proliferation of memory bring to conclusion the concept of modernization at a time when tradition has become fashion (Lipovetsky, 2008). Lipovetsky (2005) stated:

> The formidable expansion in the number of objects and signs that are deemed worthy to belong to the memory of our heritage, the proliferation of museums of every kind, the obsession with commemoration, the mass democratization of cultural tourism, the threat of degradation or paralysis hanging over heritage sites because of the overwhelming floods of tourists—this whole new insistence of everything old is accompanied by an unbridled expansion, a saturation, a boundless broadening of the frontiers of our heritage and our memory: and in these we can recognize a modernization taken to its logical conclusion. . . . The value attributed to the past is a symptom of the advance of cultural capitalism and the commercialization of culture: as such, it is less a postmodern than a hypermodern phenomenon. (pp. 58-59)

The core sculpture installation work supporting the Research Creation project, *Vulnerable: The Salmon Project*, conveys a hypermodern worldview that refers directly to the film narrative projected on the cast aluminum standing salmon sculpture. A film projection of a historical family document on salmon fishing in the Gaspe Peninsula from the 1940s brings the concept of memory to the work (Figure 1). The artist-researcher's family heritage becomes a metaphor for the declining condition of the salmon population and the expression of the vulnerability of today's marine life. The artistic work encompasses a hypermodernist worldview through image mapping a referential past on one side of the standing salmon sculpture, on the other side of which the viewer can read the text "Vulnerable" (referencing the present condition) (Figure 2). Furthermore, from this hypermodern perspective, the work methodology itself also posits opposing temporal forces: a technological approach manifested throughout the conceptualization and production process of the salmon sculpture project in opposition to the signified

Figure 1. Claire Brunet, *Vulnerable: The Salmon Project*, cast aluminum and video projection, 2007-2012.

Figure 2. Claire Brunet, *Vulnerable: The Salmon Project* (front view), cast aluminum, 2007-2012.

ecological discourse conveyed by the sculpture installation form or signifier. The work stresses the opposing values of a hypermodern society, reflecting a culture of paradox as a "hypermodern society belongs to an age where everything is made into part of our heritage and duly commemorated" (Lipovetsky, 2005, p. 57). Technological advancements influence us and affect the individual's inner strength:

> Thus it is that the ultra-modern period is seeing the growth of technological power over space-time, but a simultaneous decline in the individual's inner strength. The less collective norms can command our behaviour in detail, the more the individual shows a growing tendency to be weak and unstable. The more socially mobile the individual is, the more we witness signs of exhaustion and subjective "breakdowns"; the more freely and intensely people wish to live, the more we hear them saying how difficult life can be. (Lipovetsky, 2005, p. 56)

This concept of living freely, or "positive freedom" (Berlin, 1969), is very present in artists' minds. Moreover, it plays an important role in artists' creative thinking and modes of production. The level of freedom experienced while creating digitized forms inside a 3D digital and technological context is dependent on the artists' ease in playing with the mutability of various data forms within the 3D software interface. Artists' creative process is subject to an adaptation to the pace at which technological growth develops and how they adjust to it. Artists need to adapt to new ways of experiencing 3D in a hypermodern epoch, where space-time and materiality are greatly affected by the growth of digital media and mediums.

The concept of hypermodernity is not only shaped by self-reflectivity or values attributed to the past but also by the ways in which traditions are used through a sovereign perspective based on "the principle of individual sovereignty" (Lipovetsky, 2005, p. 67). From a philosophical point of view, the definition of hypermodernity is

linked to individualism, where the self is the main focus. A parallel could be established between this era of the self and the autonomous freedom that artists need to be able to experience creativity in totality through digital means. Again, this concept is paradoxical. The expansion of the relationship between science and art implies that artists have to work in collaboration to share the knowledge necessary for the growth of creative exploration in the artistic domain. A paradox is imbedded in opposing forces, challenging the concept of collaboration, where historically the artists' creative process has been identified as a self-reflecting experience. To foster the comprehension of artists' interactions with a 3D digital and technological context, the next section presents a view on the digital object representation or data object.

3.2 The Sculpture Data Object

The structure of an object generated through computer technology conveys a concept of fragmentation (vector or points in space) and diversification (plural condition of a digital medium). A parallel can be established between the structure of a data object and that of a text; in a similar context to that of Derrida's (1997) deconstructionist theory,[33] the data object is dismantled in its original form (Manovich, 2001).[34] This extrapolation of the concept of *deconstruction* implies that medium specificity is now discarded through digitization. Computation and softwarization favour the merging of all forms of artistic expression.

As a consequence of technological advancements, the digital object mimics this sense of self carried by hypermodern times. From diverse perspectives—philosophical, social, artistic, and technological—the same phenomenon of division is witnessed. Thus, in reference to the theory put forward by scientist Richard Dawkins (2006) in his book

The Selfish Gene, humans appear to simulate a certain organic behaviour or patterning common to all living natural environments. This behaviour is also common to technological environments where the concept of mutability is visible and also manifested through the change of societal values. The mutability of digital mediums brings about a digital object constructed through various modes of digitization.

3.2.1 Digitization

To further investigate the phenomenon of digitization, the question of how the term *medium* becomes intangible, and immaterial, through digital means is asked. As enunciated by French philosopher Jean Baudrillard (1983), the "inevitable change of the nature of the medium" that the coded environment of the new digital media engenders allows multiple interpretations of the data source (p. 54). When digitized, an object is no longer perceived as a continuous form but seen as a discrete whole that can have more than one interpretation.

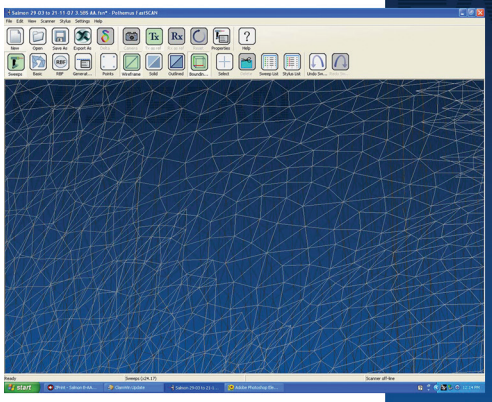

Figure 3.1. Polygon mesh from salmon scan data, close-up wireframe view.

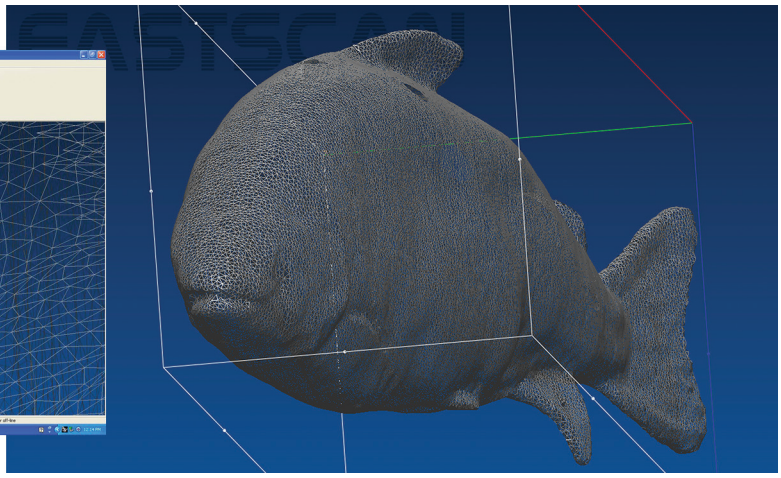

Figure 3.2. Salmon digital representation, FastSCAN post-processing software polygon mesh view.

Through digitizing processes, the sculptural object is vectorized or represented as a series of points positioned in space and in relation to one another on an *xyz* axis (Figure 3.1). This computing representation of juxtaposed triangles recreates an object known as a digital object (Figure 3.2). The immaterial state of the digital object conveys the notion of mutability. The data object can mutate into various digital forms, but its immaterial nature also conveys materiality. The mutability and volatility of the digital object contain the opposing values of the material and the immaterial.

With 3D digital technology, the relation between distance and materiality is also redefined. Distance translates into a time measurement, an expanded definition of distance that considers both time and space as linked to the travel of information or computer data (Logan, 2010). A symbiosis between the digital and the material object—that it encompasses—or the relationship between information data and data objects is experienced. The change in the artists' relationships to temporal and objectified values influences their creative process in relation to concepts and production. Traditional values carried by analogue processes shift as artists experience that both the material and the immaterial inhabit the digital object.

3.2.2 The Notion of Interactivity

The computer software interface positions artists/users within a state of participation as they experience a digital context. Artists' relationships to the spatial environment have thus shifted to a hyperactive role where they interact with all aspects of the artwork simultaneously: precept-concept and effect. From McLuhan's (2001) perspective, the digital medium and its technological context incite the "simulation of

consciousness." McLuhan (2001) expressed this change in our relation to a technological context in *Understanding Media*:

> Rapidly, we approach the final phase of the extensions of man—the technological simulation of consciousness, when the creative process of knowing will be collectively and corporately extended to the whole of human society, much as we have already extended our senses and our nerves by the various media. (pp. 3–4)

This "technological simulation of consciousness" characterizes digital media. Through technological means, the convergence of specific mediums into a code shapes the artwork into a transmittable and interactive art form.

However, artists' ideas are influenced by how they perceive the reality to which they belong. Physicist Robert Logan (2010) commented on this in a chapter entitled "Art as Radar and an Early Warning System":

> One of the unique aspects of the Innis-McLuhan approach is the way that the insights and methods of artists are integrated into their media studies. Not only is this a natural extension of their multidisciplinary approach (A.31), it is also a reflection of their belief in the superiority of artistic sensibility and its ability to detect currents of change before they fully impact on a society. McLuhan (1964, p. 65) was fond of quoting Wyndham Lewis, who wrote: "The artist is always engaged in writing a detailed history of the future because he is the only person aware of the nature of the present." McLuhan believed that the artist's insights were like radar or an early warning system, which could pick up the social and cultural problems and challenges that new technologies created. (pp. 369–370)

With digital creation, the notion of interactivity is present throughout the creative process wherein technological tooling influences the relationship between the medium and the artist. As with painting, where artists look at new optical expressions, in the field of sculpture, artists experience new temporal and spatial preoccupations. Influenced by a simulated perspectival frame of reference that triggers sculptors' perceptions of object in

space, from a computerized spatial environment digital sculpture becomes a new simulated matter. Therefore, artists experience a conceptual stage where production strategies are also simulated. All material consumption is pure simulation and decision-making is established through digital parameters.

In conjunction with its simulated characteristic, digital technology impacts the human-machine relationship. The digital space excludes a physical context but gives access to a computer numerical control technology that modifies artists' relationships with the fabrication process. Media art theorist Peter Lunenfeld (2000) characterized this expanded artist-medium relationship as a form of hybridization between human and machine. Digital creation not only questions the user-artwork interrelation but also transforms the "human-machine" or artist-medium relationship. As explained by Lunenfeld (2000):

> The human-machine relationships characteristic of mechanization, automation, and the more interactive systems don't have to be seen as absolutely clear-cut and mutually exclusive. Indeed interactive media could be seen as a kind of synthesis of the two earlier models of the human-machine system; they adopt from mechanized systems the constant interplay between the "worker" and the machine, sometime to the point of "hybridization." (p. 107)

Where the previous section presented a methodological context, the following section explores the procedures guiding the research.

3.3 Presentation of Research Procedures

In this study, the conceptualization and production of sculpture installation works were experienced, observed, and questioned through a Research Creation project and an interview process. The research focused on the influence of a 3D digital and

technological context on the artists' creative process. Information on how from a sensory and perceptual experience sculptors' interactions with a digital medium influenced their artwork was gathered. The interviews with the sculptors provided insight into the ways in which the artists' visual language was influenced by a digital medium. The elements and qualities that influenced the aesthetics of sculpture works were also explored through a Research Creation project that was shaped through a 3D digital and technological context that extended the artist-researcher spatial and medium boundaries.

The Research Creation[35] work took the form of a conceptual investigation of environmental issues, and the artist-researcher's practical investigation reflected the study's technological exploratory approach. From the case study method, interviews were used to better understand how the computerized spatial context influences artists' creative process through interactions with a digital medium. The interview data clarified the context and quality of experiences that influence sculptors' visual language and the aesthetics of their artwork.

3.3.1 Research Approach

The research followed a naturalistic approach (Rubin & Rubin, 2012). The naturalistic approach employs an interview process and gives voice to the artist-participants and to the artist-researcher's interpretation of the information gathered. Because the information collected was viewed through a hermeneutic standpoint, the findings are subjective. As they are based on what artists have experienced, voiced, and created, the findings are subject to diverse meanings and interpretations. The interpretations are focused on being and experiencing, what is known about the artists' creative activity:

> Interpreting is primarily knowing. When we interpret, we appropriate the surrounding world of our concern (being open-up) in terms of its significations. Knowing is a basic way of being-in. As such it is present in speaking and the state in which one finds oneself [*Befindlichkeit*]. All perceiving (seeing, hearing) is interpretative. (Heidegger, 2011, p. 29)

Interpreting as knowing and being in the world, is in line with the hypermodernist paradigmatic worldview conveyed through the multiple facets of the study embracing art and technology.

3.3.2 Research Inquiry

This qualitative mode of inquiry, where data were collected through scrutinizing artists' interactions with a digital medium inside a technological context, focused on artists' sensorium expressed through various forms of representation: artists' sensory experiences studied through conversation or an interview mode of dialogue; the artists' interactions with the digital medium observed through a selection of artworks; and the artworks' aesthetic qualities that informed the influence of the digital medium through the artists' shared and experienced creative explorations. The study mode of inquiry also included the collection of data that informed the ways the production process used by artists influenced their creativity and the aesthetics of their artwork.

In general, this interview approach clarified the broader question of "why and how do art and research come together to advance knowledge?" (Knowles & Cole, 2008, p. xiii). What can be inferred from the interviews is subject to interpretation, since the artists' creative experiences were embodied in their artwork. The research outcomes are linked to practice outcomes[36] (Jones, 2009).

3.3.3 Research Method

This section presents the research methods used to make sense of what influences the sensory knowledge that leads to artistic production. These methods address the Research Creation works, as well as the case study approach and the interview mode of inquiry. The Research Creation and case study methods for data collection and data analysis indicate, from diverse perspectives, what is common and what is particular about how the technology influenced the artists' creative process, and the why and how a 3D digital and technological context influenced the sculptors' imaginations and their artwork production. A multitude of pathways or directions are explored. Digitizing tools, such as 3D modelling or 3D scanning, as well as computer-aided design (CAD) and computer-automated fabrication (CAF), were considered to understand the effect they have on the artists' sculpture fabrication strategies.

3.4 Case Study

The case study approach was shaped through responsive interviewing,[37] which includes interviews and observations of visual documentation of the artist-participants' creative process and artworks (Rubin & Rubin, 2012, p. 7). Data analysis was based on interpretations of the data collected.

The artist-researcher transcribed data from audio documentation. The phone interviews were recorded and note-taking was done with a SmartPen device. The emphasis of this qualitative naturalistic approach was to make the artists' voices prominent and to better understand their creative experiences. Three sculptors working on sculpture installation projects participated in the research interview process. It was

important to interview a number of professional artists to broaden the study. This provided data beyond that derived from the Research Creation project.

Research participants included the following artists: German born American sculptor Kiki Smith from New York, Canadian figurative artist sculptor Evan Penny from Toronto, and South African born Canadian sculptor Trevor Gould from Montreal. The artist-researcher, Claire Brunet, also responded to the questionnaire and the themes covered in the interview presented in the Research Creation chapter.[38] Thus, all four artists responded to the same interview questions.

The artist selection criteria took into consideration the artists' practice genres, which varied among figurative, environmental or ecological, sociological, and feminist art. The selection was comprised of male and female artists from a North American socio-cultural context. Participants included two male artists and two female artists (including the artist-researcher), providing a gender balance to the study. All four artists were over fifty years of age. Thus, they did not grow up in a computer environment, as younger contemporary artists do. Compared with the younger generation, these artists belong to a category defined here as non-native computer users. The case study participants were selected because of the explorative and creative approaches with which they engaged with technology in their practice (Chapter 4 presents a description of each participant).

3.4.1 Interview Design

The interview was designed with initial open-ended questions addressing a temporal perspective intended to contextualize the artist-participants' profiles and artistic

practices. This enabled the artists to provide narrations on which the interview theory questions were grounded. The objective was to enable the interviewees to feel comfortable revealing their artistic experiences and to initiate a spontaneous gestalt, as suggested by social researcher Tom Wengraf's (2001) approach. To enable the gestalt of the interviewee to become observable requires adopting an interview strategy that minimizes (for as long as possible) the interviewer's concerns (system of values and significance) to allow for the fullest possible expression of the concerns, the system of value and significance, and the life-world of the interviewees (Wengraf, 2001, p. 69).

The rationale behind the choice of semi-structured in-depth interviews guided by a responsive approach rested on the manner in which responsive interviewing leads to deeper investigations of the ways in which technology affects each artist-participant. This approach implies that the artist-researcher focuses on exploring one topic thoroughly instead of jumping around from one subject to the next. In-depth qualitative interviewing research is central to naturalistic research methods:

> The techniques for conducting responsive interviews build on some of the skills of ordinary conversations but go beyond them in specific ways. Interviews are more one sided than ordinary conversations; the interviewer asks most of the questions, and the interviewee provides most of the answers. Rather than just listening, the interviewer keeps a record of the conversation. Responsive interviews usually focus on a single topic and explore it thoroughly rather than skipping around from one matter to another. (Rubin and Rubin, 2012, p. 5)

Using this approach, the artist-researcher investigated how artistic concepts and artistic sensibilities are expressed and develop through the exploration and transformation of 3D digital sculpture forms, as well as the ways in which the 3D software spatial context influences the artists' sensory experiences and the ways in which artists

manipulate digital data to create their artwork. The study looked into different approaches. Questions were posed about the artists' styles and contextual backgrounds that led them to 3D technology. Questions about how they develop ideas as well as how they situate their artwork within a theoretical framework and how they experience the work (e.g., whether they start from an analogue or digital perspective and in what direction the work evolves) were also asked. The study examined why and how the artists manipulate and transform digital forms; the artist-researcher analyzed data materialization strategies and the type of printing technology artist-participants use, from 3D printing to CNC milling.

In the next section, the questions guiding the data collection process are presented.

3.5 Interview Questions

The interview questions were framed around the ways artists' sensory experiences are influenced by a computerized environment, the technological tools that guide artists through the artwork mode of production, and the ways in which sculptors' interactions with a digital medium influence the aesthetics of their artwork. The two main standpoints described in this section are referred to as the Artist's Creative Approach (ACA) (see Appendix A.2 and A.3) and the Artist's Technological Approach (ATA) (see Appendix A.4 and A.5).

The artists' sensory experiences were questioned through looking at the artistic style or mode of representation; the artists' ways of appropriating, transforming, and manipulating sculpture data; and how the digital representation of sculpture forms were imagined, created, or formatted. This research asked how the artists engage with an exploratory creative experience from analogue to digital to analogue to create their

artworks.

The following questions about the artists' choice of software, their interactions with the interface spatial configuration, and their use of technological tools were asked to better understand the influence of the technology on sculpture production: What tools do participants use to digitize sculpture data or to build data objects? Do they start from analogue data and digitize it through 2D and 3D scanning technology? Additionally questions also addressed the specificity of the technology used (CNC milling or 3D printing). The semi-structured in-depth interview questionnaire is presented in Appendix B.

Artists' responses to the questionnaire were transcribed, compiled, and analyzed through an interpretive and comparative approach. Artists' interactions with the digital spatial context as well as their creative relationships with software tools were analyzed. Each participant's creative process from analogue to digital as well as the mode of production of their artwork through the use of technology was also studied. Questions regarding the Artists Creative Approach (with prompts in brackets) included:

- What were the artists' contextual backgrounds leading up to the use of 3D digital technology? (exposure to a computer environment at an early age; a 3D RP lab within a university context; 3D technology in an independent sculpture studio production context; a growing interest for technological development in the arts; the development of ideas or concepts that evolved from 2D digital images to 3D forms)
- From what theoretical position are the artists' artworks framed? (cultural/historical, referential, social, humanist, mythological, ecological and environmental, feminist)
- Are the artists' original ideas generated from an analogue or a digital perspective?

- Do the artists combine analogue and digital approaches to conceptualize their artworks?
- Do the artists develop the concepts directly in digital space, or do they first establish what they will be creating from an analogue approach?
- How do the artists' ideas develop and in what direction do they develop: analogue or digital or digital and analogue or analogue and digital and analogue?
- At what stage of the creative process do the artists' ideas begin to interact with technology?
- How do the artists find that the digital environment interacts with their creative process? Why?
- Do the artists use 3D printing technology to visualize their concept during the creative process?
- Do the artists use 3D printing where the print material is the final sculpture outcome?
- Do the artists perceive 3D printing as creative?
- Do the artists feel they can experience "the unexpected" when creating in digital space or do they feel limited by a mathematically controlled space?

Questions regarding the Artists Technological Approach (with prompts in brackets) included:

- What type of software interface do the artists use? (Photoshop, Illustrator, Rhino, Z-Brush, 3D Studio Max, Cinema 4D, AutoCAD, Softimage, etc.)
- What type of instrumentation is used to build or appropriate data (NURBS, polygon mesh, or point cloud) and to generate data objects? (2D scanning and Illustrator software to vectorize 2D images, 3D modelling software, 3D scanning technology)

- What type of software is used for post-processing the data collected from a mesh or point cloud scan file? (3D modelling software (Rhino mesh repair tools), Geomagic Studio (scan repair software))
- What type of 3D scanner is used to collect the sculpture form data or data object? (hand-held laser scanner, desktop, rotary, environment scanner, white light scanner)
- What type of data structure is used? (point cloud, polygon model or NURBS, polygon mesh from 3D scan)
- Do the artists work with a software interface to create their artwork? Are the artists assisted by a technician?
- Do the artists work with 3D scanners to appropriate data objects? Are the artists assisted by a technician? Do the artists work with a service bureau?
- Do the artists play with, manipulate, and transform the scan data? How and to what extent?
- Do the artists perceive digital space as a creative space? Or do the artists use it to simply facilitate sculpture processes? Or both?
- Do the artists combine digital and analogue environments in their conceptualization process?
- Do the artists prepare their data files for RP 3D printing or CNC milling? Do they send the data files to a technician or a service bureau?
- Do the artists use the technology mostly to facilitate duplicating and scaling?
- Do the artists combine analogue and digital processes in the fabrication process of their artwork?
- Do the artists re-work the 3D print? How and why?

– Do the artists first use RP technology and further develop their projects through combining other transformative processes such as the lost wax process for metal casting or other materials and processes?

3.5.1 Analysis

A step-by-step process was used to guide the data analysis and research outcomes. A template was developed to display the interview data from the artists (the template is not included in the appendix section because the interview data transcript was confidential; extracts from the interview are presented in Chapter 4). The following points describe the sequence or strategy that guided the analysis of the interview data:

– Transcribe interview responses from each artist-participant.
– Gather artists' responses from the interviews on a chart. Review note-taking with SmartPen device.
– Study artists' responses from the interview process and use the recorded information as an instrument grounded in the artists' life experiences and reflecting the artists' creative process.
– Study and analyze how artists' responses to questions may reflect special characteristics of their creative process.
– Compare artists' interactions with technology. Use artists' quotes illustrating the influence of technology on their creative process as described during the interview.
– Collect specific statements from artists about their sensory experiences and interactions with the digital medium and computerized environment.
– Establish parallels or distinctions between the data collected from the participants. Differentiate the artists' creative approaches; the works' aesthetic genres (figurative,

abstract); and the artists' statements or positions (sociological, political, ecological, environmental standpoints) and creative approaches, and the modes of production of their artwork (analogue, digital).

– Select and gather visual documents of the participants' artwork.

– Communicate research results in writing, supported by image-based modes of representation linked to artistic production.[39]

Through this responsive qualitative interview design, the artist-researcher gathered narratives, descriptions, and interpretations from conversations with the artists. The interviews concluded with questions about the artists' projections or upcoming projects. Artists' points of view on future technological developments in the field of sculpture installation art closed the interview sessions.

3.5.2 Artistic Work as a Mode of Collection

The creation of artwork is another way to collect information about the influence of 3D technology on artists' creative process and artwork aesthetics. Therefore, a research creation approach was included. This allowed for a production of artworks and their documentation as a mode of data collection. The resulting body of works was comprised of a main sculpture installation entitled *Vulnerable: The Salmon Project*. Other works are also presented to illustrate the artist-researcher's investigation. Visual and written materials support the conclusion of the dissertation.

3.6 Research Creation Data Collection Method

While the case study data collection method led to an analysis of artists' interactions with a 3D digital context through an interview process, the Research

Creation approach led to the artist-researcher's interaction with 3D technology through the production of artworks. Through artistic creation, environmental concerns from ecological to technological perspectives were explored.

3.6.1 The Concept

The concept of the Research Creation project rested on its exploration of a 3D digital and technological context and the main artwork of this project presented issues affecting our natural environment. Its purpose was to develop a deep understanding of the focus of the research raised by the two main research questions. The main project idea focused on the vulnerability of living species, specifically the salmon. The concept questioned the current state of marine life, whose living condition reflects on the quality of life of future generations. Guided by an explorative approach to a digital spatial context, the artwork's ecological discourse stressed the vulnerability of the salmon species, a Canadian icon whose condition is perceived as a metaphor for the human condition. The Research Creation process experimented, explored, and developed through digital means.

The following section focuses on the Research Creation project from the perspective of the method used throughout its production mode. Chapter 6 presents the Research Creation concept from a more philosophical point of view and elaborates on the significance of the artwork propositions. The themes addressed in the interview are discussed starting with each artist's contextual background. The Research Creation approach is presented in two different sections. Both lead to the discussion and interpretation of the findings presented in Chapter 5.

3.6.2 *Vulnerable: The Salmon Project*

The methods or research procedures that guided the Research Creation project consisted of looking, perceiving, and imagining through digital means. The artist-researcher's view on the creative potential of 3D technology was influenced by a digital knowledge that built on a more traditional analogue approach to conceptualizing and fabricating sculpture installation work. From conventional production methods using transformative processes (such as mould-making and metal casting), the method used in the Research Creation project expanded towards computerized technology, where the concept of transformation became linked to that of digitization.

Digitizers, such as 3D scanners or 3D modellers, redefine the traditional ways of mould-making to appropriate, cast, duplicate, and transform existing forms in sculpture practice. Three-dimensional scanning offers a broad and under-explored creative potential that conveys a sense of immateriality through digital sculptural object and concept representations. The sustainable attributes of a digital approach to artistic practice that avoids unnecessary material consumption proposes an openness to a more sustainable future in which all sorts of goods and resources are perceived of as valuable, where material waste is no longer conceivable, and where preserving and recycling become necessities. While computerized equipment negatively impacts the environment, it must also be emphasized that digital approaches to sculpture practice broaden the accessibility to spatial explorations of sculptural objects. In this way, the immaterial nature of the digital medium (inside which the art object inhabits) invites the merging of concepts and processes through a medium's ecology perspective.

The digitized form or data object also conveys a sense of plurality through its deconstruction mode into single unit or dot values. When art and media theorists Rosalind Krauss (1999) or Mark Hansen (2006) addressed the plurality of the digital medium from different viewpoints, they referred to the mutability and the volatility of the digital medium. Despite the fact that the Research Creation project did not precisely address the plurality of the digital medium from its translation into other disciplines, the research explored the malleability of the digital medium in sculpture practice.

3.6.2.1 An Exploratory Journey

This section presents a detailed description of the mode of inquiry of the Research Creation project. The data collection method is explained throughout an exploratory, creative, and technological investigation into the influence of a 3D digital and technological context on the artist-researcher's creative process. The ways in which a digital spatial-temporal dimension inspired the work direction and influenced its mode of production and aesthetics are described. The subject is addressed through a narrative writing approach focused on the artist-researcher's experience.

The production of the Research Creation project started at the Hexagram Rapid Prototyping Lab at Concordia University. The research method was guided by an interest in exploring the ways in which 3D scanning could replace more traditional analogue methods, such as mould-making, to appropriate, transform, and duplicate forms. As such, 3D scanning and 3D modelling were investigated. The conceptual investigation of an ecological concept directed this research towards 3D scanning a live salmon. The fresh fish was brought in a cooler to the Hexagram Rapid Prototyping Lab. The journey of discovery started in 2006, when, as suggested by the lab technician, one side of the

salmon was scanned (Figure 4.1). The other side was then scanned and the two scan files were joined together using data post-processing software. During the post-processing phase, the software analyzed the scan sweeps or surface geometry and stitched the two halves together. In theory, the process seemed quite simple. In practice, it required numerous attempts and failures and much determination. It took a few months before a decent 3D scan file of the salmon form was obtained. Scanning technology was still a novel approach to artistic practice at the start of this research and was more often used to scan small, simple, still objects. The idea of using 3D scanning technology to appropriate a form and address a sculpture concept through the digitization of a living creature or elements from nature had not been previously explored apart from body digitizing.

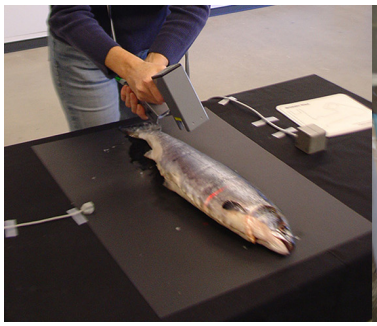

Figure 4.1. The artist-researcher at Concordia's Hexagram Rapid Prototyping Lab scanning live salmon with hand-held FastSCAN Cobra scanner.

Figure 4.2. First scan result 2007, half salmon scan, wireframe view.

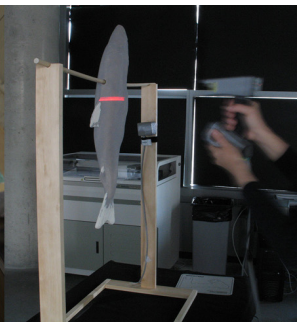

Figure 4.3. Traditional mould-making of live salmon.

The salmon project raised many technical issues that needed to be resolved prior to obtaining a satisfactory scan file. While the artist-researcher expected to address *how to do it* and *why it's not working* to a lab technician, instead 3D scanning was experienced from an exploratory perspective. After three visits to the fish market to buy a new salmon, it was clear that the task was much more complex than anticipated. As a

result, a mould of the live salmon form was made using more traditional mould-making methods (Figure 4.3), a polymer plaster positive was cast and a rack was built on which the cast salmon form was suspended (Figure 4.2). This work strategy allowed the artist-researcher to scan the salmon form from all sides. Moreover, it improved the digitizing process and provided one single data object (Figure 5.1), whereas the previous method required the stitching of two data files together to create one digital object.

The traditional moulding of the salmon also facilitated the necessary alterations of the cast polymer plaster form, such as thickening the thin parts or the fins and tail to improve the scan quality. The scanning of a plaster cast salmon also solved the problem first encountered with the reflective quality of the live salmon's skin surface, which was partly responsible for the mediocre scan data file previously obtained. It was later observed that the metallic components of the lab table, on which the cast salmon and support were sitting, were causing problems during the scanning process. Whenever the scanner laser beam was unintentionally directed in line with a metallic part of the table while the fish was being scanned, a scan registration problem was experienced. This loss of data registration resulted in a loss of reference points and affected the digitizing process or data sweep construction (Figure 5.2). After discussion with the lab technician, the table was replaced and a wooden table was purchased and put in place. Today, the artist-researcher would know how to save the already registered data, remove the unwanted triangle, and post-process the repaired scan file and add it to the new scan section to build the digital object; back then, she had not yet developed those skills and the salmon scan had to be done again.

Many elements can affect the 3D scanning process: as one problem was fixed, another situation occurred. The research exploration continued and, one evening, while attempting to scan the salmon form and as the salmon digitizing process was almost successfully completed, the scanner laser beam caught the headlight of a passing car through the lab window. Once again, the scan registration was lost. In this way, it was learned that not only metallic objects or reflective surfaces can affect the scanning process, but that light is also an important factor of influence. Moreover, workroom conditions were important to ensure scan file quality. The following day, the issue was addressed and black cardboard was installed over the Hexagram RP Lab windows. At this point, most of the physical problems were solved. The parameters around proper work conditions that allowed for successful scanning and good scan file production had been addressed.

A research approach based on trial and error iterations was fundamental to this Research Creation exploration inquiring about the impacts of technological modes of production on artists' creative process. Of course, working from ideal scanning conditions (where a form could simply be positioned in a box scanner to be scanned or body digitized) would have been faster and easier but this would not have resulted in the same depth of comprehension of scanning technology. Scanning technology addresses not only the use of a 3D scanner but also an understanding of how the data of an object is built or captured, or how the object is digitized (Figure 5.3). Digitizing strategies include the speed at which the operator moves, the laser beam angle position, and the travel direction. As a result of this exploratory research approach, the technology's creative capacity, limitation, and exigency were addressed. Therefore, the artist-researcher

encourages an exploratory creative approach to digitizing and to the manipulation, transformation, and also the plurality of approaches a digital medium to be further explored.

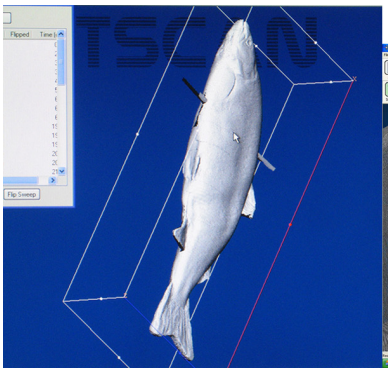

Figure 5.1. Salmon scan.

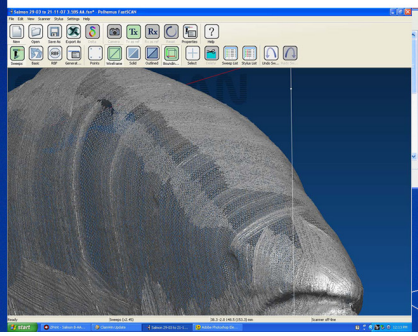

Figure 5.2. Salmon scan, wireframe sweep view

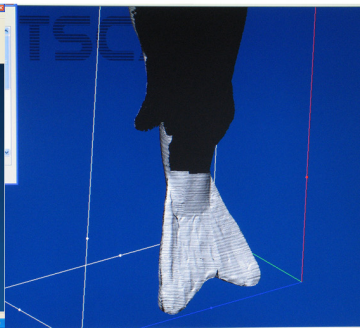

Figure 5.3. Salmon scan in progress.

3.6.2.2 Digital Sculpting

The salmon digital file was completed and repaired using a scan data post-processing and analysis software Geomagic Studio 11.[40] Rhino 4 mesh repair tools were also used for simple, easy file repair work. Then, the data or digital object was transformed or manipulated. To be able to digitally sculpt the scan data implied that the digital object presented a good surface geometry. The cleaning of the file was an important step. First, bad triangles or floating triangles and intersecting triangles, holes, and spikes were removed. The file data was also decimated (reducing the number of triangles or augmenting their size on the data object flat areas where surface detail was not needed). Reducing the file size facilitated digital object manipulation and transformation. The salmon digital representation was then reformatted. Using the Rhino software interface, the salmon form was copied, and the two were mirrored and positioned side by side. The salmon tails were twisted to allow the salmon sculpture to

stand straight up. The artist-researcher created a standing sculptural object on which a historical film of salmon fishing from the 1940s was projected.

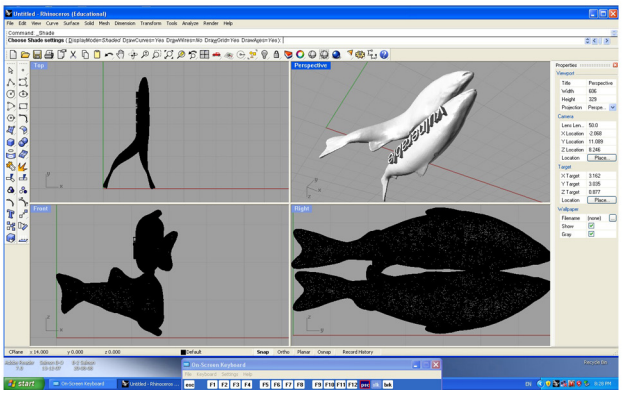

Figure 6.1. Rhino 4 software, 4 viewport digital salmon sculpture.

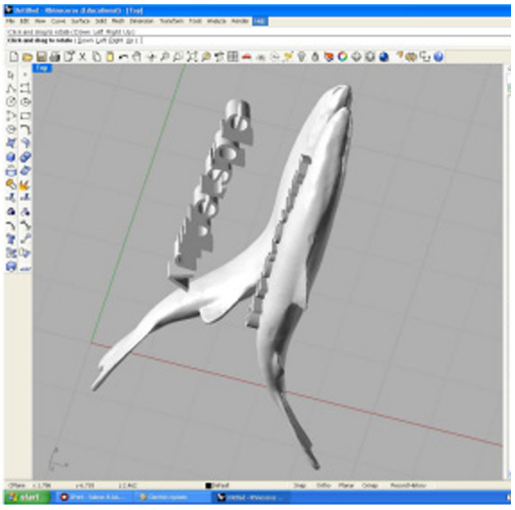

Figure 6.2. Rhino 4 software, perspective view digital sculpture and extruded text file.

Multiple attempts to twist the salmon tails were unsuccessful because the lab computer did not permit data manipulation of the salmon scan file. A computer that would allow for the manipulation of large files was needed. In the field of 3D digital representation, people working in film and animation also transform, manipulate, and animate digital objects. Therefore with the support of the Hexagram Animation Lab technician, Rhino software version 4 was temporarily installed in one of the animation lab computers, which allowed the artist-researcher to finally work out the digital sculpture form manipulation and transformation as intended (Figure 6.1). The last step was to add a text file with the word “Vulnerable” on one side of the standing salmon sculpture. A separate data object, or 3D text, was built in Rhino and imported (Figure

6.2). As the extruded letters or word object was being merged to the digital salmon form, suddenly the letters could no longer be seen; the text file had disappeared. Where had the letters gone? How wide was the digital spatial environment? How could a lost data object be found in data space?

This led the artist-researcher to question the spatial boundaries of the 3D software environment, a simulated and seemingly infinite spatial context. It was then understood that when working with digital sculpture production, a good work strategy—after importing the scan file in the Rhino 4 software interface—is to position the data object at the intersection of the *xyz* axis or spatial coordinates. If the digital object is not first positioned at the origin point (0,0,0 coordinates), it may become difficult to work with many distinct data form. In addition, it may lead to searching for these data forms in digital space. As such, a method was developed, whereby the text file was dragged and the text was positioned in relief on one side of the salmon digital sculpture. This approach to 3D digital work has now become part of the method the artist-researcher follows when importing scan files into a 3D software interface, such as Rhino, to explore digital sculpture concepts.

3.6.2.3 Prototyping: 3D Print

After the completion of the digital sculpture concept, a number of prototypes were 3D printed on a Z-Corp 3D printer (Figure 7). One was selected out of six different prints of the artwork. This prototyping approach allowed the artist-researcher to study the small-size printed version of the sculpture, make necessary adjustments to the digital file, and print out a final prototype. The next step consisted of enlarging or scaling up the digital file and CNC milling it in Styrofoam. The scaled up sculpture measured

approximately six feet in height. The Styrofoam sculpture was further moulded using silicone rubber, a wax positive was cast inside the rubber mould, and a refractory mould was made to allow the work to be cast in aluminum. The sculpture is titled *Vulnerable: The Salmon Project*.[41]

Figure 7. Z-Corp 3D print of salmon sculpture prototype.

3.6.2.4 The Digital Atelier

In 2009, the Digital Atelier[42] collaborated in the enlarging or CNC milling of the salmon sculpture project. It was at the Digital Atelier that the salmon file was formatted to be 3D milled in Styrofoam on a 5-axis computer numerical control (CNC) router. This collaboration with the Digital Atelier team, and, more specifically, with Atelier director Jon Lash and mechanical engineer John Rannou, was extremely important to the experiential learning process of the research and led the artist-researcher to realize that collaborative work between artists and engineers can be extremely beneficial to both

parties. When Rannou proposed modifying the curvature of the text file so the text would follow the salmon sculpture curvature, his advanced knowledge opened up a new approach to the artist-researcher's current knowledge in digital sculpture production. The digital text file or text object was then further formatted.

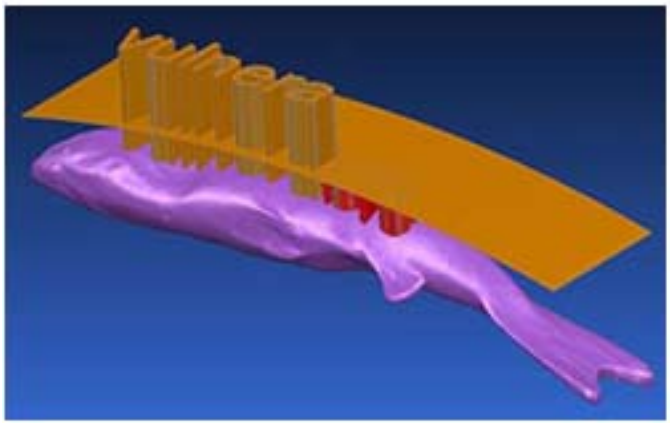

Figure 8.1. Cutting text file, view of the curved cutting plane slicing extruded letters on digital salmon form.

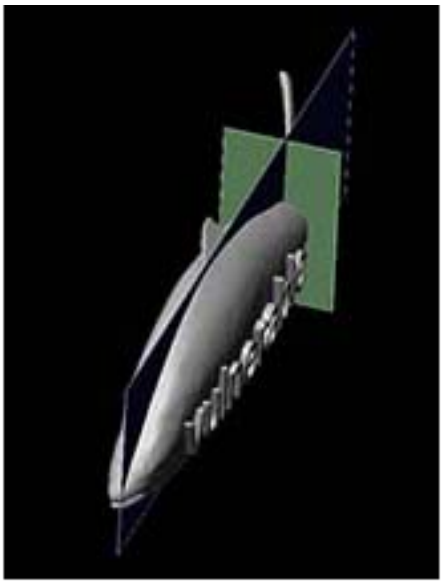

Figure 8.2. Simulation of salmon file cut sections for CNC milling process.

A curved surface was drawn over the text and the letters were sliced to follow the curvature of the fish (Figure 8.1). Furthermore, the digital salmon was sliced into sections (Figure 8.2), and each section was milled separately on the 5-axis router (Figure 9.1). A denser Styrofoam material was embedded into the large white Styrofoam block to be milled. The purpose of the operation was to increase the surface definition of the carved text and give more rigidity to the fish tails. Once milled, the Styrofoam salmon sections were re-assembled manually, sanded, and glued back together. A steel armature was embedded inside the Styrofoam form to add more rigidity to the standing salmon sculpture.

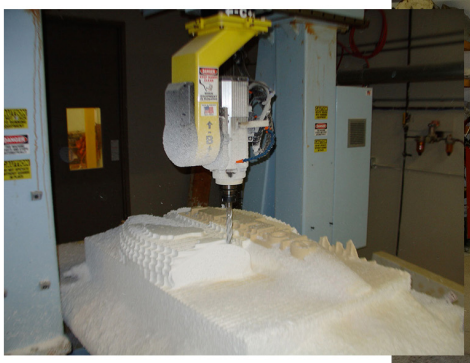

Figure 9.1. CNC milling of Styrofoam salmon sculpture section on a 5-axis router.

Figure 9.2. Styrofoam salmon sculpture.

Figure 9.3. Traditional moulding of the Styrofoam sculpture, silicone rubber mould and polymer plaster shell.

The Styrofoam sculpture was then brought back to the artist-researcher's studio (Figure 9.2) and a silicone rubber mould was made (Figure 9.3). A wax cast was extracted from the mould (Figure 10.1). The wax cast sections were assembled, adjusted, and sculpted. The salmon wax sculpture was then cut off in sections. Using a lost wax process for metal casting, a wax gating system was built on each section and a refractory mould was made over the wax parts. Molten aluminum was then poured into the moulds. The cast aluminum sculpture sections were then assembled or welded together, and metal finishing work was done to repair the welded zones and to re-texture parts of the casting (Figure 10.2). Finally, using a hot patina process, the artist-researcher applied a blended white colouration over the metal surface (Figure 10.3). The intent was to treat the sculpture surface to allow for a better reading of the film image projection.

Figure 10.1. Salmon sculpture, wax cast.

Figure 10.2. Artist-researcher doing metal finishing work on the cast aluminum salmon sculpture.

Figure 10.3. Salmon sculpture patination process.

3.6.3 The Print Project

The sculpture installation *Vulnerable: The Salmon Project* is the main Research Creation work supporting this doctoral dissertation. Additional work includes a ten-foot print exhibited and produced in the context of the *Forêt Nomade* exhibition.[43] The method used to produce the print included the 3D scanning of a piece of bark (Figure 11.1), the creation of a re-formatted scan file, and the production of a CNC milled Styrofoam print template (Figure 11.2). About a dozen sections of Styrofoam milled bark were assembled to form the print template. The print template was then inked and an edition of five prints was produced on Japanese rice paper.

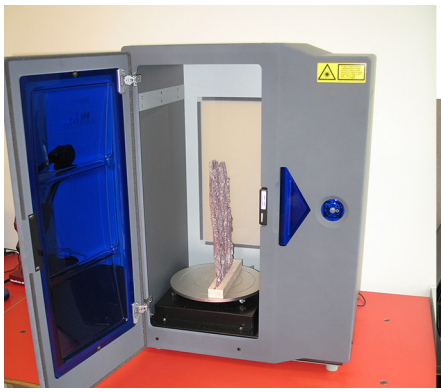

Figure 11.1. Picza 3D scanner, Concordia University, piece of bark ready to be 3D scanned.

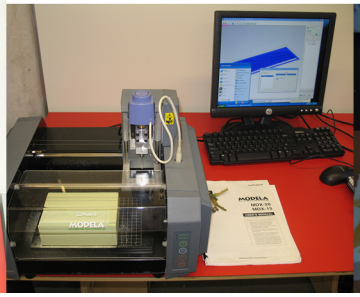

Figure 11.2. Modela MDX-20 CNC router and digital file of bark.

Figure 11.3. CNC milled Styrofoam salmon relief sections for the print template.

The print project was the artist-researcher's very first artwork using computerized technology. To achieve this project, the artist used a *Modela MDX 20* CNC milling machine at the Concordia Studio Art Lab.[44] At the time, the *Modela MDX-20* CNC milling machine had not been in frequent use, and the research method required that the artist-researcher first study the machine instruction manual. While not creative, the task was extremely informative and conclusive. It also contributed to stimulating the use of the technology and its growth at the Concordia Studio Art Lab.

The print production method comprised of different uses and formatting of the salmon scan file. A low relief representing a profile of the salmon form was milled and added to the print template composition (Figure 11.3). The original salmon digital file was scaled down, sliced, and mirrored to obtain a low relief salmon cutout. Seven Styrofoam pieces were milled and added to the composition of the final print edition.

Figure 12.1. Artist-researcher preparing the print template.

Figure 12.2. Artist-researcher with printmaker Paul Ballard removing the first print from the template.

Transforming and re-formatting the digital salmon file was a research method used to create a six-foot tall cast aluminum standing sculpture and also a ten-foot print edition made of twenty 6-inch CNC Styrofoam low reliefs sections assembled to form a template for the print project (Figures 12.1 and 12.2). In addition to this printmaking work, a series of digital prints from screen shots representing close-up views of the salmon scan polygon mesh were included in the body of works supporting the dissertation. The concept of the works developed around a common theme and proposed an ecological discourse on the natural environment as the process involves a technological mode of production.

3.7 Research Creation Analysis

After experiencing a digital and technological context and interacting with a digital medium reflecting on the body of works supporting the research, it is noted that

the malleability of the digital medium allowed for multiple transformations of the data source. The digital medium encouraged the crossover between artistic disciplines from photo-based art to printmaking to sculpture installation.

The Research Creation followed an analogue-digital-analogue process. The use of digitizing tools, such as 3D scanning and 3D modelling, guided the artist's work and influenced the artist's relation to objects in space. An interaction with a digital medium inside the computer software environment influenced the artwork's aesthetics. Scaling was key to the artwork's modes of production. From these various perspectives, the 3D digital context affected the artist's creative process and the visual aesthetics of the artwork. In the Research Creation project, the digitized object regained a physical state through transformative processes, such as rapid prototyping, metal casting, and printmaking.

The artist's creative process was guided by a digital approach in which the notion of immateriality was rooted in a computerized medium. The Research Creation method also proposed that while interacting with a digital medium, artists' spontaneity becomes linked to the concept of the "here and now" conveyed by hypermodern times (Lipovetsky, 2005) as the immediacy of function-action-reaction that artists experience while using 3D software tools or commands. Moreover, the symbiosis between concept and object conveyed by computer-automated fabrication encourages freedom of thought. In addition, the gravity-free environment of the software interface eliminates many of the constraints that artists experience while working with objects in space through analogue means. While media interaction and intangibility increase with the expansion of digital mediums,

the tangibility of the work of art, more specifically in the sculpture domain, is henceforth embedded in the digital object.

3.8 In Closing

A research creation approach was central in this study, as was the case study interview inquiry. Both research methods allowed for data collection. While this chapter presented the method that guided the Research Creation project production, the conceptual framework and artist-researcher responses from the interview questions are presented in Chapter 6. The next chapter presents an analysis of the data collected. Moreover, in Chapter 4, the interview questions are used to guide and to facilitate the analysis of the data collected from the responses of the artist-participants.

CHAPTER 4

DATA ANALYSIS

4.0 Introduction

A narrative profile of each of the three participating artists is presented in this chapter. The first section situates the artists' contextual backgrounds and leads progressively to their use of technology. During the interview process, artists presented a brief overview of the focus of their work, in which they described their artwork, ideology, style, and category of representation. Later, the artists described the contexts in which they started to work with 3D digital technology, as well as their current experience and the artwork projects they have engaged in or were working on. Starting with an analysis of the responses from the interviews in chronological order, the artist-researcher situated the artists' conceptual investigations, work focus, and directions as contextualized within the study's hypermodern worldview. This lead to interpretations of the ways in which a 3D digital and technological context affected their practice. The data collected indicates the elements and qualities that influence the modes of production of their artwork. Observations of the ways in which sculptors' spatial and medium boundaries are affected by a computerized context and automated sculpture fabrication process are presented. Artists' sensory interactions with a digital medium inside a technological context is questioned and analysed. The discussion focuses on observations indicating ways in which the sculptors' visual language was influenced by a creative process influenced by technological means. These influences were analyzed by quoting participants' responses and commenting on the ways each artist approached

and experienced technology. Finally, three artworks from each participant were selected as visual material to support the analysis.

Observations are presented in a narrative mode: the researcher comments on and examines relevant information to elucidating the research questions. This narrative approach entails a back and forth dialogue that alternates between the researcher's comments and the interviewees' responses quoted in the text. Based on responses from the interview questionnaire gathered through phone conversation each artist's approach and interactions with 3D digital technology is reported. The researcher's comments, and observations, are often linked to relevant theoretical concepts in order to highlight the ways digital mediums influence the arts.

Furthermore, the ways in which specific approaches to a digital context influence the artists' creative process is described. Through writing in a narrative format, understandings of how participants' experienced a 3D technological context from an artistic-exploratory perspective are made visible. This provides insight into individual artist's sensory experience inside a digital platform.

Chapter 4 is divided into three sections and each section addresses the data analysis of one participant: Section 4.1, Kiki Smith; Section 4.2, Evan Penny; and Section 4.3, Trevor Gould. Each section is comprised of twenty-five sub-sections that correspond to each of the main interview questions. For example, section 4.1 introduces Kiki Smith, section 4.1.1 addresses the first question of the interview questionnaire, section 4.1.2 addresses the second question, and so on. The artist-researcher's Research

Creation works and data analysis based on the themes of the interview questionnaire are presented in Chapter 6.

When developing the interview questionnaire, the artist-researcher expected that participants' technological knowledge would be much more advanced. Sometimes the participants' responses to the interview questions seem repetitive because they were unable to move ahead with the topic of the inquiry due to limited interactions with the digital medium and non-familiarity with the 3D software platform. Nevertheless, the repetition illustrates the tension between the artists' sensory knowledge and technological knowledge. The interview questions are in Appendix B.1.

4.1 Kiki Smith

Kiki Smith is an American sculptor who was immersed in a creative environment from a very early age. In her childhood, she was introduced to artistic practice by assisting her father, the sculptor Tony Smith, with assembling small paper sculpture models (Engberg, 2006). Kiki Smith was selected for this research for several reasons, the most important being that she was one of the very few American artists to explore 3D digital technology in the early 90s. Her approach to the digital medium flows from two-dimensional works to three-dimensional sculptural perspectives. Her practice is always grounded in the present, as she claims to work with things that move her. It is fascinating to observe the ways in which she engages, from a truly heuristic approach, with creative activity.

4.1.1 Contextual Background

The main focus of Kiki Smith's work is the body, more specifically the female body, which she envisions from social, political, emotional, mythological, and religious perspectives with a hands-on, interactive approach to artistic creation. She explores subjects from different angles and stresses that her work does not carry any particular ideology. Instead she creates through experiencing something that moves her. She lives in the present, a present within which her work is continuously moving. When she was asked what category of representation she sees her work belonging to, she stated:

> . . . my works move with things that move me and move my curiosity . . . it's not theoretically based and it's not didactic . . . things that present themselves to my life that I have to ponder on or deal with or that are exciting for me to investigate. . . . whatever it is. . . something formally or physically interesting, or spiritual or emotional or mental or social, or all different aspect that make us human beings. . .

If her works had to be categorized it would be considered "formal" but made of meaningful forms. The formalist character of her work is influenced by her interest in the history of object making. She explained:

> I would say primarily in a way what has moved me the most is the history of object making and what constitutes an object and the different methodologies of making things, the formal aspects of them, but also how objects use meaning, how one injects meaning into object, that's my main interest . . . this kind of object-making that I am attached to . . .

Kiki Smith's works have often been identified as feminist art. Most of her work is figurative. However, Kiki Smith's approach to figuration is quite different from that of the other artist-participants in this case study. For example, Evan Penny's figurative sculptures are based on perception and observation, and address our confrontation with ourselves as objects (Clark & Tousley, 2003). Trevor Gould's work, on the other hand,

is representational from a cultural perspective of the world we live in. Within the context of the case study interview process, Kiki Smith's work investigates the body as subject from multiple points of views through an inquiry on present social, personal, or political conditions. Kiki Smith engages with a subject or concept in concert with how she experiences production modes. Praxis and poiésis merge within Kiki Smith's creative approach. In reference to Nicolas Bourriaud, who claims that modern art refuses to consider any distinction between the artwork created and the artist's life experience, "créer c'est se créer" (Bourriaud, 1999, p. 13). This viewpoint is totally present in Kiki Smith's creative approach.

4.1.2 Contextual Background Leading up to Digital Technology

Even though Kiki Smith looks to historical references to nourish her work, the work itself is influenced by what is happening in the present, and the way she engages with it is always subject to unforeseen artistic impulses. From a creative approach, Kiki Smith's work is representative of how social and cultural changes have influenced modernity. From a technological perspective and as a consequence of her openness to the present, she started working with 3D technology in the early 90s, when very few artists were aware of its application in the arts. At that time, Kiki Smith was living in United States and working in an art foundry using 3D scanning technology and computer-assisted production processes. As she recalled in the interview, the ways in which technology was applied to sculpture practice at the time was very rudimentary and experimental. Kiki Smith stated:

> I worked in a foundry when that technology was being developed in relationship to sculpture, which basically meant scanning objects or

> programming information into a computer and then cutting that out with drills or router, drilling into Styrofoam actually.

The impact of 3D digital technology, as presented in a previous chapter,[45] was introduced in the field of design and architecture in the 1980s, before being applied in the arts and becoming more accessible to sculptors in the early 90s. As Kiki Smith related:

> When I started it was incredibly rudimentary and people did not really know what caused the Styrofoam to warp, you know, it was really a nightmare, all of it . . . I mean, in a way, you could have made the same by hand.

Kiki Smith's initial interactions with 3D digital technology or computer-automated processes were extremely experimental and exploratory. She was faced with what she described as frustrating situations where she would question the relevance of the technology. However, from an artist's sensory perspective, this new technological tooling encouraged creative freedom in sculpture practice. She explained:

> The thing I liked about it is you can have the intimate gesture of something that you form in your hands at the intimate scale of a tabletop sculpture and then blow it up; then you had to deal with the difference in scale with loss of detail or so. But you can have a more free gesture of making something at a scale that were normal to your body—or for me more normal. And now the technology has changed a great deal. You know it is far more sophisticated that it was fifteen years ago.

Freedom is essential to artistic growth and absolutely necessary to Kiki Smith's creative approach. It appears that she experiences freedom through a hands-on approach to sculpting at a small scale. However, she acknowledged the advantage of using digital technology for scaling up her handmade work, in this way combining analogue and digital processes.

4.1.3 Current Experience of 3D Technology

The interview process aimed to highlight the ways in which Kiki Smith's creative approach interacts with technology. Kiki Smith described how she applies 3D digital technology on a jewellery project or small sculptures she is presently working on,[46] stating:

> I make jewellery, like silver pins and things like that. I took some of the small sculptures, the biggest, maybe about ten inches long, but some are only three inches long and have them scanned. Now instead of remaking the piece and working on the surface, we just take the information and cut moulds directly, rather than making a positive and working on it again. We just cut a mould and then make our wax, work on our waxes, and then, you know, cast it. We then aim for about nine inches to nine feet, pretty large. Everything gets softer, but we still have . . . to me, anyway, an intimacy that you don't get if you make something to scale.

Kiki Smith uses 3D scanning technology to first digitize her sculptures to manipulate the data object and scale it up. The most interesting aspect of what she described is certainly the data file processing linked to the sculpture production mode. Considering the ways in which the data file is processed through RP (CNC milling) technology, the Walla Walla Foundry process impacts Kiki Smith's work as she uses extremely innovative and technologically advanced mode of production. This sculpture production process described by Kiki Smith as "we just take the information and cut moulds directly rather than making a positive and working on it again," indicates that she no longer produces a sculpture as such but rather cuts the negative image or mould.

To highlight this innovative approach, the artist-researcher contacted Dylan Farnum, President of Walla Walla Foundry, to share his technological viewpoints and positions on the subject. Farnum explained that the work strategy developed by the

Walla Walla Foundry team reduces the steps necessary for artwork production. Based on traditional modes of production, a digital sculpture is 3D printed or milled (CNC) then a mould of the enlarged sculpture form is made. However, the proposed work strategy described by Farnum consists of making a digital mould directly from the digital sculpture file. This strategy modifies traditional approaches to production and eliminates one step of the production stage of sculptural objects. The following method is applied: after the initial digitization of the handmade sculpture or jewel object using 3D scanning, the digital form is manipulated to fulfil the artists' creative exigencies. Then, instead of cutting a Styrofoam positive of the digital sculpture using the CNC technology, a negative form or polymer plaster mould is cut on the CNC router (creating a negative space). On the computer, the contours of the sculpture are outlined and a negative form is built digitally, which becomes the mould of the digital sculpture (D. Farnum, personal communication, April 10, 2013).

Inside the 3D software spatial environment, the geometry of the sculpture is reversed and then the form contours are selected and extruded. The digital file sent to the computer numerical control router machine becomes a mould of the sculpture. A wax cast is extracted from the mould. The sculpture form is therefore reproduced in wax through the CNC milled mould. Later, Kiki Smith uses the lost wax process for metal casting to obtain a bronze or aluminum sculpture.

This technological advancement influences the artwork production time frame through an accelerated sculpture production process, but more interestingly it proposes that sculptors' approaches to 3D modes of production become more similar to that of a 2D medium approach, as in printmaking. Printmaking artists often start by creating a

negative image and move it into a positive print through the process of production. Through interviewing other artists, further insight was gathered about different perspectives on the influence of a 3D digital and technological context on sculpture practice, including the ways it affects artists' creative process by bringing 2D and 3D modes of creation closer together; the ways in which it extends artists' spatial boundaries; the ways in which the passage from analogue to digital inside a simulated 3D perspectival space influences artwork aesthetics; the ways in which it causes artists to experience a shift of traditional production modes and a reduction of physically intensive work; and, consequently, the manner in which it frees artists' minds from physical or gravitational constraints.

Despite her thorough understanding of the many advantages that digital technology offers, Kiki Smith prefers to have a hands-on experience, and as she described, when she uses technology, she feels more passive, "I think there is a passivity in it. I always prefer to have an hands-on experience, but I like to use it I think when I can see that it facilitates what I'm working on. . . ." In Kiki Smith's creative approach, closeness to the artwork is better experienced at a small scale. As she stated: "I can feel an intimacy of the object with my hands when it starts out small and it is made large . . . that I couldn't feel if I made something nine feet to begin with."

4.1.4 Creative Process: Technology and Methods

Kiki Smith's creation mode does not follow any specific methods; the work instead informs her artistic means. She indicated in the interview that things become apparent when she engages creatively. The relation between her concepts and her

practice determines which digital technology or digital medium will be used. When describing her interaction with technology, Kiki Smith stated:

> I always say that things become apparent . . . you have an idea to do something or make something or draw something, whatever, and everything you engage with has some technological aspect to it. Sometimes it is technology that is no longer current but it works, and some is more current and up-to-date, which sometimes works and sometimes doesn't. You just gravitate towards what you need. If you see that you are doing something that would be facilitated by a given technology, then you use it. I also make multiple representations of the same piece with the same idea, using different technologies, different methods or different materials.

Through analysing Kiki Smith's interactions with technology, the artist-researcher observed that she uses different methods, and that depending on the project she is working on, she would opts for an analogue or a digital approach. Through these observations, the researcher understood that her creative strategy involves following the influences of a concept or idea that evolves and changes as the work develops. However, when working on her sculpture, she favours hands-on work, followed by 3D scanning. Once a sculpture is digitized, she plays with the form data from multiple perspectives. From 3D to 2D representations, the data output is made into a sculpture, a print, or a tapestry. The analogue artwork is then reworked in a material form by hand and transformed again. The ease with which Kiki Smith's creative process navigates from analogue to digital and digital to analogue and from 3D or 2D perspectives is fascinating. As she described it:

> I think it just depends on what I'm doing. I like doing something by hand . . . then working on it by computer . . . then having it come out again of the computer again to be either printed or woven or made into a sculpture or into a print . . . and then cut by hand.

In Kiki Smith's creative approach, concept, and process are closely related and the artwork evolves from analogue and digital platforms simultaneously. Navigating from an analogue-digital-analogue method, Kiki Smith uses technology mainly to facilitate the production mode. However, everything can change in this process: Kiki Smith is open to the "unexpected" that can manifest during the creative activity. She does not anticipate what the work will be, as she also does not anticipate how the world should be. She stated:

> I don't have a way (or imagine how) the world is supposed to be or what my work is supposed to be I think that you just use . . . everything is fair game to be used or utilized, the different technology or methodology of working . . . you do it on a case-by-case basis, of what you think makes the most sense.

Kiki Smith's approach to materials and processes is grounded in her creative process from paper prints to paper sculptures to bronze castings and from bi-dimensional to tri-dimensional artistic propositions. Her great capacity to move easily from a 2D medium to 3D sculptural form is evident. When she was asked if her working method is analogue or digital or analogue and digital or analogue digital analogue, she stated:

> I mean . . . just different methods, working with different materials . . . it changes if you make something in metal or in cloth or in paper . . . I have recently been making drawings, then I make it in book print, then a collage. I have been making them into tapestry and into low relief cut out bronzes, so you know in the end, I got three or four pieces that are very similar in image, but have a very different feeling about them depending on the material that they are made of or depending on how they are made. I have been doing a lot of tapestry lately . . . which radically changes how I can think about traditional tapestry-making, even though it comes from the early 1800s it is still a technology that can be utilised in a very contemporary way.

When asked if her original idea is based on an analogue or hands-on interaction to space, material, and process or based on a digital spatial perspective, she stated:

> I think it's both. I think it just depends on what I'm doing. I think that often I like making something by hand and then scanning it into the computer either for a two-dimensional or three-dimensional aspect and then working on it on the computer and have it come out again of the computer again either to be printed or woven or made into a sculpture, or made into a print than you would could cut by hand . . .

In regards to a digital and technological approach to sculpture practice, she commented:[47]

> I think digital computer work . . . there are a lot of interesting things (that can be done), but there are tremendous limitations too. It not particularly graceful, but it does afford you to move in a relatively fast manner or change scale, both things that you were not able to do . . .

4.1.5 Creative Process: Interaction With a 3D Digital Environment

One of the main characteristics of Kiki Smith's approach to technology is the ways in which she uses the same data to create artwork in various mediums, such as drawing, collage, tapestry, or low relief bronze sculptures. She explained that the artworks produced are "very similar in image, but have a very different feeling about them depending on the material they are made of, or depending on how they are made." Kiki Smith embodies a creative process in which the artwork "moves" with her. The work methodology is never fully resolved or planned from start to finish but evolves through its production mode, using analogue to digital means. Kiki Smith explained:

> . . . As an artist I am looking to experience something and . . . it moves. . . like I made print, I made a large etching and I thought, oh! that would be great also to make a scarf out of, to make digitally-printed scarves, you know for me it was something I worked on for a year or something as a

> traditional etching, a *Kat Fowler* etching and then I thought that . . . things can have multiple lives . . . and it just moves . . . things move around.

Although sometimes she develops ideas for which she plans on using the computer, she generally works by hand. The computer environment now and then becomes a source of inspiration from which she addresses 2D medium works and uses the Internet as a search engine. She explained:

> . . . but for other things, I think immediately that I want to use the computer, I look up pictures of things and draw from those pictures, as a resource the way you use an encyclopedia. But in terms of digital information as a mathematical situation I don't know . . . I suppose there are things that I think you could make, to begin with digitally, but I don't do it, for the most part. Generally, I start with something handmade, that I have made, and I may do something to it.

Moreover, when asked if her ideas start with a 2D digital image and develop further into 3D sculpture concept, she answered: "I think those things go back and forth." When asked if her original ideas are based on a hands-on or digital perspective, her response was, "I think it is both. I think it just depends on what I am doing." Furthermore, when the last question of this section addressed her creative process and looked into a hands-on or digital spatial context, Kiki Smith stated: "digital is just another . . . it has aspects that are useful and aspects that are big drawback, you know but like both ways of working."

Kiki Smith's conceptual approach is primarily motivated by her drive to create. Depending on what she intends to make, she will opt for analogue or digital approaches, on a case-by-case basis, depending on the idea she is working on. Kiki Smith experiences creativity through her senses. When she works on sculpture, she "senses" the work more intensely by making it by hand at a medium to small scale. From a

practical perspective however, it can be observed that the ways she interacts with digital technology is more often subject to technical assistance.

4.1.6 Software and Technical Assistance

Examining the ways in which the artistic concept and the artists' sensibilities are expressed and developed through data visualization and transformation strategies, as well as the manner in which the data is created, imply looking at creativity and tools from two different angles: artists' sensory experience and the tooling or computer software they used. Kiki Smith always requires a technician's assistance when working within a 3D digital and technological context. Once the original handmade sculpture is completed, the technician digitizes the sculpture form (3D scanning) and works closely with Kiki Smith on the digital object manipulation and transformation. When asked if she uses a 3D software interface when she creates her work, Kiki Smith replied:

> No, I don't know how to do anything like that. Even when I use the computer I have to sit next to somebody doing it. You know, when we use Photoshop, I can do a couple of things, but I have to basically sit with somebody doing it . . . . I don't think I use any 3D software . . . at the Digital Atelier I have . . . actually, I have a couple of pieces I made, but I think I made the original drawing still, so we still vectorize things, though. I made drawings that we vectorize up, but I got the closest to something workable for computer information by doing it by hand . . .

Evidently, Kiki Smith's creative process is triggered by an analogue approach to creating and conceptualizing drawings, prints, sculptures, or any artwork in any medium. However, following the hands-on work, the data is further processed through the computer, where technical assistance vectorizes her 2D drawings or fixes 3D scan data. Kiki Smith does not consider the data processing stage as being creative, as she only uses it to fix things. She stated:

> . . . I try to think about as many aspects of it as possible before I put it in the computer. With the computer we fix things up, but even that's not making sculpture, but just vectorizing so that they can be cut, water cut . . . you know, maybe once or twice I have used 3D something or other . . .

In Kiki Smith's works, many software programs and applications are used, such as Photoshop (2D), Innovmetric (3D scan post-processing), and Picza (scan post-processing). When a software program is used for her work, a technician always assists her. Photoshop is the only software with which she feels at ease and with which she can, to a certain extent, work independently, although she still experiences creative limitations and requires technical assistance.

When Kiki Smith works on 2D drawings or print projects, she uses a flat bed 2D scanner to import data into the computer. When Kiki Smith creates small-size jewellery or small- to medium-size sculpture works, she uses a 3D scanner, such as the Artech hand-held 3D scanner (Walla Walla Foundry), the Romer rotary 3D scanner (Digital Atelier), the Roland 3D flat bed scanner (Walla Walla Foundry), or an MRI medical scanner for hospital use.

The data structure is directly linked to the technology and software used. When working in Photoshop, the data structure is a bitmap. However, when Kiki Smith's work is 2D scanned and the scan data is imported inside a 3D software interface, the data structure becomes vectorized (NURBS[48]). When 3D scanning technology is used to digitize her sculpture works, the data structure is either a point cloud[49] or a polygon mesh.[50] Most often the data is saved in an STL format.[51] During the interview process, Kiki Smith never mentioned using a 3D modelling approach to create data objects, which indicates that she never builds forms inside the 3D software interface or works with

NURBS. However, when data is imported from 2D to 3D, the vectorized data may be slightly transformed.

4.1.7 Artist's Creative Approach: Impact of 3D Software on Artistic Concept and Artwork Aesthetics

When asked if the software interface influences her concept, Kiki Smith stated, "I suppose it does in a sense." Kiki Smith explained that she mostly uses Photoshop, but when she works with technicians she does not always know what the visual outcome will be:

> I use Photoshop mostly, and the technicians can do things and can't do other things, so you try to utilize whatever aspect or property . . . you can imagine doing something but it is not necessarily that . . . Sometimes I work with people who are very technologically engaged and they all have different ideas about what you should be doing, but my work is not very tricky, so I am not trying to be clever in it . . . often I can see that there is tremendous potential in all different kinds of technology, but it does not mean that it's something that really inspires me to make something I can appreciate it, but it doesn't mean that I have any idea of what I want to do with it . . .

Evidence of digital manipulation in her drawings and prints can be observed. For example, in the work entitled *My Blue Lake*, 1995 (Figure 13), the visual aesthetics of the print is influenced by digital manipulation of an original drawing. To support this observation, Kiki Smith explained that she manipulates data from scanned drawings, and stated: "I have scans of drawings I have made . . . then we work with them digitally . . ."

Figure 13. Kiki Smith, *My Blue Lake,* 1995, photogravure and lithograph in 3 colours.

However, in her sculpture works, she does not manifest the same engagement with the digital medium or digital object transformation. She mostly digitally manipulates the 3D scan file for scaling purposes or to fix technical problems on the scan data. Very often scan files need to be repaired before being printed and, as Kiki Smith stated, she digitally sculpts the data if it is needed to improve the digital object technically, rather than for aesthetic motives, as she did with the crescent bone:

> . . . maybe a little bit, like I had a corner of a bone . . . a crescent bone, and I think that it's too flat or too thin . . . making something have more volume but it's not really playing, it's just expedient; to make the form better . . . I'm using it as a tool . . . Okay, this thing is too thin, we have to thicken it, we have to make the edges prettier, something like that, and both of those things still have to be worked with afterwards by hand, you know, into an actual object. . . . I use it in a very old-fashioned way, just the way you would scale something up or . . . just a relatively rudimentary way of working.

When she engages with sensory experiences, Kiki Smith's creative process always brings her back to the material object.

When Kiki Smith was questioned about the ways in which the digital spatial context may influence her creative process, even though she acknowledges that the computer "can be an enormous resource," she indicated that she only uses it when she senses that an idea necessitate its use. She does not particularly like sitting in front of a computer, as she is not inclined to do so: ". . . the thing about digital is that people have to sit at a table, sit down for hours and not move and I don't think that generally that's a good thing to do." She sometimes uses technology in a creative way, but she certainly does not deeply engage with the process. As she stated, ". . . I only use it when I think there is something for me to be doing. I don't think, like, I want to go sit in front of a computer for ten hours, and that it would be fun."

4.1.8 Capacity of the Digital Medium to Translate Into Other Art Forms

Digital object manipulation is not something Kiki Smith explores very much as she creates works. She only uses basic features of the 3D software interface. As she stated, she uses 3D digital technology "just in a very rudimentary way" and mostly to facilitate sculpture processes. However, the ways in which her work moves through 2D mediums, such as drawing, photography, printmaking, or tapestry, and also the ways she translates 2D works into 3D, show that she does explore this concept of plurality of the digital medium, up to a certain extent. Although the mediums she translates her work data into have a very similar coded structure, Kiki Smith still allows for multiple interpretations of the data source.

4.1.9 Experiencing the Unexpected

When Kiki Smith was asked if she feels that she can experience the unexpected when playing with digital data, she said that she does not really play with the data in ways that would allow the unexpected to happen and stated:

> I don't think I really use it that way. I mean I have done things where you can draw on those mouse pad things . . . the thing is that I really do use it in a very rudimentary way. I am not sophisticated in that way. What I am doing is: if I see something that I think is useful I will . . . utilize it.

One way to describe Kiki Smith's relationship with technology would be to say that she is not very technologically engaged. That does not mean she does not use technology, but rather that she does not feel particularly inspired by it. As she explained:

> . . . often I can see that there is tremendous potential in various kinds of technology, but it does not mean that it is something that really inspires me to want a make something. I can appreciate it, but it doesn't mean that I have an idea of what I want to do with it . . .

Through the interview process, it became clear that Kiki Smith's creativity is bound to some form of physical interaction with the work, which is an important aspect of her creative approach. The passivity inherent in computer activity does therefore play a role in her reluctance to fully engage with technology. However, she is curious and always interested in collaborating with people who are technologically engaged. She experiences a certain kind of freedom through collaborative work, while also acknowledging that creative activity is linked to decision-making, self-organisation, and artistic autonomy. This concurs with Boden's (2010) observation, "Freedom is often compromised as a result of . . . just plain ignorance" (p. 182). All three artists interviewed experience creative obstacles caused by a dependence on technical

assistance. Hence, greater comprehension of software interface and in-depth technological knowledge would increase artistic autonomy and therefore impact creative freedom.

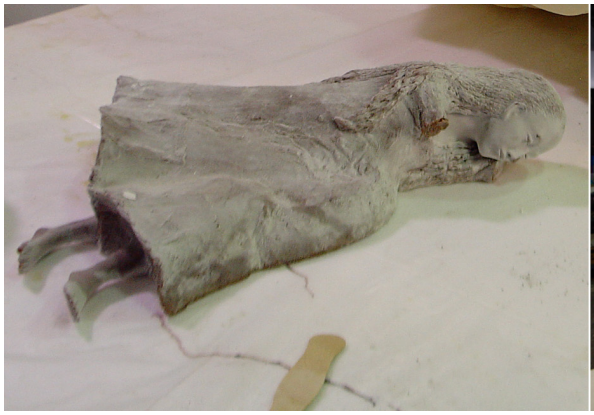

Figure 14.1. Kiki Smith, small size wax model for *Women with Sheep*, 2009, ready for 3D scanning.

Figure 14.2. Enlarged and duplicated CNC milled Styrofoam form from the wax model scan data.

4.1.10 Data Structure, Data Object, and Data Space

Observing digitized forms shows that Kiki Smith does work from 2D vectorized drawings data and manipulates it but, her original work is always first handmade, and then scanned. Kiki Smith manipulates data from digital photography that she transposes into photogravure and lithograph. In her work *My Blue Lake* (Figure 13), the artwork aesthetics indicates a digital manipulation of a photographic image, although a hands-on lithographed work is used as a printing process. Most often the digitizing of forms is for scaling purposes (Figure 14.1) or to fix the form thickness and rebuild spiky edges. With 3D works, Kiki Smith does not really play with digital data to create something visually different. As she indicated, she uses 3D software interface toolbar options in a very basic way, approaching it just as a tool. More importantly, she always modifies the result later by hand, re-working the surface of the RP CNC milled sculptural object

(Figure 14.2). She also duplicates forms to create large sculpture installation works, such as the cast bronze installation titled *Women with Sheep (Three Women, Three Sheep)* (Figure 14.3).

Figure 14.3. Kiki Smith, *Women with Sheep (Three Women, Three Sheep),* 2009, bronze.

Kiki Smith's relationship with forms and objects is not primarily influenced by the 3D software interface, she basically use it for scaling and duplicating. As she indicated, she uses it "in a very rudimentary way." Moreover, her creative approach and sensory experience are influenced by the creation of palpable sculptural objects and their interactions within an analogue spatial context.

4.1.11 Creative Spatial Context

Because Kiki Smith's works develop primarily inside an analogue spatial environment, she engages with digital mediums more creatively inside a 2D perspective. This could be perceived as a consequence of the ways in which she experiences greater freedom and spontaneity when working on a 2D software interface platform, such as Photoshop, compared with when she is entirely dependent on technicians' assistance when working with 3D software. Software knowledge does influence artists' creative

exploration, but Kiki Smith's creative process is driven by a hands-on approach where sensory knowledge influences her creative investigation.

4.1.12 Working With 3D Digital Technology

As Kiki Smith explained during the interview, she works with an independent sculpture production studio lab where they do not print prototype of the scanned sculptures: "we don't print them. We just use scanners. We scan it and then either it's made large by cutting foam, which I don't do anymore. I just cut moulds now and they just cut the moulds in plaster." Today, Kiki Smith uses RP CNC technology to cut large moulds from analogue sculptures scan data.

4.1.13 Artist's Creative Approach: Rapid Prototyping

When Kiki Smith was asked if she uses 3D printing creatively or if she thinks it can be used in creative ways, she confirmed having used it once for the skull project where the MRI file was simply printed. She did not manipulate or transform the data of the digital skull representation other than scaling it. When Kiki Smith was asked if the 3D print of the skull was the final sculpture, she said, "No, no, I just used it to make a bronze sculpture." Besides the skull project, she does not use 3D printing in creative ways or at all.

4.1.14 Artist's Creative Approach: 3D Printing or CNC Milling

Looking at 3D printing and analyzing how it can be used in creative ways and be directly linked to the artist's creative process implies looking at the print material as a final sculpture or as a step preceding the final cast bronze sculpture. As Kiki Smith explained, she experienced 3D printing when she had an MRI done of her skull. She

Figure 15. Kiki Smith, *skull*, 2000, cast bronze and engraved Latin words.

then collected the data and 3D printed it to cast it in bronze. Although she transferred the skull data in 3D print format using RP technology, she reworked the printed object by hand before casting it in bronze. In addition, she engraved a text on the cast bronze skull surface. Kiki Smith stated:

> . . . I had a CAT scan made of . . . an MRI of my skull with two parts, made fifteen years ago . . . I went to an hospital where they made an MRI of my skull and then we printed the skull out in a 3D machine, and then I carved into it and we made a bronze from that. So that's one time where we did use a 3D printer. But then I still brought it back into my hands and I hewn into it.

Kiki Smith always ends up transforming the printed data through analogue creative means and even though she uses 3D technology to create the work, final hands-on work is applied. Aside from the skull project, Kiki Smith has not use 3D printing very much in her creative process. During the interview, she recalled, "I only did it once with the skull about eight or ten years ago. It is the only time I ever did something like that. I never made anything like that before." On the cast bronze skull sculpture (Figure 15) are engraved the Latin words *Vis consilli expers mole ruit sua*, which translate into

"Force without wisdom falls of its own weight" (Smith, 2013b). As with other works, Kiki Smith uses RP to facilitate sculpture processes, but the final artwork is most often cast in metal.

To resume how technology influences the mode of production of Kiki Smith's artwork: when using CNC milling in the early 90s at the Digital Atelier, Kiki Smith enlarged her small sculpture from the 3D scan data. The sculpture was scaled up and milled in Styrofoam. A decade later at the Walla Walla Foundry, Kiki Smith cast a wax positive[52] inside the CNC milled or cut plaster moulds from her 3D scanned sculpture. Using the lost wax process, the wax sculpture was cast in bronze or aluminum.

4.1.15 Artist's Technological Approach: Digitizing Tools

Today, Kiki Smith uses 3D scanning technology in her creative process to create large-size sculpture projects. She starts by modelling a small-size sculpture or jewel by hand. She uses 3D scanning technology to digitize her analogue sculpture form. But, when she works in 2D, she uses a regular bed scanner to digitize her original drawing or photograph and import the data into a vector graphical software interface, such as Illustrator (2D) or Rhino (3D).

4.1.16 Artist's Technological Approach: Manipulating and Transforming Data

When Kiki Smith was asked if she manipulates, transforms, and digitally plays with scan data, she acknowledged that she does so only when she is assisted by a technician. As she explained: "we just move it around when we need it. We just change it as we need to change it, just to make the shape better . . . I always think okay, it's all experiential." Kiki Smith does not manipulate or transform data object to create new work; she uses digital technology as a tool to improve the scan data. She stated: "No, I

just use it to fix what we have done or to make what we have done better. I don't really use it as a material itself . . . I just use it like a tool."

4.1.17 Preparing Files for RP Process

Kiki Smith does not prepare files for 3D printing or CNC milling. She works with people who know how to do so. As she explained: "I don't know how to do any of those things." Kiki Smith expressed that she enjoys working with those who have knowledge to share. Since she has no interest in learning the specifics of the technology, she works with technicians throughout the creative process almost as if they were an extension of her. This technical assistance does not affect her relationship with the artwork. She stated: "I am used to working with people all the time, you know, people that have knowledge of a particular technique or skill that I don't have; it is a very normal process of working for me." Kiki Smith acknowledged having limited knowledge of digital tooling and that she finds working with others enriching. She sees this form of collaborative work as an exchange of creativity and feels great satisfaction in this process of skill-sharing. She stated:

> I mean, I don't know how to do a lot of it, and I like working with people. I find it a pleasure to share in their creativity. You get to use other people's skills, which is better than only using your own.

4.1.18 Service Bureau

Kiki Smith works in collaboration with private artwork production companies and art foundry studios like the Digital Atelier and the Walla Walla Foundry, both of which are located in United States.

4.1.19 Re-Working the CNC Milled Form

When Kiki Smith was asked if she reworks the printed form, she promptly responded: “Yes, of course.” Once the digital object has regained its physicality, Kiki Smith always steps in. She modifies the cast wax sculpture and the cast bronze sculpture again; she intervenes at every single step of the process. Even after the CNC milling of the mould, every step of the process that allows her to create something new is explored. She described this particularity of her creative process as such:

> I don’t work on the moulds. I don’t do anything. We just have the moulds and then we make the wax. I change the waxes as I want to. First we change maybe a little bit on the computer and then we change the waxes . . . then I change the metal. I change everything every single way; every single step I change it.

Kiki Smith’s creative process is a work in progress, an ongoing creative activity in which there is a true correlation between concept and production, as if the work is continually re-invented. The ways in which her interactions with a digital medium influence her artwork aesthetics is also subject to the production mode of the artwork and varies constantly. Her work is representative of a strong belief in the relevance of object-making in sculpture installation practice, meaningful objects reflecting through physical representations of social, historical, political, mythological, or feminist issues; her profound sensibility; and her sense of creative freedom. A heuristic creative approach is reflected throughout her creative activity from precept-concept to percept.

4.1.20 Combining Digital-Analogue Artwork Output

As observed, Kiki Smith combines analogue and digital processes and her artwork output always proposes a palpable object. For Kiki Smith, sculpture installation

art remains representative of an artistic discipline linked to the creation of physical objects. When asked if a sculpture work could be a digital representation of an object or if it has to have a physical content, she replied:

> . . . that's up to the individual artist . . . but me, I like making things. I want to be able to see them outside of a computer . . . it doesn't mean that it can't have. . . maybe a sculpture can be a projection or something . . . a tri-dimensional projection or something. . . For me the whole reason to make sculpture is to be able to put something outside a body that I can look at, and outside a computer . . .

The physical object as Kiki Smith described it is a meaningful object that engages the viewer and conveys a presence. Even though she likes making things she leaves it open to many forms of representation, adding:

> . . . I don't really find looking at a computer all that engaging . . . for the most part, it's not that I want to get close to it particularly but I can imagine that kind of information and project . . . I think that's just up to the artist individually, artists can define what they do anyway they want.

4.1.21 Artwork-*NetArt*

Kiki Smith is very much connected with her time, being "the time of the here and now" (Lipovetsky, 2005), and therefore she is open to change. When asked if she envisions that she could create work that would be digital in its final form (*NetArt*), she replied:

> No, not really . . . I mean I am not attached to my version of life either . . . things can change, everything can change within two years or six months or two weeks. I can think, oh yeah, that's a good idea, I want to do that, but at the moment I don't do that . . . I haven't felt that in the past, so far I haven't done that at all.

4.1.22 Technological Approach: Scaling and Duplicating

When Kiki Smith was asked if she uses digital technology mostly for scaling and duplicating purposes, it became clear that technology means much more to her than what she uses it for and she answered: “For me, I don’t see it like that, but that’s how I have used it. I see that it can do anything, but for me it’s how I have used it.” In this way, while Kiki Smith knows what technology can offer as a creative medium, she does not actively explore its creative dimensions.

4.1.23 Rapid Prototyping Combined With Other Processes

Through sculpture production modes, Kiki Smith combines RP[53] technology with another transformative process: metal casting. Kiki Smith’s idea of the artwork output often implies the production of a bronze or aluminum casting of the sculpture concept. In fact, she uses RP technology because it is expedient. When comparing RP with more traditional analogue processes used for the production of cast bronze or aluminum sculptures, RP technology significantly reduces the production time and facilitates the process. Kiki Smith explained that she uses technology as an “expedient way of working.” She alleged, “I am only making things in foam or cutting moulds to make metal casts.” When asked how she sees the transfer from an RP print to a bronze or aluminum sculpture affecting the visual aesthetics of her work, she confirmed that she uses technology as a tool: “ . . . It’s just the practical way of doing it, making . . . the foam is just an expedient way of working.”

Even though Kiki Smith does not take an explorative approach to the digital object, she is very much aware of the creative potential of technology. She explained

that there is a new generation of artists who work with the Digital Atelier (former Johnson Atelier) in explorative ways:

> . . . a lot of younger people at Johnson use it in a much more extensive and contemporary way . . . as a fundamental part of what they are doing. I didn't do that. I quit by the time the technology got better.

As she acknowledged, Kiki Smith was pioneering with the technology, but in the past the technology was so experimental that it became frustrating for her to use. This is the reason why, with time, she stepped away from it. Today 3D digital technology influences her creative process in the ways it merges concept and practice. The artwork she creates from an analogue perspective at a small scale is technologically driven through a 3D digital mode of production.

4.1.24 Upcoming Ideas

When Kiki Smith was asked what she anticipates her upcoming ideas will address, she indicated that she lives in the present, replying:

> I don't anticipate. I just see what happens. When something occurs to me to do it, I do it. I don't really think about the future. I just see what's in the present moment . . . if at some moment it occurs to me to do it, I just go ahead and do it.

4.1.25 Views on the Future of Sculpture Practice in Relation to Technological Advancements

When Kiki Smith elaborated on her views of the future of sculpture practice in relation to technological advances, she suggested that sculpture practice is always influenced by technological innovation from a practical perspective and influenced by

social changes from a conceptual perspective. Consequently, it is always subject to change. Kiki Smith stated:

> . . . sculpture changes in relationship to technical advances—that's the primary reason to change. I mean there are social changes, but that's a very big one, so it will just continue to change, you know. We can't always anticipate what that would be like . . . I can't . . . I am not someone who can speculate about the future I mean I have no idea what the future will be. . . .
>
> . . . I am using a sort of outmoded technology for the most part of my work, like bronze casting, things that have existed over thousands of years . . . in general, I don't think about the future, . . . I don't think about the future other than if I want to get from one place to another, then I have to take steps, but I don't speculate. . .

When Kiki Smith claimed that she uses "outmoded technology for the most part," the artist-researcher replied by asking her if she has stepped away from using a technological approach in her creative process. Her response was negative:

> No, I just use it in the same way that . . . I don't make paper . . . I don't make the paper that I use, I don't make the pencil . . . I mean, it is different from making a mould, but whether a mould is made from digital information or whether it is made from taking a cast from or of something you know, its just a mould to make something with, so it's not something that I am interested in. You know, if I have an idea . . . I just use whatever I need to use . . . I mean, you can use all this technology, it's just . . . I don't know how to do it . . .
>
> But I do know how to grind metal and I know to some extent how to use Photoshop. I mean, I can select and use the mouse, some things like that but I have them push the button while I do it . . . you know it is like that.

With this last quote, the artist expressed how much technological knowledge constraints influence her creative process. Kiki Smith's creative freedom is affected by her level of technological knowledge or her difficulty in experiencing freedom of expression and spontaneity when working inside a 3D software platform with technical assistance. When Kiki Smith said that she knows how to grind metal, it is understood that she feels

autonomous and free when working with a hands-on approach. This affirmation is supported throughout the interview narrative.

Kiki Smith pointed to another important influence of artists' interactions with 3D digital technology: the generational factor. Kiki Smith admonished:

> . . . I hope you talk to somebody younger than me because I think there is . . . so much interesting stuff happening that's really engaging and . . . using that technology in an interesting manner and I am not. I just use it the way I would use a pencil or something, but I think that if I go out there, there are really a lot of things going on . . .

Selecting artists that belong to a younger generation would imply addressing questions to computer "native," as opposed to "non-native," users. Artists' levels of software knowledge and familiarity with the software interface elements would have possibly brought a different point of view to the study. Nevertheless, this study recognizes the influence of artists' contextual backgrounds on their creative approaches to technology and emphasizes that each participant's life experience provides a unique perspective that brings to this study a broad range of creative directions. In the following sections (4.2 and 4.3), the analysis of the data collected continues with artists Evan Penny and Trevor Gould.

4.2 Evan Penny

Evan Penny was selected as one of the participants because of the exploratory approach to spatial dimensions and the perceptual and observational process conveyed in his work. His fascination with the figure is a means to represent time and history through figurative concepts. Penny's work expresses a sensory knowledge of time and

an awakening to the technological influences of digital mediums in our society and in the arts.

4.2.1 Contextual Background

Penny, a Toronto-based artist born in South Africa, stresses the relevance of figuration in contemporary art. Two questions shape his work: "How to be a figurative artist and be contemporary at the same time? How to be a figurative sculptor and keep it interesting?"[54] Penny's work is influenced by observations rather than realism, and his principal subject is the human body. Penny's figurative works inquire into the ways in which we perceive each other and ourselves in real time, in photographs, or in the media. In the interview with Penny, he explained that the examines "How we imagine ourselves in the context of an environment."

At a time when the arts, design, and architecture are experiencing shifts from traditional linear perspectives to simulated computer interface perspectival elements, Penny's perceptual and observational process is also shifting through the influence of a digital framework. Rooted on an analogue production mode, Penny's spatial boundaries extend as new digital mediums emerge. Today, both the human subjects he explores and the digital medium he uses influence the way his ideas develop through enabling the creation of artwork using malleable and transformable data forms.

4.2.2 Contextual Background Leading up to Digital Technology

Penny recalled being first exposed to digital technology in the late 1990s and early 2000s through the film industry. He worked in special effects studios. Back then, cinema used digital technology through special effect features, and as Penny stated, "the

shift to the digital was happening in the film industry and so I first started by doing projects that were, let's say, hybrid projects" (Penny, 2012b). Penny was greatly influenced, conceptually and practically, by working in the film industry. Conceptually, it shaped the notion of observation in his work. As if from the camera's eye, he questions the real as the "illusion of the real" that the film industry promotes. Hence, the simulated spatial environment of the software interface presents an illusion of the real that he has already been exposed to. Practically, it influences his mode of production as he experiments with new materials and processes. He recalled how fortunate he was to have worked for a company doing research in silicone rubber technology: "It has exposed me to materials like silicone which is a *slice-of-life*, *illusion-capable* materials" (Art, 2007). Even though he insisted that his work is not about illusion but about representation, he acknowledged that the film industry pushed him to explore new directions in his work, stating, it "forced me to open up in ways that I probably wouldn't have" (Art, 2007).

The influence of the image is also significant in Penny's work. As with cinema, the photographic process within its digital dimension influences Penny's artistic work. In the early 2000s, Penny established a relationship between sculpture and photography, a relationship that evolved towards digital technology, which he directly applied to his creative process. In the interview, he stated:

> Within my own practice in the early 2000s, it shifted towards photography and the relationship between sculpture and photography, very quickly that would have been informed by digital technology that probably started happening only directly in my work, probably around about 2006 or 2007, prior to that it only had been applied, but not directly applied.

Penny's figurative style conveys, as he described, a "kind of traditional sculptural context." He feels the "need to create a relationship with history." With a view to defining this relationship with the *figure image* as a sculptural object, Davis Moss, the curator of the Art Gallery of Ontario, addressed Penny's work by stating: "The object-ness has a realness about it that no image can have" (Art, 2007).

Penny's work is thoroughly framed inside a hypermodern worldview rooted in modernism and reflecting Lipovetsky's (2005) concept of the "here and now." Penny's current practice is bounded to a 3D digital and technological context that influences spatial-temporal exploration in his work. Penny's perception and interaction with object in space moves from an analogue to a digital dimension. Penny's figurative works focus on perceptual means and questions how we imagine ourselves in the context of an environment. More recently, a digital medium and a 3D software spatial context have influenced his relationship with figuration.

In his more recent practice, direct observation is influenced by digital mediums that facilitate the passage from a 2D photograph to a 3D digital representation of the human figure. Traditional analogue processes, such as clay modelling and mould-making, are still used but are combined with digital and technological innovative production strategies.[55] Conceptually, Penny's works convey a relationship between human beings and their perception of themselves within a social environment saturated with images that permeate the spatial context. In his recent work, Penny defined this concept as "image-space," where the space positions the image that he turns into an object within the sculptural figure that he sculpts. He described his sculpture as being half object and half image. He defined space as "the space between how we experience

ourselves in real and how we experience an image simulating how we see" (Penny, 2012a). Penny's conceptual framework is set on this image-object relationship and questions "how an image becomes an object" (Penny, 2012a). The idea resolves itself and is defined through the photograph, not the sculpture. The sculpture is a projection of the idea inspired by the photograph transposed in three-dimension.

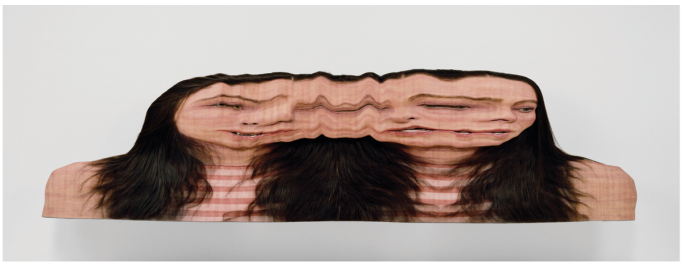

Figure 16. Evan Penny, *Panagiota: Conversation #1, variation #2*, 2008, silicone, pigment, hair.

Penny explained that in the last ten years, as his exposure to digital technology expanded from 2D to 3D, his work started to question how digital technologies affect who we are and how we imagine or represent ourselves and also what happens when a 2D feature is brought into 3D context. The work entitled *Panagiota: Conversation #1, variation #2* expresses this transposition of a 2D photographic image into a 3D sculptural form that brings in a trace or memory of a cinematic moving image (Figure 16). Penny explores the concept of instability of perception influenced by a 3D digital and technological context, as though the more information that is available, the more subjective and visually unstable the object becomes. It is as if he senses that a digital spatial environment influences artists' perceptions of object in space, a phenomenon that he described as causing an object to be unstable (Penny, 2012a). This instability is the

consequence of the porous nature of 3D digital objects and transcends the object itself to address a medium that Rosalind Krauss (1999) described as a "postmedium."[56]

4.2.3 Current Experience of 3D Technology

In Penny's practice, digital processes are used in combination with hands-on processes. As new technologies build on older ones, Penny uses more traditional, yet exploratory and inventive, ways of working. For example, although silicone rubber technology was traditionally developed as a moulding material, Penny uses it as a sculpting material. Through his artworks, he shows creative ways of working with technology from analogue to digital. Most of Penny's projects are technology driven. He uses 3D scanning, such as laser scanning or white light scanning, to digitize models or hands-on clay modelled figures and small-scale sculpture forms. As he explained:

> Pretty much all of my work at this point is funnelled through it, let's put it that way. I mean, I still view myself as basically a traditional figurative sculptor in lots of ways, but all my projects in some ways are channelled through some kind of digital process. Most specifically, I think it would be that I employ scanning, either scanning or a kind of photographically based, a digital capture of an image initially memorized for that.

In this way, digital technology is key to Penny's work.

4.2.4 Creative Process: Technology and Methods

Within Penny's creative process, interaction with technology develops right at the beginning, during the conceptual stage. As he stated, "it is embedded in the idea . . . the relationship with technology is in the concept." Moreover, the artwork production mode is also influenced by digital technology. In fact, technology defines the project methodology and as Penny suggested: ". . . it is a relationship between an idea and the methodology or logic that engages with it and that would differ from project to project.

The way I apply the actual digital capture is generally influenced by it." When Penny was asked about whether his creative approach is more digital than analogue or more analogue than digital, he explained that the work is always meant to regain a material form as sculptural object. Today, most of the time, Penny starts from a digital perspective; he 3D scans his model. When his approach to 3D scanning is compared with the more traditional life-modelling method he used in the past, it can be seen that the way his creative process interacts with technology reduces the time factor related to traditional clay modelling method.

In the past, Penny would basically start with sculpting the model in clay from direct observation. Then, during the course of the clay modelling process, he would photograph the clay sculpture and play with the 2D digital photo data on the computer. He would transform the image, study different options, and think about the direction his work was going to take. Furthermore, he would alter the clay sculpture by hand, guided by the digital manipulation he had done in 2D. Today, this method has shifted to a 3D digital mode of production. The clay sculpture is 3D scanned and manipulated digitally inside a 3D software interface environment. Later, the data file is sent to the printer or CNC machine and a Styrofoam sculpture is milled or cut. He also uses body digitizing and 3D scans his model and then plays with the data digitally, CNC milling it in Styrofoam.

4.2.5 Creative Process: Intervention With a 3D Digital Environment

Penny's concept of observation is key to his creative process. His perception of the figure is influenced by the perspectival attributes of a 3D software interface spatial context. As an example, in the sculpture titled *Jim Revisited* (Figure 17.1), the standing

figure posture presents a formal appearance reflecting the perspectival quality of the interface configuration that was not present in the original *Jim* sculpture (Figure 17.2).

The ways in which Penny's creative process interacts with a 3D digital context is guided by his perception of the figure as he shapes its digitized data and manipulates the form inspired by the malleability of the digital medium. The 3D data manipulation is done with technical assistance, which represents a form of creative constraint for him.

Figure 17.1. Evan Penny, *Jim Revisited*, 2011, silicone, pigment hair, aluminum.

Figure 17.2. Evan Penny, *Jim*, 1985, resin, pigment.

Rapid prototyping technology is used to get a 3D print of a sculpture prototype. Later, the digital sculpture is enlarged and CNC milled in Styrofoam. Once the Styrofoam sculpture is ready, as he explained during the interview, "the rest of the process is analogue." Penny applies clay over the Styrofoam sculpture and adds details or character to the clay figure. He reiterated: "Then pretty much from that stage on it's all analogue . . . sculpting, then mould-making . . ." During the production mode, the final clay model is moulded and a silicone rubber positive is cast. It is important to mention

here that Penny's creative process extends into the production mode. When casting the silicone, he adds features through the layers to enhance the realistic and visual impact of the artwork. Therefore, up to a certain extent, the work continues to evolve and develop during the production stage. Sometimes the work is subject to another digital process before Penny engages with an analogue approach again. His creative process is guided by his motivation to bring the subject of his inquiry, as he indicated, "back to the way we experience it in real time and space."

Penny's creative process is influenced by a spatial-temporal dimension inside which the representation of the self is important; the ways we present ourselves or "project our own identity onto others" (Penny, 2012a). The self represented in the work belongs to a spatial-temporal context and as Penny explained:

> . . . most all of the work or grounding principals is that I try to situate the work sculpture that I make . . . somewhere between the way we imagine ourselves in real time and space, and . . . the way we imagine ourselves through the image, whether that is photography, or digitally . . . . The initial position and the main motivation is to bring it back to the way we experience it in real time and space.

Experiencing the work in real time also involves the viewer's relationship to the artwork and it is essential for Penny that the work be physically and sensorially engaging. Penny likes to anticipate what type of technology he is going to use. Before engaging with an artwork, he plans in advance how to proceed from one project to the next. He explained:

> . . . most of my work is very systematic; the technical process is dealt from piece to piece. The pieces themselves vary, but it is not like researching new territory in terms of the technology each time. Maybe, initially in the process, when I was first working digitally, it might have been less truthful, but at this stage it seems (each time) anyway that it's a fairly constant kind of relationship.

Penny's creative process addresses very specific problems raised through conceptual and practical perspectives. Problem solving is often dealt with through technological tooling.

Despite his production mode being controlled, Penny is always creatively engaged with it; therefore he is open to "the unexpected" experienced through creative activity. This unpredictable aspect of the process appears to be more present at the beginning of a project, when distortion and manipulation of a 2D photograph or 3D scan representation is done prior to transferring it back to a 3D analogue mode.

4.2.6 Software and Technical Assistance

Penny works mostly with Photoshop to manipulate 2D images. He also works with 3D Z-Brush software but is assisted by a technician when he uses 3D software to work on 3D scan file manipulation. He acknowledged feeling dependent on the technician's assistance, but conceded,

> . . . it certainly helps me achieve my goals, I couldn't do without the technician otherwise. But I am aware that it is a very limited stage . . . because I don't have the expertise, I am limited to what they can come up with . . .

Penny experiences creative constraints caused by his lack of expertise with 3D software work. He admitted that the knowledge constraints he faces limit his action to simple digital data manipulation, but if he was able to explore and be at ease with the 3D software elements, new questions would come up and stimulate his creativity. He stated:

> I think in my case, because what I'm trying to accomplish is actually very simple, it's not that big of a deal. I can imagine however, you know, if I had more expertise, I might be able to perform an action and then certainly different questions would arise and motivate the process.

It can be understood that technological knowledge and creativity are intertwined, even more particularly when creative innovation stands on a software knowledge linked to a digital platform. However, technical assistance, and most of all collaboration between artists and computer-skilled people, can open artists' ways of engaging creatively within interactions with digital mediums and technology. In this way, collaboration with others influences artistic concepts and processes. The philosopher Henry Nelson Wieman[57] suggests that creativity is dependent on the ways artists are open to receive from others and be inspired through this interaction and says, "how creative we can be depends radically upon the extent to which we open ourselves to the influence of others" (as cited in Hartshorne, 2011, pp. 131-132). Wieman introduced a concept that he defined as "creative interchange" and added, "being creative is a social phenomenon" (as cited in Hartshorne, 2011, p. 131).

Penny senses the creative potential within this form of "creative interchange," but he pointed out that when working with different people all the time he could not establish a continuity that helped him in this regard. He explained: " . . . sometimes it's a different person, so I work with two or three different people I haven't established a constant rapport, a kind of continuity that is necessary in this process of creative interchange." In this way, Penny experiences collaboration in a mode that does not allow for this opening to the influence of others and exchange of thoughts and feelings that can optimise artists' creative activity, as defined by Wieman (as cited in Hartshorne, 2011, p. 131).

Both Evan Penny and Kiki Smith share a similar concern that their creative interactions with technology do not provide a context in which they can have creative interchanges with others. To establish a constant rapport or continuity with an assistant or

technicians in a creative context of shared technological and sensory knowledge seems to foster creative freedom. This proximity with a technician favours an exchange of thoughts and feelings and promotes the technician's understanding of the artist's creative intention. Consequently, this close proximity influences artists' interactions with the digital medium, through which technical support becomes an extension of their own perception of the spatial environment.

4.2.7 Artist's Creative Approach: Impact of 3D Software on Artistic Concept and Artwork Aesthetics

Artists' interactions with forms in space are subject to the spatial boundaries within which artistic activity takes place. The 3D software spatial configuration influences the ways in which artists' ideas take shape through a creative activity inside a digital spatial environment. When Penny was asked if the software interface influences the ways in which he develops his concepts, he replied: "whatever we can come up with, that's what I will work with. I'll have a broad idea, but in the moment, we will just be experimenting and seeing if we can do something that relates to the idea." Despite the fact that he has a general idea of where his project is heading, the knowledge constraints experienced through his technological approach lead to other explorative propositions. Therefore, his artistic concepts are influenced by the 3D software interface inside which unforeseeable actions take the work somewhere unexpected. As Penny explained: "Sometimes, something else will present itself or sometimes I will try a few options, and that can also lead to work quite spontaneously and unexpectedly."

The digital spatial context influences artists' relationship with objects in space. Penny expressed how his creative process is influenced in this way:

> I'm aware that on a really specific level, on an individual sculpture project level, the image that I am able to get from the process is shifting the way I imagine an object in space. For instance, the way it's presented me to very unpredictable solutions, solutions that I would not have been able to anticipate or come up with on my own.

However, when Penny was asked if the software interface influences the meaning of his artwork, his response was negative; his sculpture concept embeds a meaning that is not defined by any kind of digital manipulation. The software interface therefore has no impact on the meaning of the artwork but does influence the artwork aesthetics.

4.2.8 Capacity of the Digital Medium to Translate Into Other Art Forms

Penny does not explore how the data object can translate into various art forms through digital convergence, but, as he stated, his work is figurative and focuses primarily on the relationship between 2D data and 3D sculptural objects: "To me it's strictly this relationship between that digital information and the digital image and the sculptural object . . . or figurative sculpture." However, it can be seen that in Penny's creative process, 2D photo data manipulation is used to guide his 3D hands-on intervention of the modelling of clay figures.

The technological environment of the 3D software interface influences artists' interaction with data visualization. What artists' see on the computer screen as a bi-dimensional image is in fact experienced under 3D perspectival computerized conditions. Penny perceives this 3D digital image as an image-object. Hence, the 3D software interface environment influences his perception of objects in space. Penny explained that this phenomenon brings closer together a 2D process—such as photography, which is central to his creative process—and a 3D process. Penny affirmed:

> Well, for me, it still extends from a relation to photography. So, to some extent I'm interested in the shift from photography to digital. Not in the ways that it has shifted the work, but in how we understand an image, or the idea of an image, and that image that is now in my mind has become much more of a tri-dimensional idea. I think that most of us probably when we think of the word image, we associate it with a two-dimensional concept. I think with the digital, we are finding ourselves in this kind of strange new relationship with an image that is now tri-dimensional or has a three dimensional attribute. So, for me, the idea that the image can be embedded in the object is probably my prime concept towards the digital. We are shifting from an analogue or conventional photography or even a digitally based photographic 2D process to a 3D one.

The aesthetics of his artwork reflect this image-object interrelation. For example, in the series titled *Female Stretch*, Penny deforms the sculptural figure and the work aesthetics creates a visual ambiguity (Penny, 2014). It can be sensed that Penny's creative process is driven by digital photographic image manipulation that extends towards 3D digital object transformation.

4.2.9 Experiencing the Unexpected

Penny suggested that the concept of experiencing the unexpected through creative activity is present in digital space. Penny stated that he perceives digital space as a unique spatial environment and that its uniqueness fosters unexpected results. He elaborated on his relationship with the digital spatial environment as follows:

> . . . that's a kind of a unique space that I am trying to squeeze my ideas through . . . and that context is altering the idea in the process, so there is always something unexpected from time to time . . . and you have to work with it. So then you kind of go with that . . . I think that's the case with any medium though, it's just a normal process . . . of visualizing or being engaged in a process where you are building or representing something. The technology offers something, but also it is very limiting of what you can do, or what it presents to you . . .

Technological limitations are at play again within this context of experiencing the unexpected since Penny's experience of digital space is subject to technical assistance. When Penny was asked if he feels limited by a mathematically controlled environment, he confirmed that his limitation was a result of needing hand-holding assistance. He stated:

> I guess I feel limited by it, but also I'm sure that's because I'm standing behind a technician basically doing the work. I don't have necessarily all the skills to understand how to create solutions. But at the same time, I'm interested in that limitation, a particular sort of moment that the work . . . holds a kind of truth. The idea has to confronted and resolved thoroughly . . . so the artwork can happen.

Penny is interested in the ways in which his work is influenced and inspired by this limitation caused by a lack of software knowledge and capacity to go beyond what the technician accomplishes. It is quite interesting to recognize that Penny sees this creative constraint as bringing a kind of authenticity to the work. Penny's creative process is very much open to experimentation and experiencing the unexpected, the constraints of which he sees as being essential to creative activity.

4.2.10 Data Structure, Data Object, and Data Space

In Penny's works, scanning technologies are used mostly to create 3D scan files of his life modelled clay figures or to body digitize a life model. The scan data structure varies from polygon mesh to point cloud. Penny does not process the digital data himself but is assisted by a technician. Two different scanning technologies are used to digitize his work: a white light photographic process and hand-held 3D laser scanning process.

The way Penny interacts with digital objects is guided by the unexpectedness that he experiences from the creative obstructions his work is subject to inside the digital

spatial context. Even though he manipulates 2D digital data, he does not fully engage creatively with the malleability of 3D digital objects and cannot fully anticipate the visual outcomes. Therefore, when he was asked how he perceives a digital object, he replied that besides being very interested in the tri-dimensionality of it, the digital form itself remains outside his comfort zone. However, to a certain extent, Penny is able to rotate the digital sculpture form to study it from different perspectival views. Penny questioned the coherence of the sculpture representation in real space and wondered:

> . . . would it still function as a convincing representation of ourselves? Would it still perceptually be convincing after all sorts of manipulations that I can make or that we can make that would take us into a completely other round, which no longer then would be something that we could look at and have any sense of tension . . . around the question: does this represent me?

Penny does limit his use of digital sculpture manipulation and transformation to basic software commands. He explained:

> So I limit my manipulation, the manipulation I make are actually very limited, very simple ones, because I don't want that object, that final piece, to deviate that far from a plausible kind of representation of the living in the virtual.

In Penny's creative process, the digital object becomes an object of transition between the digital representations of the sculpture and the analogue sculpture form. Penny admitted that materiality is in fact what he works with. He works with clay and transforms the clay accordingly to a 2D digital image manipulation or a 3D scan file transformation, which is then subject to scaling prior to being CNC milled in Styrofoam. The Styrofoam sculpture is then covered with clay and sculpted by hand again. Penny stated:

> . . . what I really do work with is material. I work with clay, so until it is in a clay form, I'm not really working with those shapes, or at least in my mind I'm not. What precedes this is a kind of very general image, where I'm manipulating the shape in broad and general ways, but basically I'm rotating the image, and then pushing and pulling and essentially scaling it in one direction or another.

Even though Penny's relationship with sculpture works is truly experienced from an analogue perspective while working with clay and later with cast silicone figures, the object conceptual frame is explored through visual object representation inside the software spatial environment. Digital manipulation of images and forms remain the focus of his main concept of "representation."

4.2.11 Creative Spatial Context

For Penny, the spatial configuration of the software interface, while a creative space, is a transition space. He stated: "I don't see it as the primary space. I see it as a space I have to move through." It is clear that it is not Penny's prime space. Similar to the creative process of the other two artist-participants, Penny is driven by the material output enabled by computerized fabrication processes.

4.2.12 Working With 3D Digital Technology

Penny is interested in the creative exploratory dimension of a 3D digital and technological context that extends sculptors' spatial boundaries. However, he acknowledged that, at the moment, he uses the technology mostly to facilitate sculpture processes. He does not truly create with it but experiences basic interactions with the digital medium using software tools and commands and, more importantly, computer-automated fabrication modes through which the sculpture concept regains materiality.

4.2.13 Artist's Creative Approach: Rapid Prototyping

Within Penny's creative process, RP technology, or more precisely CNC milling, represents one stage of the process (Figure 18). In his practice, the CNC milled sculpture result becomes part of his production mode strategy. As he stated: "It's a step in the process. Again, the work has to evolve through that." As with all three artists interviewed, Penny combines hands-on sculpting and CNC milling processes.

Figure 18. Evan Penny in his studio holding a CNC milled Styrofoam sculpture, 2009.

4.2.14 Artist's Creative Approach: 3D Printing or CNC Milling

For Penny, the 3D printing process, or CNC milling, is a way to get to a palpable tri-dimensional object and study the artwork outside a digital spatial context. It is a step in the artist's creative process and is never used or perceived as a mean to produce a final sculpture work.

4.2.15 Artist's Technological Approach: Digitizing Tools

As stated previously, when using technological tooling, Penny works with a technician who assists him with the digitizing process and the digital sculpture manipulation on Rhino or Z-Brush software. Penny uses 2D and 3D scanners to digitize images and forms, which he studies and manipulates digitally.

4.2.16 Artist's Technological Approach: Manipulating and Transforming Data

Penny takes photo shots of his clay sculpture works in progress and manipulates the 2D data until he feels satisfied with the visual result. Later, he makes changes to the clay model according to the 2D data file manipulation. After 3D scanning the clay sculpture, he once again creatively interacts with the data and digitally transforms his sculpture concept, to finally define the sculpture scale before CNC milling it.

4.2.17 Preparing Files for the RP Process

Penny does not prepare his file for RP processing; that is a done by a technician. He expressed feeling dependent on the technician or assistant. However, this technical aspect does not influence his creativity, as it is exclusively process-oriented at this stage. Therefore, technical assistance does not influence his relationship with the artwork printing or milling process. His relationship with the artwork fabrication process is primarily focused on the clay work through a hands-on analogue approach.

4.2.18 Service Bureau

Today, Penny's Styrofoam figure works are made at the Digital Atelier in the United States, which processes the digital files and produces the sculpture form (CNC milled on a 5-axis router).

4.2.19 Re-Working the CNC Milled Form

Penny does not work directly on the Styrofoam sculptures. Influenced by a digital and technological context that has extended his approach to sculpture practice, he now moulds the CNC cut Styrofoam and then casts a clay positive and sculpts the clay form. His transitive approach to technology allows Penny to study the various options or directions that the sculpture work could take without direct physical intervention prior to reproducing it in clay. It also cuts down his production time as he often body digitizes his life model or the subject of his conceptual investigations. Further questioning arises when the vectorized data is imported inside a 3D software interface prior to being CNC milled in Styrofoam.

To resume, Penny's artwork production mode strategies begin with the digitizing of the original hands-on modelled clay sculpture. The clay figure is digitized with a white light 3D scanner and the scan data is manipulated. Today, Penny also uses 3D scanning technology to digitize human subjects. The digital sculpture is transformed and scaled prior to being CNC milled in Styrofoam. A traditional analogue mould-making process is used to mould the CNC milled Styrofoam and a clay positive is cast in the mould; the Styrofoam sculpture is either reproduced in clay or clay is added onto its surface. Inspired by digital manipulations, Penny transforms the clay sculpture manually to create the original artwork, which is then moulded to be cast in silicone rubber. Additional creative interventions happen during the brush-on process, which is used to create a silicone rubber figurative sculpture. The hyper-realistic quality of the work clearly demonstrates the influence of the sculptors' interactions with a digital medium on the aesthetics of the artwork.

Finally, the main difference between the production mode used by Kiki Smith with that of Evan Penny is that Kiki Smith's current approach to mould-making is conducted through digital means. As explained in a previous section (4.1: Kiki Smith), Kiki Smith's use of RP technology accelerates the production mode, as the mould is milled instead of the sculpture being CNC cut.

4.2.20 Combining Digital-Analogue Artwork Output

Penny alternates from digital to analogue throughout his creative process. When asked if he thinks that his sculpture work could exist digitally or if it must convey a physical content, he replied: "But does it have to become a tri-dimensional object? No, I don't think so. In my case, it does." His answer challenges the bi-dimensionality versus three-dimensionality of a data object perceived inside a 3D software interface environment. Penny's response indicates that despite the constant presence of object materiality in his work, his sculpture installation art could expand in many other directions.

4.2.21 Artwork-*NetArt*

Penny strongly stands for the relevance of object in sculpture practice. In his work, he always materializes the digital sculpture. He stated: "I probably always will materialize it. I imagine myself as a sculptor and this is a relationship I have with this . . . but it's always in relation to sculpture and to the tri-dimensional space, the physical space."

4.2.22 Technological Approach: Scaling and Duplicating

Scaling and duplicating are strategies of making that influence the aesthetics of Penny's figures' and their interactions with the viewer. Scaling seems to be embedded in his work concept.

4.2.23 Rapid Prototyping Combined With Other Process

Mould-making is certainly the production process that is most characteristic of Penny's work. Interestingly, he starts by using traditional mould-making to mould the clay figure. Then he applies platinum cured silicone rubber in successive layers inside the mould to obtain a cast of the moulded figure. The tinted rubber gives to the work a hyper-realistic look of human flesh. Basically, he uses silicone rubber technology in his creative process not only to make moulds, but also to create work in ways in which everything is continuously transformed. As Penny stated:

> There are multiple moulding processes that take place, so if we're talking about transformative being those moments of state change from one form to another, there would be the scanning, the milling, there would be moulding, there would be the clay, there would be another mould typically . . .

The concept of transformation is very present in Penny's creative process, as he merges concepts and techniques and often combines RP with mould-making and casting. As Penny explained: "I think my work basically operates from the presumption that all aspects of the process, all technical aspects are also conceptual aspects. We can't separate them."

4.2.24 Upcoming Ideas

At the end of the interview, Penny was asked what he anticipates his upcoming work will address. He answered that his upcoming work would be grounded in the question: "Who are we now?" Penny added:

> For me, that question has always been bound up in the making of the tri-dimensional object, the sculpture of realistic objects in the sense that they reflect roughly what we look like, they reflect the world as it appears. So the relationship between the world of appearances and the technologies we use to represent ourselves and imagine ourselves is in constant flux. That is my subject matter and so I assume that I will be constantly challenged to update or renew or re-assess questions. . . I honestly can't say that I'm always going to employ digital features either. I don't know that for sure, but it seems like I certainly should have a few works in the future . . .

Penny's ambivalence about whether or not to use 3D digital technology in future works is clear. As demonstrated through the interview process, even though Penny brings a digital dimension to his work, his sculptures remain grounded in a concept of appearance.

4.2.25 Views on the Future of Sculpture Practice in Relation to Technological Advancements

The interview was concluded by asking Penny to express his views on the future of sculpture practices in relation to technological advancements. He stated:

> I have no idea. Again my interest, my area of interest is the human body and how we represent it in a tri-dimensional context. I really can't say I have any idea how that can or should evolve, but I can totally say I am sure it will. I'm sure there will always be some need to make representations of the human body within a tri-dimensional context, the arts that it is going to progressively be reliant on the digital . . . some kind of digital interface.

In this way, Penny envisions a future open to the pursuit of artistic investigations into representations of the human figure but subject to the inevitable advancement of computer technology in the arts.

4.3 Trevor Gould

Trevor Gould is a Canadian artist born in Johannesburg, South Africa. His works reflect a strong cultural dimension. Social and cultural identities are themes conveyed through the ideology and messages that his works embody. Trevor Gould was working on a mould of a life-size figure project in the Fine Arts Department of Concordia University when he was first approached to participate to the study. As he engaged in a discussion with the artist-researcher on the relevance of objects in contemporary art questioning the role physical objects play in the communication of ideas in sculpture practice, the focus of the discussion on physical object representations that convey cultural, political, and environmental issues moved to that of data objects as mutable, malleable, and immaterial objects conveying coded information. The conversation shifted to an exchange of views on a digital medium. Later, the case study interview direction was addressed and the ways in which a 3D digital and technological context broadens artists' relationship to spatial, temporal, and material dimensions was discussed.

Trevor Gould was selected for this case study interview process because of the ways in which the concepts of cultural and social identities are dealt with in his artwork through 3D modes of production. Gould's works explore images and objects that address the values of a hypermodern society and reflect a culture of paradox (Lipovetsky, 2005). In relation to the hypermodern paradigmatic worldview conveyed

through the case study analysis, Gould's works indicate an openness to creative exploration of a 3D digital and technological context in his sculpture practice.

The interview began with a focus on the artist's contextual background and moved to an exploration of Gould's current practice and his use of 3D digital technology.

4.3.1 Contextual Background

Gould's sculpture installation projects reflect a social condition through figurative representations. When Gould was asked to comment on his work ideology, he stressed the cultural dimension that his work conveys regarding ideas of history or post-colonialism expressed through diverse forms of representation. Despite the fact that the work does not belong to a specific category of representation, Gould pointed out that his work is not abstract. Moreover, the work seeks to understand our human condition. He stated:

> . . . my work is based on a strong cultural dimension, particularly, post-colonialism. In this context, my work is not abstract. It has sometimes abstract motifs, but they're always associated around both; strong representation and forms. These forms typically are animals, plants, and humans. The way that my work has evolved over the years, it is really a way of looking at the world, the natural world and in this process, developing some kind of an understanding as human beings today.

From a conceptual approach, Gould's work addresses the human figure through a cultural perspective, inciting a culture-nature relationship that explores "the way images and objects represent the beliefs, attitudes, and values in our social history . . . His work thus addresses issues of social awareness and understanding of cultural space" (Fondation Daniel Langois, 2004). Through digital spatial interactions, Gould's work

expresses socio-cultural issues and questions our relationship with the environment. Gould's sculpture practice expresses social concerns through strong figurative representations. The sculptural form conveys a discourse reflecting his perception of the natural world and understanding of the human condition within a contemporary social context. From the research's methodological standpoint, this context is shaped by the concept of the here and now (Lipovetsky, 2005).

4.3.2 Contextual Background Leading Up to Digital Technology

Gould's interest in 3D digital technology started in 2002 with the establishment of the Hexagram-Concordia Centre for Research-Creation in Media Arts and Technologies.[58] Back then, Concordia University, as an institution, encouraged all professional artists and teaching faculty to get involved with research creation project development shaped by a digital and technological context. This prompted Gould to question how he could respond to the university's new direction while following through with his own work. Therefore, when Gould was asked to describe how he started to work with 3D technology and to interact with a digital medium in his art practice, he responded:

> How it started is actually very simple. It all arose with . . . the initiative and innovation of the Hexagram Institute and the sense that this was a necessary part of research; as an institution the university needed to be involved in this particular way of thinking and this approach to research. It wasn't evident how I could become involved with the technology because I didn't really understand much about the processes involved, and I also couldn't at the beginning see any purpose or how it could extent my practice. However, once I started thinking about it, and having some sense of it, I realized it was not too dissimilar to the reproduction and the sort of processing techniques of mould-making. Once I came to understand that there was this idea of duplication, copy or reproduction from an original, original of course being virtual, it was a 3D model, then I understood that there was some kind of potential for me and my work, in fact all of my thinking, my

> attitude towards technique is . . . it's a means to a end, it's not a means in itself.

Similar to most artists belonging to his generation, Gould was not exposed to a computer environment in his childhood. He stated:

> I am too old to have been exposed to computers as a child. Nice thought, though. No, I do think about this as also part of my understanding of cultural and social change . . . . My first computer was . . . a Casio tape cassette computer that hooked up to TV monitor that I bought at The Bay. It wasn't even available in any kind of specialized store and that was not so long ago, that was in the beginning of the 80s. So, when you think about change and the rapid introduction and development of these things, that's fantastic. Fortunately, I have lived long enough to have known a life before, so anyway just to answer your question, no I never grew up with computers.

This generational factor described by Gould is important. Most artists of Gould's age group first experienced a digital medium through a 2D platform. All three artists interviewed started using digital photography and Photoshop processing software in their practice first and then moved on to a 3D digital platform.

Cinema often acts as a stepping-stone to bring a digital medium inside the spatial-temporal dimension of the practice. In addition to the space-time concept conveyed by the *septième art*, the cinema industry uses the physical state of objects to simulate 3D visual exploration. It is often through this perspective proposed by the medium that sculptors understand how they can connect with a digital spatial environment through their own practice. Therefore, the influence of digital mediums such as photography and cinema on sculptors' approaches to a 3D digital and technological context broadens their spatial-temporal relationship from image to object in sculpture practice.

As presented in Chapter 1,[59] Walter Benjamin argued that technological development expands the concept of distance and influences the viewers' spatial-temporal interactions.[60] Furthermore, Benjamin's writings on the impact of technological growth in the arts primarily addressed the medium of photography, an analogue image-capture reproduction mode characteristic of a 2D medium. Today, this digital direction has further expanded and has been applied to other artistic fields. Similarly, cinema triggers ideas in the artists' mind through perceptiveness. As Gould stated:

> It occurred to me that in the virtual world . . . like a photograph, which is also a virtual world . . . and I was actually being quite influenced by cinema at the time interestingly enough because of the 3D imagination . . . but they're still virtual, although in the cinematic context, we imagine them to be real, with real actors, but it's still a virtual space.
>
> What I thought is, like in a photograph, and this is where it started, if you move your hands through space in slow motion, you get a blur, so there is a trajectory in space and there is a form. All I wanted to do in the beginning was to simply say: "if I could reproduce that blur in 3D, what would it look like? what is the backside of this image like? . . . how does it really appear as solid state form?"

Through this statement, Gould described how he experiences "movement" inside a 3D software perspectival plane: influenced by a 2D image of object in motion, captured by the lens of a camera. Also, Gould's ideas imply a need to explore a 3D digital spatial context and his artworks are conceptually influenced by a computerized spatial environment. What comes first in Gould's creative approach is a technological stimulus that provokes questions relating to a technological context. He explained:

> That was my initial interest, and in fact, these two large scopes are a result of that . . . just thinking simply about how to recreate a three-dimensional blur, and if it stood in solid form, what could it be?

Furthermore, Gould's question suggests that the concept of materiality stands within a digital representation, as he probed, "if it stood in solid form, what could it be?"

How do artists materialize the distance or trajectory of an object in space? Does working from a 3D digital and technological context force artists to re-define what a material object can be? The interview process moved ahead, in search of answers to the principal research questions. Gould's probing informs on the ways the 3D software interface spatial environment influences his creativity. It can be seen that the concept of distance conveyed through the blur visual exploration influences the aesthetics of Gould's works. This space-time concept traditionally explored through the study of movement from a 2D medium[61] indicates that within a 3D digital software interface environment, artists fundamentally work within a bi-dimensional but simulated 3D formal representation of object in space. A phenomenon of convergence between artistic mediums that is influenced by a digital medium can be noticed.

4.3.3 Current Experience of 3D Technology

Gould has started to work on the idea of the blur and, through this idea, to explore many interesting facets in which technology can be applied in sculpture practice. He explained:

> I have worked on specific works. The ones I just mentioned were a 3D blur. It's the first time I've actually used this technology. The work was really interesting for me. Apart from the blur itself, I was also interested in the transposition of scales. I made a small 15-20 cm model figure, we scanned this in 3D, and this was then reproduced as the basis of the sculpture just under two metres, so the transposition from the miniature to the large or over full scale.

In the sculpture work titled *Untitled (Cain and Able)* (Figure 19.1), Gould's idea of the blur has taken a material form. The digital manipulation of the scan data is noticeable through the two standing figures' heads (Figure 19.2, detail). The duplicated enlarged standing bodies also indicate that the artist utilizes the duplicating and scaling functions of the 3D software interface tools. Through analyzing this work, it can be seen that Gould's creative process, from concept to production, is influenced by a 3D digital and technological context that extends the sculptor's spatial boundaries.

Figure 19.1. Trevor Gould, *Untitled (Cain and Able)*, 2003-2012, polymer gypsum, metallic paint, Styrofoam, plaster, clay, epoxy, glass eyes.

Figure 19.2. Trevor Gould, *Untitled (Cain and Able)*, 2003-2012, detail.

Based on an analysis of the ways in which Gould experiences technology in this project, it is relevant to point out that he first developed an interest for digital processes through observation. He then questioned the ways in which what he perceives in real space could be transposed inside a 3D digital context. Later, Gould was inspired by the idea of the moving image and how movement or distance could be materialized: How could he capture the movement of a data object between two points? Gould further explored this concept through the 3D blur project within which he digitally captures and materializes space. As presented in Chapter 3, from a digital media context, the notion

of distance translates into a time measurement, an expanded definition of distance that considers both space and time, as linked to the travel of information or computer data (Logan, 2010).[62]

It is interesting to see how the concept of space-time influences Gould's creative approach. When describing the blur, he is basically introducing space-time inside a 3D formal context. Space-time is also a concept linked to the moving image; within a 3D software interface spatial configuration, the concept of time is conveyed by a digital medium, which in this context is a digital sculpture, and its immateriality encompasses materiality or can move through any computerized media context.

Returning to his comments in reference to the blur project for which a small-scale sculpture was 3D scanned, Gould explained:

> . . . Because you make something small, it has a completely different character when it stands in front of you as another figure. So, that was also a very interesting part and the potential that I can see in using this digital technology . . .

However, when Trevor Gould's experience of technology is compared with that of Kiki Smith, it can be observed that through the artwork conceptualisation both have expressed that they relate to their small-scale sculptures differently than the ways they interact with enlarged art objects. From a different perspective addressing the artwork fabrication, it can be observed that Kiki Smith's sculpture mode of production is assisted by an independent sculpture production studio and she appreciates the expediency of the digital process; in contrast, Gould works in a university research lab, where proficiency in technology is attained through trial and error. Gould revealed:

> . . . so this 3D blur has taken a long time to complete . . . I shelved it for four, five years and all of a sudden, it's there. I've had the foam milled and they were ready for me to make the moulds, and it's only now that for some reason or another, they're made, they're out there, and they have been received very, very well. So this is now the piece of groundwork I've completed. I fully went through the whole process, and this will certainly be the basis for the development of new work because I think this intervention possibility in the program (3D software) for extending, pushing, pulling, all of these kinds of things, has really got a lot of potential for me.

The case study interview questions addressed Gould's approach to technology from two interrelated perspectives: the artist's sensory experience and a technological approach to sculpture production. The study questioned what happens when the artist's exploration of cultural space is driven by a creative process that interacts with a digital spatial context. To answer this questioning, the artist's creative process was analysed and Gould was asked to describe the ways in which he engaged conceptually and the methods he used to produce his sculpture work.

4.3.4 Creative Process: Technology and Methods

In Trevor Gould's work titled *Solid Ground* (Figure 20), the idea of juxtaposing an animal figure on a human body and the way in which the animal figure is scaled in relation to the human body (whereby the man's head has been replaced with that of a monkey's) indicate that computerized manipulation inspired the artist's creative process.

Figure 20.1. Trevor Gould, *Solid Ground*, 2012, polymer gypsum, metallic paint, Styrofoam, plaster.

Figure 20.2. Trevor Gould, *Solid Ground*, 2012, detail.

However, when Gould first started to explore 3D digital technology in the early 2000s, his sensory knowledge was not particularly driven by a technological direction. He stated:

> I'm not really a fan of virtual space in the sense of digital representations and know that . . . that is a very specific interest and it's become its own field. But in terms of my own sensibilities, this is not what I'm after as I always want to return to solid state form. I always want to return back to, let's call it the real world or real space.

Even today, despite the influence of the technology identified through the aesthetics of his works, Gould's interest in digital technology does not come naturally. His familiarity with the digital spatial context slowly grew through exploration and questioning how he could possibly interact with a digital medium in his practice and what technology could bring to his work. He explained:

> . . . there was the technology and I thought about how to interact with it, what could I possibly do that could take me outside of my own thinking, in other

> words, how could I stand beside myself in this kind of context, and that's how I started the whole process.

Later, as Gould's understanding of the technological context and its creative possibilities increased, 3D technology began to influence the ways he approached figuration, affecting his vision of the human figure. He explained:

> My work is figurative, my work is representational, so in choosing to deal with the human figure, the results have been quite extraordinary because it pushes in a real way . . . a fantastic sense of understanding of the being human and it pushes it in a way that's challenging and future-oriented—if you know what I mean—and I think in terms of the context of any tradition of figurative work, I find it particularly exciting for me, because it seems to put us in the place of the present near future. It really kind of articulates some of the dynamism of the sense of being human, or post-human . . .

It is as if the cultural space that Gould explores in his work has expanded through the influence of a 3D software interface spatial environment. Despite this technological influence, Gould's creative process remains grounded in an interaction with materiality, with which he finds explorative ways to engage. As he described, the work does not start from a digital format. It remains driven by an interaction with material, although he acknowledged, "from that, there is the movement into a digital technology."

4.3.5 Creative Process: Interaction With a 3D Digital Environment

Three-dimensional digital approaches incite Gould to a more experiential creative process. He can no longer fully anticipate the work outcome. His conceptual investigations are influenced by this sense of the unexpected that comes across as he experiences the software interface environment. In reference to the 3D scanning or digitizing of a small-scale figure project that he enlarges and transforms, he stated:

> . . . what I'm very satisfied and content with this project is that the manipulation stands outside of my own thinking, and capabilities, because it's really like trying to engage with the software and let the software do its work. In other words, I couldn't imagine the outcome. If I am to imagine the outcome, it would be a very, very different result . . .

Gould's sensibility is affected by a mechanical or algorithmic quality hidden behind this technological platform. When describing his interaction with the 3D Rhino software, he stated, ". . . in the end there is a set of circumstances and a kind of level of intervention that's really machine-oriented."

Gould is not motivated by a 3D digital and technological context comprised of tools and software interface elements, which he perceives as being too "machine-oriented." Moreover, Gould always feels the need to touch base with what he defines as real space. He affirmed, "I'm grounded in that space and this is the area I'm going to work in personally as a personal choice for my research." Later during the interview session, he added, " I always want to return to the real world or real space." Gould's creative process is first of all grounded in an analogue approach. His artistic concept further develops through digital means, but he always returns to an analogue mode through the materialization of the digital sculpture representation. This analogue perspective gives greater understanding into the direction of his production process. Gould's strategy of making connects CNC fabrication technology to analogue transformative processes, such as mould-making and casting.

Guided by a sensory knowledge, Gould engages with conceptual and practical approaches to a creative process shaped by the "condition of the presence of material. "He stated, "I didn't have a clear sense of the final outcome nor the procedure. What I did

have was an idea. . . . ” His ideas develop through digital means, but he insisted: “But . . . my working process is a constant response to the conditions of the presence of the material, and then making decisions . . . at that time.” It appears that in Gould’s approach, decision-making becomes part of his creative process and the work develops within it. It is not as if the work is fully planned in the very beginning, but rather that the strategy of making is something that evolves within the work.

4.3.6 Software and Technical Assistance

Assisted by a technician, Gould works with Rhinoceros (Rhino) 3D software interface elements and tools. Using Rhino, Gould’s technician generates an STL file format used for RP 3D printing or CNC milling his digital sculpture project. Gould’s creative process interacts with technical assistance. As was pointed out previously, the generational factor linked to Gould’s computer skills is an important influence that affects his capacity to work independently within a software spatial context.

Gould does not feel that experiencing a “digital work dependency” with technical assistance is in any ways different than other aspects of sculpture practice where technical support is needed. Contrary to what other artists may perceive as a major creative constraint, Gould enjoys technicians’ collaboration. He finds it beneficial and stated: “I welcome it because for me it’s a collaboration and I welcome being put into a situation or a context, that I can’t get to myself, and it is the whole benefit I think of any collaborative work . . . ” Because of this collaborative approach, technical assistance does not negatively impact Gould’s creative process; on the contrary, he benefits from it. He stated: “that’s really a situation that’s been benefiting me because I’m being taken to a place that I can’t get there easily or on my own. So, I love this kind of collaboration.”

4.3.7 Artist's Creative Approach: Impact of 3D Software on Artistic Concept and Artwork Aesthetics

When asked if he could describe how his interactions with a digital medium influenced the visual aesthetics of his work, Gould explained that he feels that the question addresses a system of methods that are contrary to his way of looking at artistic practice. In this way, Gould's artistic practice is very much grounded in an analogue approach. However, when examining his artwork, the visual influence of the software tools on the aesthetics of the sculpture form can be observed. This influence is particularly noticeable in the blur project exploratory work.

To support this observation, his recent sculpture works presented at VOX Centre de l'Image Contemporaine in Montreal in 2012 were re-analysed,[63] more specifically, the works titled *Untitled (Cain and Able)* (Figures 19.1 and 19.2), which represent two standing figures with extruded heads extending from their bodies; *Solid Ground* (Figures 20.1 and 20.2) presented at the Musée d'art contemporain de Montréal in 2012, which proposes a standing figure whose head has been replaced with a seated monkey imitating the posture of Rodin's famous sculpture *Le Penseur*; and finally, his permanent installation at the Musée d'art contemporain de Montréal 2012, representing a monkey with an extruded, curved, and elongated neck titled *God's Window* (Figures 21.1 and 21.2). The visual aesthetics of these works brings evidence that the sculptor's visual language has been influenced by his interactions with a digital medium.

However, when Gould was asked about this evidence of influences in the aesthetics of his artwork (specifically, if the software elements and tools impact the ways in which he develops his concepts or if the artworks' concepts are influenced by the software tools), contrary to what was anticipated as a response based on observations of the works, Gould expressed that in his practice he does not feel at ease with, and even feels frustrated by, technological tools. He stated: "No, the software interface frustrates the development of the concept." Gould's creativity is not driven by a digital and technological context; he stated that he cannot "immerse" himself in it. He explained that he would need to invest time into software training to benefit more from it. His limited software knowledge and hence his inability to experience creative freedom within a 3D digital and technological context affect the ways technology extends this sculptor's spatial boundaries.

Figure 21.1. Trevor Gould, *God's Window*, 2012, permanent installation, Musée d'art contemporain de

Figure 21.2 Trevor Gould, *God's Window,* 2012, detail side view.

Figure 21.3. Trevor Gould, *God's Window,* 2012, detail front view.

Gould's creative process engages with a sensory knowledge stimulated by a palpable spatial environment. Furthermore, the structure of the 3D software interface does not conform with his sensibility. Gould stated:

> . . . I'm constantly bumping up against a structure that I'm just not really compatible with. I've long given up trying to fight that. I just accept it as a condition, and so I realize that the machine-world has a logic . . . that is completely different to the world I inhabit.

The computer logistics that Gould refers to seems to be at the opposite pole of the ways in which artists' creativity, sensory knowledge, and perceptiveness translate into a work of art. Within this technological environment, collaboration becomes a necessity. Traditional analogue ways of working stress a different approach to experiencing artistic creation than that of digital and technological means. Analogue approaches are linked to the notions of palpability, materiality, and physicality where digital approaches are all about simulated perceptiveness through different modes of production. Contemporarily, digital media and digital mediums encourage collaborative work and favour the concept of networking through which everything and everyone is interconnected.

4.3.8 Capacity of the Digital Medium to Translate Into Other Art Forms

This section addresses how artists can export and transpose digital data from one medium to another. To understand how the digital medium can translate into other art forms, artists' comprehension of the intrinsic nature of the digital medium, which is also linked to the concept of plurality in the arts or medium convergence, is necessary. The level of familiarity with the digital medium and 3D software interface of the artists who participated in the case studies hindered them from exploring deeper aspects of the3D digital and technological context of the study.

Gould is aware of the capacity of the digital sculpture data to mutate to another digital medium. When asked if he exports the data of his digital sculpture and transposes the data into other art forms, his response was negative. However, it appears that he would probably be interested in exploring that aspect of the medium. He stated: “It would be interesting, but it’s just a step out of my reach.”

4.3.9 Experiencing the Unexpected

Gould believes that it is possible for artists to experience the unexpected when working within a digital spatial context. He does not feel limited by a mathematically controlled space, but rather feels limited by his own inabilities to work independently, as he always requires a technician’s assistance.

4.3.10 Data Structure, Data Object, and Data Space

Gould’s approach to technology is primarily experienced through 3D scanning or the digitizing of analogue sculpture forms. The scan file structure is a polygon mesh. The digital object is then imported inside the Rhino software environment. The artwork develops through data manipulation by scaling, duplicating, or transforming the polygon mesh data. Gould does not use the software interface 3D modelling tools to build digital sculpture forms directly in Rhino. Rhino tools are used exclusively for the manipulation and transformation of 3D scan polygon mesh data.

When Gould, assisted by a technician, transforms the scan sculpture data, his relationship with forms in space shifts as he imagines and anticipates what the artwork could be through analogue perceptual modes. The digital sculpture transformation that he

imagines or anticipates is visualized at first in his mind and not on the computer. He explained:

> I see the transformative potential, of course . . . but I don't actually see it on a computer. What I'm looking at is my imagination (visualization) of the finished product, so it's always secondary to something that is always going to be.

One wonders to what extent Gould's imagination is informed by his previous experience with the software elements acquaintance. When assisted by a technician, he learns different transformative options for data manipulation inside a digital spatial context. Nonetheless, Gould's creative process is very much anchored to analogue production modes. Paradoxically, his recent work conveys digital production modes that strongly reveal a visual language driven by digital means.

4.3.11 Creative Spatial Context

Trevor Gould acknowledged that digital space is a creative space, but one that is complementary to an analogue spatial environment. When asked if he perceives the 3D software interface spatial environment as being a creative space, he replied:

> I believe it is. I'm not sure that I can actually see it, but I do believe that it is a very creative and dynamic environment. I mean somehow it is a complementary shadow to the other one that we inhabit.

By stating "I'm not sure that I can actually see it," he demonstrated the technological limitation that he experiences, reflecting a knowledge constraint that does not enable him to fully experience creativity through digital means. Familiarity with software interface and learning object manipulation strategies are important to artists' interactions with a digital medium.

4.3.12 Working with 3D Digital Technology

When Gould was asked if he works with digital processes only to facilitate sculpture production or if he is interested in the technology creative exploratory dimension, he explained that he sees 3D digital technology as a tool. But the study identifies two intertwined aspects that influence the ease with which artists experience creative freedom within this technological context: a generational one and software interface acquaintance or knowledge conditions. In support of the above observations, Gould stated that working with graduate students makes him aware of the creative possibilities of digital technologies.

> I've worked with graduate students, supporting and promoting the technology for them, seeing the potential in their work, and seeing how they look and how the students develop it. It's clear that it has really interesting and fantastic capabilities. Should there be time or should I be able to take the time would be very beneficial.

The ways in which artists interact with technology is influenced by their ability to freely navigate inside the software platform. It is essential to artists' creativity and spontaneity to find fast and easy pathways through the 3D software interface. Margaret Boden (2004) stated, "In general, one hopes not only to find the right path, but to do so as quickly as possible" (p. 91). In the "expeditious" time of the here and now (Lipovetsky, 2005), artists look forward to experiencing the spatial-temporal expediency that characterizes 3D digital technology and its influence on sculpture practices.

4.3.13 Artist's Creative Approach: Rapid Prototyping

Gould does not use RP technology to visualize his work during his creative process as he moves along with his project. In Gould's creative process, ideas develop

from a hands-on approach and RP technology is used only to reproduce the digitally re-formatted work.

4.3.14 Artist's Creative Approach: 3D Printing or CNC Milling

Gould acknowledged having never used 3D printing simply because the ideas he has worked on so far did not need to be 3D printed. As he stated, he has "not yet had application to do so." Gould's creative approach to 3D printing more directly addresses the making of small-scale models. Gould may consider using 3D printing to build a *maquette* for a public art proposition. He recognized that there is potential within that kind of application and stated: "I have thought about the possibilities of all of these things and making small or simple models that could be then refined and then printed. All of those things, then of course, in terms of model making, have huge potential."

While Gould understands how 3D printing could be linked to his practice, he has never used 3D printing as a final sculpture output. However, Gould uses CNC milling to materialize his digital sculpture data. His sculpture mode of production includes the digitizing of analogue sculpture form, the formatting of the digital sculpture and CNC milling of the scaled up sculptural object.

4.3.15 Artist's Technological Approach: Digitizing Tools

As mentioned previously, Gould uses 3D scanning technology to digitize small-size forms that he creates and scales up. He further develops his digital sculpture project inside a computerized context.

4.3.16 Artist's Technological Approach: Manipulating and Transforming Data

Gould is used to working within a context where the work is processed through technical assistance. Technicians' collaboration influences the progression of his artwork. As noted during the interview, Gould is interested in exploring how and in what ways he can digitally manipulate sculpture data. Gould's intuition comes to the rescue of the computer knowledge constraints that he experiences. Through a heuristic approach to problem solving, he triggers the "computational resources" of his mind.[64]

A heuristic problem-solving approach can be clearly identified when Gould revealed the experiential relationship between himself as human and the computers:

> . . . as I was trying to reproduce a blurred image and to scale it using the function of the program and the kinds of steps that could be put into the program to let it simulate what a blur might be, so in other words, there was a face and this face was split in two. You had the back of the head and the front of the face. The whole challenge was how the distance between the front and the back was created. How would the machine program deal with an interpretation of that? That's really the interesting part of the process.

In the work titled *Untitled (Cain and Able*) (Figures 19.1 and 19.2), Gould's digital manipulation of the form to obtain the so-called "blur" suggests that movement is now imbedded in the human face. The idea that the concept of space-time (distance) can be sculpted in 3D clearly illustrates the influence of sculptors' interactions with a digital medium on the aesthetics of their artwork.

4.3.17 Preparing Files for RP Process

All three artists interviewed do not prepare their digital files for RP processing. They always work with a technician. At that stage, Gould only wants to ensure that the result is going to be as close as possible to what he was anticipating, but as he stated

"there is never no deviation, but the least amount possible." Gould is aware that artistic flexibility regarding the final output is important when one creates work inside a computerized environment.

4.3.18 Service Bureau

Gould feels that he never works "freely at all," and as a sculptor, he "always worked in an industrial context." Therefore he identifies as: "being a client and the service is that of a technician's . . ." Gould works inside a university structure and technical support to technology is available inside the institution walls. As a member of the Hexagram-Concordia Centre for Research-Creation in Media Arts and Technologies, he also has access to the rapid prototyping research lab equipment and support.

4.3.19 Re-Working the CNC Milled Form

Gould re-works the Styrofoam sculpture surface after the CNC milling process, and, as he stated, he works on the milled form, "very much, very much, yes." Therefore, when asked in what ways he transforms the original CNC cut form, he explained that he engages with different modes of hands-on manipulation of the Styrofoam surface. He makes adjustments or changes to the CNC milled form in order to reach his objective.

4.3.20 Combining Digital-Analogue Artwork Output

Gould does not combine his analogue work output with his digital sculpture output. However, he envisions sculpture installation art from both perspectives: digital and analogue. Gould stated that an artwork can be analogue or digital or "it can be both."

4.3.21 Artwork-*NetArt*

Gould always materializes his digital data. He does not necessarily see sculpture processes as being only digital. He stated: "it could be one work or two works, but as a whole process, no."

4.3.22 Technological Approach: Scaling and Duplicating

Scaling and duplicating are commonly used in Gould's creative process from the conceptualization to the production of his sculpture installation works.

4.3.23 Rapid Prototyping Combined With Other Process

Gould combines casting processes with RP technology. He does not necessarily use metal casting but definitely uses other moulding and casting processes. As an example, for the works *Untitled (Cain and Able)* and *Solid Ground*, he moulded his CNC cut form and cast a polymer plaster positive. Often Gould creates work that he intends to cast in metal, yet the highly glossy metallic look of the rendering effect from Rhino prompts him to cast the work in aluminum. Gould stated:

> . . . the idea of casting it in metal with a high finish actually came from the resolution of the dot image in *Rhino* because once we render it, it looks metallic and that's really where the metallic effect came from. So, I suppose in a way, I'm duplicating the effect of the software program.

When the artwork has regained an analogue form, Gould duplicates the visual effect he got from the digital sculpture rendering. [65]

4.3.24 Upcoming Ideas

Gould's upcoming projects aim to focus on the human body. He stated:

> . . . changing the direction of my work is this potential at looking at human form and human reproduction, and sort of postulating other representations out of this confluence of machine reproduction and representation, and what it means as a kind of constitutional form of the human body.

In Gould's sculpture practice, his interactions with a digital medium seem to broaden the visual representation addressed in his work. Gould's intention is not to restrict the work to the human form but to extend other forms of representation, such as that of the animal world. His recent permanent installation at the Musée d'art contemporain de Montréal depicting a chimpanzee with an elongated neck is one example of the upcoming direction of his work. The influence of a digital medium on the visual aesthetics of the chimpanzee, more specifically the way in which the animal's neck is elongated and twisted, is noticeable (Figure 21.2). Gould's recent work direction indicates that from many perspectives, a 3D digital and technological context extends sculptors' spatial-temporal boundaries in sculpture practice.

4.3.25 Views on the Future of Sculpture Practice in Relation to Technological Advancements

For Gould, sculpture practice has always been influenced by technological advances and, as he stated, the impact of digital technology on younger artists' work can be easily observed. Gould stated: "it's having an impact . . . this really exciting work that is being made by young artists . . . always engaging in and reinvigorating the concept of sculpture through the root and the process of technology." However, Gould expressed how he wants to "shy away" from aesthetics identified as belonging to digital sculpture, an aesthetics defined by traces of the process (such as the layering effect often present on 3D print material output or CNC milling assembling strategy). Nonetheless, he made a clear distinction between that and artists' creativity and sensory experiences reflected on

the visual effect obtained through digital sculpture file manipulation, which also affects the artwork aesthetics.

Considering Gould's observation and analyzing his responses to the interview questions, it is clear that his interactions with the digital medium have an impact on the aesthetics of his work, but not the kind of visual influence that he wants to shy away from. He stated,

> I never want it to look like digital sculpture. I want it to have the influence of the digital format . . . I think that there is a difference, so I'm less incline to be interested by work that looks, I am more inclined by work that somehow extends and pushes understanding through a process.

Today, creative experiences are understood from immaterial perspectives, inside which a digital medium and its technological context have extended artists' spatial boundaries and interactions with mediums in their creative process.

Chapter 4 presented the data analysis of the case study interviews. In the following chapter, the data from the interviews and the Research Creation project are summarized to present the responses to the research questions.

CHAPTER 5

DISCUSSION AND INTERPRETATION OF THE FINDINGS

5.0 Introduction

This chapter presents the findings from the Research Creation project and the case study.[66] It discusses the ways in which each artist's creative process is influenced by a 3D digital and technological context. An interpretation of how the artists' creative interactions with a digital medium influence the aesthetics of their artworks is also discussed. Throughout the chapter, the researcher's research creation experience and the responses from the three artists who participated in the case study provide a backdrop for the discussion of the findings.

The findings from the material collected are presented from two perspectives. The first is thoroughly hermeneutic, where the results are based on the researcher's interpretive view of what was said during the interviews and what was observed when analyzing the participants' selected artworks. The influence of digital technology on each individual artist's creative process is also presented as an interpretation of the ways artists' interactions with a digital medium reflect on the aesthetics of their artwork. The other approach is based on the researcher's creative experiences within a digital and technological spatial context as she engaged with the Research Creation project. The researcher's interactions with a digital medium are reflected in the artworks presented in the exhibition supporting the doctoral dissertation.

Lastly, the importance of the findings and their influence on the domain of sculpture are presented. The significance of the study focuses on creative approaches to a

3D digital spatial-temporal and material exploratory context. The findings point towards future research creation exploratory investigations aiming to extend spatial and medium boundaries in sculpture practice.

5.1 Artists' Contextual Backgrounds

While all of the artists' contextual backgrounds influence the ways in which their creative process is affected by a technological context, this influence comes from a different perspective for each artist. In the study, all four participants belong to the same generational category; none of them were exposed to computers as a child or grew up in a technological context—they are all computer non-natives. They also all have a basic level of experience with 2D software (such as Photoshop) but more limited experience with 3D software. Based on the level of technological experience of these artists, it seems that acquaintance with computers at an early age would have facilitated the comprehension of the software spatial configuration and improved the artists' spatial-temporal interactions within a digital creative context. In this way, it would appear that computer proficiency stimulates sculptors' creative interactions with the digital medium.

In the eighties, the artist-researcher was influenced by a socio-cultural context that brought to her practice an interest for art research and experimentation that continued to influence her creative process. During this time, the researcher pursued research creation work involving experimental works in metal casting in a context of artistic creation. Her artwork concepts were influenced by her experience of the transformation of matter through metal casting technology. Moreover, the trajectory leading to the exploration of 3D digital technologies through artistic creation followed a natural progression of transposing ideas and concepts from a tangible to a less tangible form. The artist's

research project was influenced by the growth of technological and creative directions in sculpture practice.

Kiki Smith's collaborations with the Johnson Atelier in the early 1980s brought a vision for advanced technology applications in sculpture that she applied to her practice. Today she collaborates to create works driven by various technological means. Even though she does not find it engaging to "sit in front of a computer for hours," she acknowledged the importance of technology in the arts. From concept to fabrication, she uses digital technology to facilitate the sculpture process but such technology is dependent on the idea she is working on: as she engages with technology, it informs her ideas. Thus, the visual aesthetics of her artworks are affected by the technology she uses throughout her creative process.

Evan Penny's relationship with the film industry inspired his early works and continues to influence his visual language. Driven by a questioning of how people perceive themselves within their social environment, his artwork's conceptual exploration translates into a sculptural discourse through innovative uses of silicone rubber as a sculpting medium. Technological advances in cinema special effects studios have influenced Penny's creative process in relation to his work concepts and production. This contextual background stimulated his openness to technological perspectives and led him to explore 3D digital spatial-temporal directions in his work.

Trevor Gould's interest in 3D digital technology is motivated by his collaboration with the exploratory inter-university Hexagram Research Centre. His recent work is shaped by a digital spatial and medium exploration that reflects on the aesthetics of his

sculpture works. As seen in *Untitled (Cain and Able)* (Figures 19.1 and 19.2.), his sculpture installation composition and visual language definitely present 3D digital attributes.

5.1.1 Contextual Backgrounds: Work Category of Representation

The artists each produce works that are representational of human or animal figures.[67] Their individual artistic perspectives influence how much they digitally manipulate the 2D or 3D scan data. The artists have limited interactions with a digital medium and limited software knowledge. They do very basic digital manipulation of images and forms, resulting in simple transformation, such as scaling, duplicating, extruding, stretching, and pulling. The Research Creation exploratory work direction influenced the artist-researcher's interactions with the digital medium, and a greater understanding of the software interface allowed a deeper exploration of the technological context leading to the transposition of ideas through a digital medium.

The human or animal form in these artists' works is affected digitally in ways that indicate the use of 2D and 3D software tooling. Examples of this are Evan Penny's *Panagiota: Conversation #1, variation #2* (Figure 16), which presents a combined 2D and 3D data transformation; Kiki Smith's *My Blue Lake* print (Figure 13), which indicates the influence of a 2D software on the manipulation of a print image; the 3D software element used for stretching, pulling, and curving the monkey's neck in Trevor Gould's *God's Window* (Figures 21.1 and 21.2.); and the researcher's *Vulnerable: The Salmon Project* (Figures 1 and 2), wherein the researcher uses 2D text data to explore passages between 2D and 3D digital forms. Within these projects, the artists' ideas are influenced by a software interface and digital medium that facilitate formal

transformations of 2D images or digital sculpture works. Many of these changes in the aesthetics of the artworks would have been difficult or even impossible to create without the sculptors' interactions with a digital medium or outside a gravity-free spatial context.

5.1.2 Contextual Backgrounds: Artists and the Production Lab

All four artists work in collaboration with one or both of two different sectors: independent sculpture production studios and university facilities. This influences the ways in which the artists approach technology in their work. When the artists collaborate with independent sculpture production studios, they are exposed to the technological developments in the private sector. As a result, the greater the exposure, the more technologically advanced the artists' applications of technology in the artwork's production mode seem to be. As presented in section 4.3.3, while the university environment encourages creative exploration, the artists working in university settings often do not have the technological knowledge or support to move the idea quickly enough compared with the artists working with independent studios, who are fully supported technologically.

The technological context of the artists' work environments is reflected in their creative process and the production modes of their artwork. Evan Penny's early work is influenced by the cinema industry, as can be seen through his creative use of silicone rubber (which characterizes his hyper-realistic figurative sculptures) and his concept of the image-object (which influences the production mode of his sculptures). Kiki Smith's innovative ways of using CNC technology in her work fabrication strategy reflects the development of CNC processes at the Walla Walla Foundry. The university environment encourages research creation projects and offers artists access to a technology that

stimulates their imagination, as can be seen in Gould's exploratory research on the concept of the blur experienced inside a digital spatial context (shown in his work *Untitled (Cain and Able)* (Figures 19.1 and 19.2.)), an idea that took a long time to come to fruition due to the research conditions and level of technological support experienced by the artist inside a university context.

The Research Creation project was motivated by new ideas for sculpture projects that opened out to a digital creative context. Research directions in 3D scanning technology, 3D printing, and CNC milling automated technologies were shaped through collaborations with universities and independent sculpture production studios. These collaborations stimulated the exploration of the crossing over of artistic mediums from analogue to digital approaches in the artist's sculpture production work.

Collaboration with independent sculpture studios can extend artists' perspectives on exploratory approaches to sculpture production. The study emphasizes the qualities of Evan Penny and Kiki Smith's technological production modes, as they both work with either the Digital Atelier or Walla Walla Foundry. Within artistic fields, such as the sculpture domain, creative approaches to 3D technology are currently expanding, as is the collaboration between universities and independent art studios in the private sector. This collaborative approach encourages and provides knowledge growth from two perspectives: research creation exploration and technological innovation.

5.1.3 Contextual Backgrounds: Influence of Technical Assistance

The artists often experience creative constraints when they attempt to interact with digital sculptures inside a computerized spatial context. These obstructions to a

more intuitive and spontaneous creative pulse influence the sculptors' interactions with a digital medium. In addition, when an artist's creative intention is dependent on a technician's comprehension and openness to the artist's sensitivity and perceptivity, a feeling of frustration and dependency is experienced and the artists' creative process is further influenced.

However, technicians are important because they assist artists through their creative process and facilitate their interactions with the digital medium. Trevor Gould's collaboration with the Concordia Hexagram Research Centre encourages innovative directions in his artwork and the technicians' support provides him with an openness to artistic research. Working with people with different knowledge and expertise stimulates creative activity and brings innovative perspectives into the practice. As proposed by Trevor Gould, "I welcome being put in a situation or a context that I can't get to myself, and it is the whole benefit of any collaboration." Nevertheless, Gould also expressed a level of frustration when interacting with the software interface, stating, "the software interface frustrates the development of the concept." Closer relationships and interplay between artists and collaborators, such as technicians, influence artists' creative interventions within a 3D software interface context. But, even though the technicians help artists achieve their goals, the counter-effect is that the technicians' assistance affects artists' creative freedom and, as Penny noted, "because I don't have the expertise, I am limited to what they can come up with. . . ." The feeling of being limited because they cannot experience the digital medium thoroughly from their own sensibility, spontaneity, and intuition explains why most artists perceive technology as a "tool"; their creative interactions with the digital medium are not absolute. For them, 3D digital

technology remains a creative means instead of being a means to create: *un moyen de faire au lieu d'une approche créative*.[68]

5.2 Current Experience of 3D Technology

The interviewed artists often use 3D technology in combination with hands-on production modes—digital technology builds on analogue processes by proposing a different relationship with a medium and its physical context, thus influencing artists' creative process. Through interactions with analogue and digital approaches, the artists' perceptions of objects in space are influenced by palpable and impalpable sensory experiences. The intangibility of a digital medium influences the artists' need to go "back to the way we experience sculpture it in real time and space" (Penny) or to "want to return back to real world or real space" (Gould). As Kiki Smith stated, "for me, the whole reason to make sculpture is to be able to put something outside a body that I can look at, and outside a computer."

To discuss this phenomenon, several aspects of sculpture practice were examined, with a focus on the artists' interactions with the spatial contexts and their relationships with objects in space. During the interviews, the sculptors indicated that they experience more control over the sculpture process when they work from an analogue standpoint. They feel dependent on technical assistance when they engage creatively inside the software interface platform. The artists apply basic manipulation of sculpture forms and have limited understandings of how to use advanced techniques in 3D modelling and 3D scanning polygon mesh transformation. In sculpture practice, analogue interactions with objects in space are physically engaging and, as expressed by Kiki Smith, looking at a digital object on the computer is not something that is "that engaging." However, the

artists acknowledged that sculpture practice has always been influenced by social and technological change. There is a discussion further in this chapter about the interaction between technical assistance and the ease with which the artists create inside a digital context, which indicates why they feel “more in control” of their creative intentions when working from an analogue perspective.

5.2.1 3D Scanning

The concepts of the artists’ sculpture installation works most often take form inside an analogue platform, through which their ideas expand freely. This so-called analogue platform is the ground from which digital means to create emerge; starting from the digitization of hand-sculpted forms or found objects, the artists import the data inside a digital spatial context. The artists’ creative process is influenced by 3D scanning technology, as it opens the door to their interactions with a 3D software interface. Three-dimensional scanning offers an accessible and comprehensible passageway from analogue to digital representations of objects in space.

In sculpture installation practice, 3D scanning technology is complementary to mould-making processes; both methods are used to appropriate (to reproduce, duplicate, manipulate, or enlarge) forms. The 3D scanning of small-scale sculptures invites a visual exploration of a sculpture form inside the four perspectival views of the spatial configuration of the software interface. The scan data is sculpted digitally and artistic concepts develop through the manipulation and transformation of forms and objects inside a 3D software interface platform. The artists sometimes combine 3D scanning with 3D modelling as they work on sculpture concepts. Sculpture processes are facilitated by an ease in transforming, scaling, and interacting with objects inside a spatial context free

of the constraints of size, weight, or gravity. Spatial-temporal and material dimensions are broadened as the artists interact with two spatial contexts through which ideas move from analogue to digital.

Nevertheless, the artists' relations to materiality and palpability remain key to their creative process and there is still a need to materialize the data and study its interactions in real space. For example, as the idea of using an enlarged duplicated salmon surface as a screen projection developed in *Vulnerable: The Salmon Project*, the sculptor explored the form's relationship to space. Inside a digital perspectival frame of reference, the sculptural object can easily be studied and moved around. Digitizing the salmon influenced not only the artist's relationship with the object in space but also the mode of production of the artwork; through 3D modelling and 3D scanning, the artwork re-gained materiality when the sculpture data was sent to the 3D printer or CNC milling machine.

5.2.2 3D Printing and CNC Milling

Most often, the artists use 3D printing technology to get a prototype; within the artists' creative process, 3D printing allows for a visualization of the digital sculpture form in real space. But if the artists do not sculpt the digital data and simply transpose an analogue sculpture inside a software context without transforming the data, there is no need for the 3D printing of a prototype to study the form interactions in real space. Because with 3D printing technology the prototype size is restricted to relatively small-size work, in general CNC milling is the fabrication process used in the production of large-size sculpture projects.

In the Research Creation project, 3D printing was combined with CNC milling. With *Vulnerable: The Salmon Project*, the scan data of the salmon form was digitally manipulated and transformed. Six 3D Z-Corp prototypes or variations of the digital sculpture form were printed and one was selected and further enlarged on the CNC machine (Figure 7). The decision to first 3D print the form was motivated by the need to study the different versions of the salmon sculpture in real space.

The immaterial nature of digital objects and their impalpability inside a computerized context influence the artists' creative process and often result in a need to transpose the digital object into a material form. The artists combine other transformative processes, most often metal casting, with RP processes. With metal casting technology, the artists use a lost wax process, in which a wax sculpture or a 3D print is cast in bronze, aluminum, iron, stainless steel, or another metal alloy. The artists can combine analogue and digital approaches from concept to process, as both are in line with a transformative mode of production. With *Vulnerable: The Salmon Project*, CNC milling was combined with a more traditional mould-making process (Figure 9.3), as the lost wax method was used in the production mode of the cast aluminum sculpture.

From a different standpoint, Kiki Smith also combines CNC milling and the lost wax process in the production mode of her enlarged cast bronze and aluminum sculptures. Kiki Smith's collaboration with the Walla Walla Foundry indicates the research potential in technological advances through the crossing over from analogue to digital transformative processes.[69] Innovative directions are presented through the CNC milling of moulds, stressing the ways 3D digital technology influences digital and analogue approaches to the creative process. CNC technology influences more traditional

processes and re-positions the time frame of the sculptures' modes of production. RP technology—3D printing and CNC milling—provoke a shift in the artists' concept-process relationship understood through the values of analogue processes. Through digital spatial-temporal interactions, artists' conceptual and practical approaches to the creative process are influenced by a 3D technological context that merges concept and process, or mind and matter.[70]

5.2.3 Influence of 3D Technology on Artists' Conceptual Approaches

Through creative ways of interacting with a digital medium, the artists experience an extended relationship to materiality. Movement or the concept of distance gains tangibility inside a 3D computerized context. In the same ways that within the mediums of photography or cinema the movement of a subject captured in slow motion leaves a visible spatial trajectory (perceptible inside a 2D dimension), the distance between two objects, or the trajectory of a form inside the 3D software interface, can be shaped into a tangible object. Inside a digital spatial context, impalpable time-based data or movement can shape into a three-dimensional form and be materialized. In Gould's works, distance is no longer an abstract concept but is represented in a sculptural form and perceived as an object. In his sculpture installation work entitled *Untitled (Cain and Able)* (Figures 19.1 and 19.2), Gould's *Blur* study is influenced by a digital-spatial dimension and computer-automated production mode permitting the materialization of the trajectory of a form.

5.3 Creative Process: Sensory Experience

The artists each follow an analogue to digital to analogue method and they initially engage with sculpture work from a hands-on analogue approach. The artists

experience a greater intimacy with the artwork when they work on a smaller scale. When working on a larger scale, the relationship between the artist and the sculptural object is affected by physical constraints. While the artists favour this hands-on approach, the combination of this approach with a 3D scanning mode is what seems to be key in their processes.

However, the artists do not feel the same spontaneity and "intimacy" towards the digital object compared with an analogue object. The artists' relationships to materiality is embedded in their creative process and when the sculptural form becomes immaterial, their relationships with the object are affected. Once the sculptural object is digitized, the data is in fact much more malleable. The structure of the sculptural object changes to a vector configuration (mesh), a simulated form inside a computer context; the artists experience a visual representation shift through the passage from analogue to digital. As the artists' relationships to objects in space differ, ideas reflect a visual language distinct from that developing outside these technological contexts and artwork production process directions.

It is interesting to observe that creative constraints arise when the artists interact with a digital medium inside a 3D software spatial context. The artists are taken away from a creative "comfort zone" and become subject to a technological context that influences their creative process. As they experience a loss in their ability to freely interact with the object in the spatial environment, they engage with an experiential creative approach through which collaboration or technical assistance sometimes provoke feelings of dependency. Creative autonomy can be gained and enhanced from basic knowledge of, and acquaintance with, 3D software language. Research creation

explorations encourage an experiential learning approach to technology through creative activities.

Kiki Smith's sculpture work is 3D scanned, and thus digitized, and the digital data is scaled to finally conclude as a material artwork output. Apart from being scaled and duplicated, very little transformation is done to the digital sculpture form. Her approach to 3D technology is primarily focused on the sculpture fabrication process, and this remains in the ways her collaboration with the Walla Walla Foundry brings to her work a very inventive fabrication process, but she basically uses technology as a "tool." Kiki Smith's creative process explores the passage between digital and analogue mediums; she often uses the same data to create many different artworks crossing artistic disciplines, such as printmaking, tapestry, and sculpture. She is extremely creative within the spontaneous ways her ideas can move between 2D mediums or from 2D to 3D.

Evan Penny's creative approach to a 3D digital technology is currently more exploratory than experiential. In his more recent works, the digital object is stretched, pulled, and scaled, and Penny's formal explorations are primarily dependent on the concept of perception in relation to the human figure or, as he stated, is focused on conveying the idea of "living in the virtual." The aesthetics of Penny's digital sculptures reflects the conceptually rooted quality of his work. It also informs on the creative constraints he experiences due to his limited acquaintance with the 3D software interface spatial environment.

Trevor Gould's work questions the digital object in relation to the perspectival views of the 3D software platform and he explores the ways in which sculpture data

manipulation can conceptually develop through digital directions from an experiential approach. His work is conceptually influenced by the perspectival frame and tool presented on the software interface. From a 3D digital and technological context, Gould's digitized analogue sculpture data extend the medium spatial boundaries and influence his interactions with objects in space.

With a Research Creation project, the artists-researcher thoroughly engaged with a creative process influenced by technological challenges, as described in section 3.6. The study led the artist-researcher to an exploratory creative experience. Through conceptual investigations, the artist-researcher experienced interactions with a digital medium and a sculpture production process influenced by a shift from analogue to digital modes. While adjusting to the material and the immaterial object interaction inside two different spatial-temporal contexts, the researcher acquired an expertise in an underexplored field of research. The artist-researcher experienced ways in which a 3D digital and technological context extends sculptors' spatial and medium boundaries through a relationship with digitized objects sculpted inside a computerized environment. The artist-researcher's perception of visual representations was broadened through a deeper understanding and familiarization with the immaterial qualities of digital objects. When 3D scanning a salmon, nature was appropriated from a digitizing process, and the manipulation of the data informed the artist-researcher about the structural malleability of the digital sculpture form. But most of all, an investigation of a digital medium not only extended the artist-researchers' spatial and medium boundaries, but it also stimulated ideas for the direction of interdisciplinary work addressing nature, art, and technology.

5.3.1 From 2D to 3D: The Plural Condition of a Digital Medium

The digital medium influences the artists' creative process through the ways in which a numerical image and a digitized form can share the same spatial context. The artists in the study use both 2D and 3D scanning in their work. With Kiki Smith's and Evan Penny's works, 2D scanning is a step in the artists' creative process that transforms a 2D concept into a 3D one. Kiki Smith uses 2D scans of her drawings to create water jet cut reliefs or low relief cast bronze sculptures. Penny uses 2D scanning of pictures of his life modelling project and plays with the digital photo to give direction to his 3D work. The digital image reshapes the artists' perceptions of any visual artistic form, which, through digitizing processes, becomes a "purely arbitrary construct" (Hansen, 2006) that encourages a plurality in the arts. [71]

The concept of plurality in the arts (Krauss, 1999) conveyed by a digital medium influences artists' conceptual approaches as it encourages the passage from a 2D image to a 3D digital representation. In Evan Penny's and Kiki Smith's creative approaches, the data of a drawing or a photograph are used to create a series of works in which the original data are transformed into something different. The sculptors' interactions with the digital medium influence the aesthetic qualities of their artworks as the same data shapes the work into various art forms. However, the plural condition of the digital medium is explored within a limited range and does not extend to other digital media or other disciplines. Creative explorations from 2D to 3D were also experienced through the Research Creation project when a typed word on the computer screen took up spatial attributes.

Furthermore, the digital medium gives rise to the concept of "the necessary plurality of the arts."[72] Today it is possible for artists working with diverse mediums, such as cinema, photography, or sculpture, to push the concept of spatial-temporal (a space-time dimension linked to a technological era) further in their work. As presented in section 1.7.2, this extrapolation of the notion of medium provokes a shift away from more traditional understandings of art. It forces artists to re-visit the concept of the specificity of the medium and their relationship to artistic practice. Artists' comprehension of the plurality of the arts is affected by an impalpable, intangible, and malleable computerized and digitized medium that belongs to a digital creative context. Finally, the malleability of the digital medium allows for many interpretations of the data source. For example, with the blur project, Gould uses 3D scanning to digitize his hand-made small-size figure and then manipulates, duplicates, and enlarges the digital sculptures.

Similarly, it is through direct application and exploration from a heuristic approach to digital technology that artists become proficient in data manipulation. By interacting with a digital medium in their own projects, artists become familiar with the malleability of the digital object. This creative learning approach facilitates artists' comprehension and stimulates their interest in technology. As the artists' interest grows, applications of digital means in the arts increase, encouraging innovative ways of approaching technology.

Digital technology influences artists' visual language, as it facilitates the interactions between various modes of artistic expression, such as from writing to sculpture production. From a spatial-temporal and material standpoint, interactions with

an analogue or digital object (as presented on the four viewports of the 3D software interface) brings into play two very different sensory experiences, one palpable and the other impalpable. Interactions with simulated objects influence artists' perceptions, which are guided by the impalpability of the digital representation. The artist can see the digital object but cannot touch it, like a chef who can smell but cannot taste. Therefore, as artists create digitally, they often move back and forth between analogue and digital production modes. However, if they bring the artwork data into other digital mediums, the artwork, while no longer recognizable in its original form, is discernible within the medium specificity of the media in which the data is transposed. The creative process experiences a digital data transfer mode through which digital convergence encourages a crossover medium approach to artistic creation and also to all disciplines, from concept to process.

5.3.2 Sensory Interactions With Technology

Each artist's interactions with technology are different. Artists adapt to technology but everything can potentially change during the creative process. From another perspective, technology adapts to artists or, as in Kiki Smith's creative process, concepts and objects inform the technology, she stated: "It is slightly different using different technology, different methods or different material." Her artwork evolves from concept to process back to concept and process again, shaped by an analogue-digital-analogue mode of production. The role technology plays in her creative process is influenced by her sensory interactions with the medium. Kiki Smith shows an ease with moving from a 2D paper print or tapestry, drawing, or collage to a 3D cast bronze sculpture or low relief water jet cut mural. As she said, "everything is fair game to be used" and she insists on using that which serves the creative intention. Her focus is not on

the use of specific technologies but is about creative activity ideas and imagination. She never anticipates what the work should be: her artwork is subject to a technologically uninhibited creative process. The computer environment turns processes into ideas and becomes a source of inspiration. This is how she frees herself from technological constraints and how the aesthetics of the artwork is subject to her creative freedom.

In contrast, Gould's sensory interactions with technology remain within a 3D perspective. His work reflects on the relationship between the digital object and its computerized spatial context. He questions this creative context, as he attempts to communicate his creative intentions to the technicians who assist him with the software interface toolbar commands. Gould's sensibility becomes linked to that extension,[73] through which his thoughts or ideas are expressed.

Within a computerized spatial context, artists' ideas are influenced by unforeseen actions moving the work in unexpected directions. Experiential learning frees up artists' minds from technical constraints and fosters innovative ways of thinking, imagining, and hence expanding spatial boundaries in sculpture practice. The learning curves required for most 3D software interfaces do not adequately address the ways in which artists engage intuitively with creative activity. More tactile and sensory applications in software programming advances (that address the cognitive mechanisms of users)[74] would encourage experiential learning through creative activity.

5.4 Experiencing the Unexpected

Artists' creative explorations of a digital medium inside a computerized spatial context push the boundaries of the medium. The 3D software environment is perceived as

a creative space inside which unexpected interactions between the artist, the medium, and its production processes influence not only the artist's creative experience but also the aesthetics of the artwork. Trevor Gould senses that the unexpected, which is inherent to creative activity, occurs inside the software interface, but he feels his experience is limited by his difficulty to freely navigate and create independently. From another point of view, Penny perceives the digital spatial context to be as creative and unique as an analogue environment. In his creative process, there is always something unexpected that happens and the spatial context inside which the artwork develops does not seem to influence the probability that unexpected things may happen. However, Kiki Smith feels that to experience the unexpected, one has to engage with the digital medium creatively. Because she does not create works directly from digital data, or as she says "I do not use the data that way," she does not comment on the concept of experiencing the unexpected inside a 3D digital and technological context.

In the Research Creation exploratory work *Vulnerable: The Salmon Project* the artist-researcher engaged with unexpected creative insights; the ways in which the digital sculpture data was transformed through playing with its mesh structure concluded in very spontaneous interactions with the digital sculpture inside the software interface environment. The creative freedom experienced demonstrated ways in which artists' can engage with a digital medium inside a spatial context open to the unexpectedness of creative activity.

A comprehension of the structure of digital objects, of their interactions inside the 3D software interface, facilitates the artists' understandings of the ways objects can be manipulated and transformed. When artistic concepts or ideas are explored inside a

digital spatial environment, increasing artists' spontaneity through the creative process provokes a merging of thought and action, or concept and process. With 3D technology, the sudden move of the sculpture form experienced inside the software interface, combined with RP automated fabrication processes, influences the way thoughts and actions or an artistic concept and its fabrication process can form a single entity. Engaging creatively through a sensorial experience of a digital medium is different from working with sculptural forms in real space as it is exempt from not only physical but also spatial-temporal constraints.

Moreover, experiencing a 3D digital and technological context through research creation exploration leads to the observation that the artists experience creative constraints when technological limitations are at play, when they need hand-holding assistance or must stand behind a technician. But, as expressed by Evan Penny, creative constraints can also bring a "kind of truth" to the work so that "the artwork can happen." This position is supported by Margaret Boden (2004), who proposed that, contrary to the belief that "rules" and "constraints" are irrelevant to creativity, "Constraints map out a territory of structural possibilities which can then be explored, and perhaps transformed to give another one" (p. 95).

The impact of a digital medium on the artists' creative process, however, is also relative to the ways in which the artists engage with technology in their work and, as Kiki Smith stated, "I just use it the way I would use a pencil . . . but I think that if you go out there, there really are a lot of things going on. . . ." Kiki Smith's remark proposes that technology influences a number of artists' creative explorations, but that her creative

process is primarily driven by a hands-on approach, where a more tactile sensory knowledge impacts her creative investigations.

5.5 Artists' Interactions With 3D Digital Technology

Artists' research creation explorations denote that artists sensory experience gains from a familiarity with the software spatial configuration allowing the sculptors' interactions with the digital medium more fluidity. The 3D software interface spatial context does not seem to inspire Kiki Smith's creative exploration of digital sculpture forms, which are basically scaled up, duplicated, and enlarged. However, when she works inside a 2D digital platform, visual explorations through scan photos or drawing manipulation seem to be more at play, as if greater familiarity with the 2D software influences her spontaneity.

Penny merges concepts and techniques throughout his creative process. Conceptually, object transformation takes place from a 2D to a 3D software interface. Through the sculpture production mode, CNC milling is combined with mould-making and casting. Within silicone rubber layout creative strategies, Penny brings authenticity to hyper-realistic digitally transformed figures. As Penny explained: "I think my work basically operates from the presumption that all aspects of the process, all technical aspects, are also conceptual aspects, we can't separate them." Penny's creative process alternates between analogue and digital, using digital processes to study the various options or directions that the work could take. Thus, the software environment is where the image-object relationship and transformation are explored. Penny's relationship with forms and objects is thoroughly experienced from a palpable material standpoint, as the digital sculpture is never presented as the final artwork output.

Trevor Gould is interested in exploring how the computer, as a machine, can build the visual form he mentally projects or imagines. Gould's interactions with the software interface spatial configuration influence his analogue perceptual modes. Similarly, digital space influences his relationship to forms and objects but not necessarily through explorative and unexpected interactions with digital sculpture transformations. Rather, it occurs through his own imagination and anticipation of how the visual qualities of the sculpture can change digitally. He questions the artist's relationship to objects in space within a digital spatial context, but he imagines the sculpture output from his analogue sensory knowledge. Gould's creative process is also affected by the constraints and obstructions he experiences—by not being able to work freely inside a 3D software environment.

5.6 Interpretation of the Results: Inferences

Acquaintance with a digital and technological context, including the software spatial configuration, the digital medium structure, and automated production processes, extends not only artists' levels of creative freedom but also their ability to explore different ways in which a digital medium eliminates the boundaries between disciplines. Artists can imagine and investigate how the malleable qualities of a digital medium and technological context can transform the significance of objects in sculpture practice as well as the means of their production.

Technological knowledge may encourage creative freedom, but what comes first: creative freedom or technological knowledge? This is a causality dilemma: artists' augmented experiences of creative freedom can be a consequence of a technological knowledge growth. But without creativity and imagination, any form of artistic

manifestation or even humans' most significant experimental findings would not have happened or be possible. It seems necessary to free creativity from technological constraints. Recognizing that creativity and technological knowledge affect and depend on each other, which one comes first? To answer this question, it is important to approach both from the same perspective and understand that once they are in symbiosis, they become free from one another.

Just as materiality implies palpability, immateriality implies volatility. Thus, because a body perceives external stimuli, senses react to "touch" within a physical and material world. Furthermore, people respond sensorially to a display of rapid change or the volatility of a digital medium in an immaterial dimension. Similar to learning sculpture processes using analogue modes of production, as artists engage with digital modes of production, their creative process is expected to adapt to a digital medium and a CAD technology subject to the rapid transformation of the digital sculpture through RP fabrication process. As a consequence of artists' adaptation to a different spatial-temporal context and sculpture mode of production, the same level of creative freedom is expected to be experienced from both perspectives.

The study does not look primarily at the influence of a 3D digital and technological context on the artists from the perspective of how it affects sculpture fabrication or through the ways in which it can be used as a tool to facilitate sculpture processes. Rather, this research is motivated by the creative potential embedded in a malleable medium shaped by a generative process within which artists' imagination can explore both aspects and qualities of the technology and bring innovation to the arts.

The study observed that creative exploration includes artists' conceptual investigations not only with digital mediums but also with automated fabrication modes where concepts and processes are bound to a 3D digital and technological context. From conceptual to practical means to address research creation, artists can extend not only the spatial boundaries of the medium but also the process-oriented perspectives of the practice. Therefore, when the artists say that they are using technology as a tool, it can be interpreted that technology does not inspire these artists' ideas or stimulate their creativity but simply meets the basic fabrication needs of their sculptures. In order for a 3D digital and technological context to be the artists' means to create—and influence their creative process from concept to fabrication—technology and creativity must be experienced in symbiosis, reflecting on the artists' concept, percept, and process in such ways that the sculptors' interactions with a digital medium influence the aesthetics of their artwork from different perspectives.

Collaboration between the university sector and private company research centres or independent sculpture production studios influences artists' creative exploration growth. It also supports artists' experiences of a symbiosis between creativity and technology. This study presents different levels of collaboration, as well as different technological resources. Trevor Gould and the researcher (Claire Brunet) work inside a university environment (the Hexagram Research Centre, Concordia University). Kiki Smith and Evan Penny work with artistic production labs, including Walla Walla Foundry (Dylan Farnum, USA), Digital Atelier (Jon Lash and John Rannou, USA), XYZRGB scanning services (Toronto), or the cinema industry. In addition, the Research Creation project necessitated the artists-researcher's collaboration with the Digital Atelier,

Schindler Technology (for advanced Rhino software training), Creaform 3D scanner, (which brought technological support for the use of a Handyscan 3D digitizer and data post-processing Geomagic software advanced training).

With time, the expansion of 3D digital technology ubiquity in all artistic domains extends sculptors spatial and medium boundaries and brings to sculpture practice great potential for artistic exploration and creative innovation. Two important influential aspects of digital technology are at play: the ways technological advances can adapt to artists' creative process to facilitate artists' sensory interaction with a 3D digital and technological context, and the digital medium's plural condition, which theoretically and practically augments the crossover of all artistic digital mediums.

The artists creatively engage with a digital medium and software spatial environment from a sensory side, experiencing technology through trial and error, with an openness to the creative constraints and obstructions that bring about the unexpected, which is essential to creative activity. The research findings present ways in which a 3D digital and technological context extends sculptors' spatial boundaries and influences their creative process. The research findings support that software programming advances should better adapt to the users' (artists') needs. In this way, programming directions should move away from systematic programming and focus on adapting to a context more in line with artists' sensory interactions with spatial environments and the interrelationships between objects in space.[75]

CHAPTER 6

RESEARCH CREATION

6.0 Introduction

Chapter 6 looks into the Research Creation project supporting the doctoral dissertation. In previous chapters, the ways in which a 3D digital and technological context influenced the case study artist-participants were discussed, observed, and interpreted. In this chapter, a focus is given to how 3D technology influences the artist-researcher's creative process through analyzing the body of works presented in the exhibition supporting the doctoral dissertation. This chapter informs the reader how the research problem is addressed and the research questions are answered through experiencing creative propositions. An exploration of artistic concepts is proposed through a narrative approach to the subject of the inquiry. This chapter also presents the ways in which the artist-researcher adapted to a creative experience inside a digital context where space-time and materiality were greatly affected by a digital medium.

In Chapter 3, the research creation data collection method that guided the Research Creation project and the influence of a 3D digital and technological context on the artist's creative process was presented from a process-oriented point of view.[76] This chapter addresses the research problem through scrutinizing the artist-researcher's creative work with a focus on the main sculpture installation project from a conceptual standpoint.

The themes exposed in the case study interviews analysis are addressed through describing the researcher's creative process, which led to the artwork presented in this

chapter. Following the direction taken in the interview questions, light will be shed on the ways in which digital technology influence the researcher's interactions with time, space, and materiality. Guided by an exploratory direction, the Research Creation works contribute to encouraging an artistic approach described by Eisner (2008) as a research method that encourages the researcher "to invent new ways through new means" (p. 6).

This chapter is divided into sections that correlate with the case study interview questions and themes addressed in the study. The artist-researcher is first introduced, just as the artist-participants of the study were introduced in Chapter 4. The contextual background leading up to the artist-researcher's use of 3D digital technology is then examined and an overview of the focus of the Research Creation project is presented including the ideology, meaning, and anticipated viewer interaction. The context in which the researcher became interested in technology, more particularly 3D digital technology, is also described. The researcher's current practice and artwork projects presented in the exhibition supporting the doctoral dissertation are discussed. The artistic concepts through which an exposure to a 3D digital context influenced a visual language that merged digital and analogue approaches to spatial-temporal dimensions in sculpture installation art practice is also explored.

6.1 Claire Brunet

The artist-researcher is a Canadian sculptor, born in London, England, but raised in Quebec City in a French Canadian family. Throughout her childhood, she was exposed to an artistic environment and influenced by the explosive growth in the arts scene in the 1960s. At a young age, she engaged with sculpture in her family's home pottery studio.

She studied sculpture in academic institutions but also through mentorships, while taking part in the underground art community of the 1980s.

Her Research Creation projects inquire into the state of the natural environment. The work ideology addresses environmental awareness. In the early eighties, the influence of the urban environment can be seen in her sculpture installation works. *Lavori in Corso* (1986) engages in a discourse on the speed of life; the artwork reflects urban living conditions as a metaphor for life. By the late eighties, her work direction shifted and started to address ecological issues, for example, the sculpture installation project *Ozone: La Chaleur Trop Intense du Temps* (1988), which focuses on global warming, and *Molusma* (1989), which depicts disastrous petroleum spills in the ocean. In the 2000s, the works addressed engineered food, with *Potato Column I, II,* and *III* (2002), and genetically modified organisms, with *Soul Lost in the Genome* (2003). Going forward, her artistic propositions never stopped demonstrating environmental awareness, which continues to bring to the work a concern for the state of the natural environment and living conditions.

The ecological discourse of her current Research Creation project addresses the salmon, an iconic figure of Canadian marine life. The sculpture installation work positions the salmon as a visual metaphor for the vulnerability of the living condition. As a way to express the paradoxical aspects of life, this fish species also symbolizes the strength of nature's instinct for survival. The sculpture installation work investigates a concept of time, and the researcher explores new ways of looking, inventing, imagining, and expressing past, present, and future perceptions and interactions with the world in which we live. An exploratory study of the influence of a 3D digital medium on sculpture

installation practices triggered the artist's relationship with two confronting environments: the natural and the technological, both of which influence contemporary life.

6.1.1 Artist's Contextual Background

An ongoing interest in research in art and technology arose for the researcher when she worked with sculptor André Fournelle. In the mid-sixties in Quebec, Fournelle led the new concept of merging technology and art in sculpture practices through his work with the Fonderie Expérimentale et Collective project. During that time, a growing interest in developing new approaches to artistic expression linking art and science was also manifesting in the United States. The American collective, Experiment in Art and Technology (EAT), was founded in the mid-sixties by Robert Rauschenberg and had taken root in New York.[77]

In the early 1980s, the artist-researcher collaborated with Fournelle, as an apprentice, on several art-based research projects. Fournelle transmitted his passion for art research and experimentation, a vision of a shared knowledge between art and science that continues to impact the artist-researcher's creative process. In the mid-eighties, the researcher moved to the United States to join an apprenticeship program at the Johnson Atelier Technical Institute of Sculpture (JA), located in Princeton, New Jersey.[78] The Atelier used an approach to teaching where learning derives from doing. The learning focus of the apprenticeship program specialized in metal casting processes with an ongoing avant-garde experimental and creative vision. While living in the United States during this period of her life, the artist-researcher engaged with artistic creation surrounded by state-of-the art international artists and a multicultural group of peer

apprentices. The researcher experienced socio-cultural and technological interactions in a context of artistic creation focussed on art and innovation. Surrounded by masters and assisted in her art practice by the newest American technology in the field of sculpture the artist-researcher was exposed to artistic knowledge based on the crossing of boundaries between art, science, and technology. Since then, her artistic practice has been experienced through an ongoing investigation of the concept of *transformation* as it shapes the boundaries of her creative activity. Influenced by an increased interest in matter transformation,[79] inside a context in which materiality and palpability are a means to create, her artistic concepts inevitably led to a need to explore new spatial-temporal dimensions.

Working with more traditional analogue transformative processes inevitably led the artist-researcher to inquire into digital processes. The artist-researcher moved from experiencing the transformation of matter through metal casting technology to the transformation of immaterial digital objects. Moreover, the trajectory leading to the exploration of 3D digital technologies through artistic creation followed a natural progression from working with transformative processes from analogue to digital perspectives.

6.2. Research Creation Project

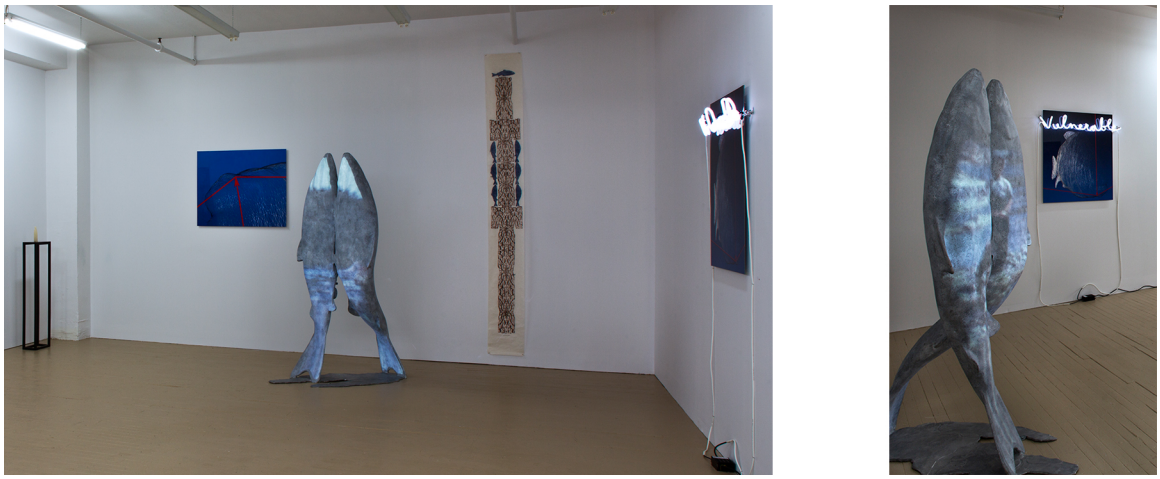

Figure 22. Exhibition at POPOP Espace d' Art Contemporain, Montreal January 2014. From left to right; *Self Portrait* (MJM print), *Digital Landscape* (digital print), *Vulnerable: The Salmon Project* (sculpture installation with video projection), *Entre l'Arbre et l'Écorce* (print on Japanese paper), and *Vulnerable* (digital print and neon light).

The outcomes of the Research Creation project at the focus of this chapter include a major sculpture installation project titled *Vulnerable: The Salmon Project*. Addressing an ecological discourse and referencing a living condition through the concept of historicity,[80] the mode of production of the artwork was explored primarily through 3D scanning and rapid prototyping (RP) technology. The digitizing method, the manipulation and transformation of the data, brought along other works, including an edition of prints titled *Entre l'Arbre et l'Écorce* (Figures 12.2, 22) and digital prints inspired by the main research project method and proposing the visualisation of the mesh structure of the salmon scan data. A neon light sign is juxtaposed on one digital print, and, in reference to the main sculpture installation work, the neon tubing forms the word "Vulnerable" (Figures 22, 25). The other digital print work propose a close-up view of the 3D scan mesh data (Figure 22). In addition, a digital sculpture work titled *New Media_Old Medium* shows manipulation of the salmon scan data (figure 26).

6.2.1 Contextual Background of the Research Creation Project

The main themes developed in the work are nature, transformation, and change; ecological issues are presented through this sculpture installation work that reflects a line of inquiry into the condition of the living environment. The sculpture installation concept proposes a referential loss of natural resources but the artist's intention is not to reveal the past; rather, the Research Creation project draws on Heidegger's concept of time by using the past to reveal a present within a perspective on the future.[81] The artist brings to the work a historical referent through a film projection on one side of the standing salmon sculpture. On the other side of the sculpture, extruded letters are used to address the state of the salmon's living condition.

As the viewer walks around the sculpture, a "state of having been" is revealed. The artwork is intended to make the viewer experience a historical investigation that enters the present (Heidegger, 2011) and to provoke an awareness of the vulnerability of life (of all living species). Again in reference to Heidegger's (2011) concept of time, the artwork becomes a critique of the present:

> Authentic historicity is not a matter of presencing something, but that state of being futural [Zukünftigsein] in which one readies oneself to receive the right impetus from the past in order to open it up. In such futuralness [Zukünftigsein] historiological investigation enters the present; it becomes a critique of the present. . . . it is in fact the right way of becoming contemporary [Gegenwärtig-werden]. (p. 80)

As the artwork concept develops, a digital and technological medium guides the artist's creative investigations. The artworks presented in this section propose a view not only on ecological issues as a means to address awareness of the state of the natural

environment but also on a digital medium moving objects into a code and fabrication processes into automation.

Although the artwork concept addresses a temporal and historical referent, the sculptural object proposes a vision that questions the future. As evidenced in this Research Creation project, looking at sculpture practice through envisioning a process of creation as a medium of expression (as opposed to approaching it by excluding concepts from production and looking at process as a means of fabrication) leads to a knowledge based on an experimental approach to sculpture continuously engaged with the concept of transformation.

6.3 Current Experience of 3D Technology

Through working on Research Creation artworks, the researcher engaged creatively with ideas conveying an ecological content in relation to issues of actuality. Current experiences of 3D technology, among other strategies, include an approach to a 3D scanning digitizing process that replaces—to a certain extent—more traditional mould-making techniques. The researcher digitized objects as a way to appropriate forms from nature used in her art projects. The researcher explored 3D software through the manipulation of 3D scan data in an experiential way. By sculpting inside a simulated environment, the researcher experienced a digital spatial context that freed up her mind from constraints of size, weight, and gravity. Inside this computerized space, the researcher framed important questions that further support the Research Creation project and artworks' mode of production.

Furthermore, the researcher experienced RP technology through exploring 3D printing and CNC milling within a print edition and the sculpture installation production processes. First, 3D printing was used to get a few prototypes of the salmon sculpture and second CNC milling was used to enlarge the prototype selected. In addition, the CNC milling process was also used to create low relief Styrofoam cut sections assembled together in the composition of the template for the print project. A salmon form and a piece of bark were digitized and the scan data was manipulated inside the software interface to create the artworks. From a digital back to an analogue spatial context, the tangibility of these elements from nature shifted from being an intangible gravity-free form to a tangible form inside a gravitational space. The sculpture and print works were then completed from a hands-on perspective.

The print work description is presented in section 3.6. The conceptual framework of the print is in line with the theme addressed and conveys ecological content. The bark element of its composition was chosen in reference to the impact of deforestation on marine life and addresses the influence of the natural environment on a living condition.

In the following section, the main sculpture installation proposition supporting the research will be presented. The conceptual aspect of the work *Vulnerable: The Salmon Project* will be addressed.

6.3.1 Sculpture Installation Project: *Vulnerable: The Salmon Project*

The artwork carries a concept of memory, a trace of the past as evidence that something has happened to provoke a change in the natural environment. The concept of time is key to the Research Creation project. Time is conveyed from two perspectives:

first through the *presentness* of nature[82] and second through technological means linked to the artwork production mode. As introduced in section 3.6, the inspiration for the sculpture installation work came from viewing a 16 mm archival family film projection showing moving salmon in the river that showed their abundance in the 1940s. The artist-researcher then questioned the losses of the natural world and how to transpose this questioning into a work of art.

The sculpture also expresses the vulnerability of the living condition. As a means of stressing the salmon's living condition, the viewer can read the word "Vulnerable" in extruded letters on the front side of the cast aluminum standing sculpture. The sculpture represents an enlarged and duplicated salmon form standing up on two curved tails; a film is projected on the backside of the sculpture. As viewers walk around the work, they experience images of salmon fishing in the 1940s mapped on the whitish patina surface of the cast aluminum salmon.

By projecting historical salmon fishing images on the sculpture, the artist-researcher's intention was to create an interaction with the viewer, who becomes a participant in the artwork, a *regardeur* witnessing the present and experiencing the past, experiencing historicity (Figure 23.1).

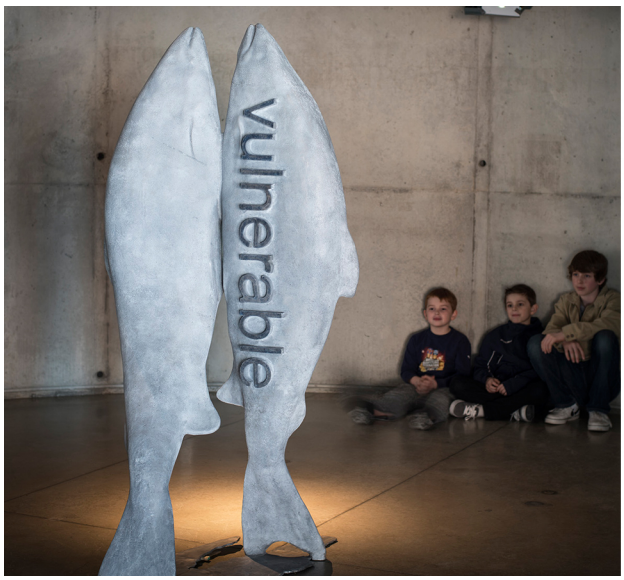

Figure 23.1. Claire Brunet, *Vulnerable: The Salmon Project*, 2007-2012, exhibition at the Canadian Clay and Glass Gallery, Waterloo, Ontario, 2012-2013.

Figure 23.2. Claire Brunet, *Vulnerable: The Salmon Project*, 2007-2012, exhibition at POPOP Espace d'Art Contemporain, Montreal, Quebec. Video mapping.

6.3.2 *Dasein*

In Heidegger's (2011) concept of time, the experience of living is conveyed through the German word *Dasein*.[83] In the context of this research, that concept is moved through a paradigmatic worldview addressing a hypermodern time, the time of the "here and now" (Lipovetsky, 2005). Heidegger (2001) proposed that facilitating understandings of historicity involved "lay[ing] bare the nature of the being of *Dasein* [*Seinsverfassung des Daseins*] by showing positively what the phenomenon of time is" (p. 10). Time, for Heidegger (2001), is about living, and in his words, "human life is geared towards time . . . Events [*Ereignisse*] occurring in the world around us [*Umwelt*] and the processes of the natural world are 'in time'" (p. 11).

In the work *Vulnerable: The Salmon Project*, the concept of *presentness* expresses a temporality that connects past events (a film narrative) with a sculptural object (a cast aluminum salmon form), questioning a future condition that informs the present, or, from a Heideggerian perspective, "a future event [*das Zukünftige*] of the kind that we expect that-which-is-not-yet-become-present [or is] with respect to the present as something potentially present" (Heidegger, 2011, p. 48). The artwork also suggests that we, as a society, should not let it continue into the present or, as phrased by Heidegger (2011), "not let that-which-is-not-yet-present come straight towards one into the present" (p. 48). The condition of the natural environment rests on a common respect for the ecosystem of living species and the decisions and actions taken today will affect the future quality of life. Moreover, the work conveys a temporality in line with Heidegger's concept of being futural.[84] The artwork expresses an awareness of a phenomenon happening in the present time but impacting future generations. Therefore, *Dasein*, or the concept of experiencing living, is represented in the work in reference to a past and a present that lead to an ecological discourse addressing an awareness of a future embedded in time, as the viewer experiences the artwork (Figure 23.2). Moreover, when viewers face the artwork, they at the same time face a choice as individuals taking part in society, and thus, have to decide between "being conscientious" [*gewissenhaft*] and "not being conscientious" [*gewissenlos*] (Heidegger, 2011, p. 49) of their impact on the state of our ecology or of the living condition of the salmon species, as suggested by the artwork. As a result, the sculpture installation provokes an awareness in the viewer of questions of sustainability.

From a different perspective, through sculpture modes of production, 3D technology's application in sculpture practice is explored. And the concept of "what has

been lost" proposes a view on "what is available," suggesting ways in which the past can be projected onto future directions.[85] In the following section, the artist-researcher's practical approach to the creative process guided by digital to analogue modes is presented.

6.4 Creative Process: 3D Scanning, 3D Modelling

One of the main characteristics of the influence of 3D digital medium on the aesthetics of the artwork rests on the digitized object manipulation done inside the 3D software interface environment.[86] In the work *Vulnerable: The Salmon Project*, the scan data or mesh file was transformed as the salmon sculpture was taking form. The scan salmon form was digitally manipulated, but a typed word was also brought into the artwork composition. The text file apposed to the salmon form indicates how a NURBS geometry can move to a polygon mesh structure. The text file and the salmon form are no longer two independent entities but compose a sculptural form that embeds meaning in an object. Since the letters are extruded, they formally shift from text to object. The sculpture presents both digitizing approaches—3D modelling and 3D scanning—that are combined in the sculptor's interaction with the digital medium and influence the aesthetics of the artwork.

In *Vulnerable: The Salmon Project*, the word "Vulnerable"[87] communicates the concept carried through the artwork. The precariousness of life is stressed through a specific film sequence: the viewing of the artist-researcher's grandfather canoeing down the river holding a large salmon. Her grandfather experienced a progressive loss of eyesight and total blindness at an older age; he was blind when the artist-researcher knew

him as a child. The film sequence brings meaning to the work by situating the word "Vulnerable" from the perspective of our vulnerability as human beings.

Digital approaches to sculpture practice were used to stress the artwork concept. The artist-researcher explored the ways in which a digital medium and a technological spatial context influence her creative process, as the artwork concept and sculpture production correlate.

6.4.1 Rapid Prototyping: 3D Printing and CNC Milling

The role played by rapid prototyping technology (RP) on sculpture production strategies must be considered when looking into how a 3D digital and technological context extends sculptors' spatial boundaries and influences the artist-researcher's conceptual and practical approaches to the creative process. Digital objects can easily be reproduced with automated fabrication technology, and, as presented in Project Gutenberg:[88]

> The premise on which Michael Hart based Project Gutenberg was: anything that can be entered into a computer can be reproduced indefinitely—what Michael termed "Replicator Technology." The concept of Replicator Technology is simple; once a book or any other item (including pictures, sounds and even 3D items) can be stored in a computer, then any number of copies can and will be available. Everyone in the world, or even not in this world (given satellite transmission) can have a copy of a book that has been entered into a computer. (Hart, 1992)

In terms of 3D technology, the sculpture installation work presented in this section implies not only 3D scanning, where the information is received and transmitted, but also rapid prototyping processes, through which information is sent to the machine. The machine receives and transmits it and the data are 3D printed in a sculpture format, a process through which the sculpture data can be reproduced endlessly.

When creating forms from a 3D software interface context, the sculptural object is simulated and viewed on the *xyz* perspectival plane inside a gravity-free spatial context. For the Research Creation project, prototypes were 3D printed to study the interactions of the sculptural object in real space. This sensory experience of a palpable form in real space that 3D printing facilitates—from digital to analogue—enabled the study of a small-scale reproduction of the sculpture concept during the creative process. The artist-researcher considered using the 3D print form as a final output but was more inclined to transform the printed form into a bronze or aluminum sculpture.

6.4.2 Transforming Data

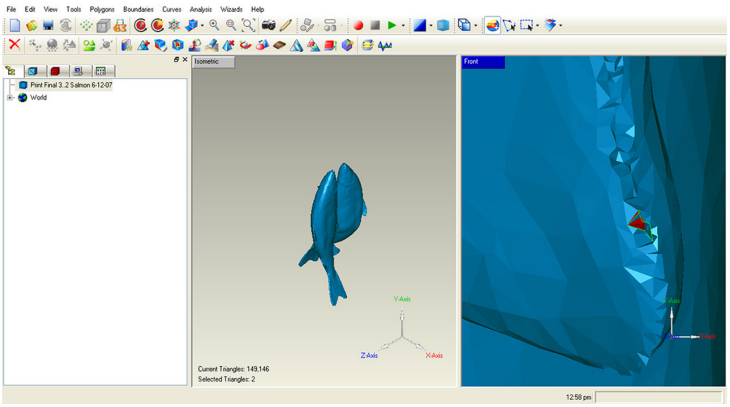

Figure 24. Geomagic software interface, digital salmon and mesh triangulation, close-up view.

Transforming data is an important aspect of digital sculpture exploration and interaction with objects in space inside the 3D software interface environment. Over time, the artist-researcher learned how to use different 3D computer programs, starting with Form Z at Concordia University in 2006, to Rhinoceros, the software she uses primarily today, in combination with Geomagic, a scan data post-processing software (Figure 24). The artist-researcher collaborated with a painter on a sculpture competition project in the

summer of 2012. Two-dimensional hand-made drawings were 2D scanned on a standard tabletop bed scanner and the data was vectorized in Illustrator before being imported into a 3D software interface. The reformatted digital sculpture data were then 3D printed to create a sculptural object inspired by the merging of 2D drawings and 3D modelling (Rhino). The 2D concept was transposed into a 3D object and materialized through 3D printing technology to produce a prototype of the sculpture proposition. The aesthetics of the artwork was influenced by technology that allows the passage from a 2D to a 3D medium. This is characteristic of a digital medium that encourages plurality in the arts.

The artist-researcher experiences creative freedom inside a digital spatial context when interacting creatively with 2D data to 3D objects. On certain projects, technical assistance may be required, yet she does not experience this as a creative constraint but as the sharing of knowledge and expertise, which encourages artistic growth.

6.4.3 Preparing Files for RP Process

Digital files were sent to the RP lab for 3D printing. However, with CNC milling technology, the artist-researcher learned how to prepare and process files as she experimented with the technology at Concordia University Fine Arts Studio. The artist-researcher stressed a creative research approach to RP processes. Creativity should not only reflect on data transformation but on experimental approaches to how the data is sent and received.

6.4.4 Re-Working 3D Print and CNC Milled Form

The artist-researcher does not dissociate concepts and processes and engages with both aspects of sculpture practice as an ongoing creative act. When working on a 3D print

or CNC milled form, she mostly envisions 3D printing as a transitory step, needed for the production of a model or prototype. Based on the result, and after studying the sculpture form's interactions inside an analogue context in real space, the artist-researcher decides whether or not to re-work the digital sculpture file. However, once the artist-researcher scales up the work and CNC mills it, as done with the salmon project, besides assembling the Styrofoam parts and adjusting the form, sanding, and slight carving, she does not re-work the entire RP print form to make something new or different with it. Because the concept is already in place, she steps into data manipulation as a creative act and moves on to the next idea.

Today, interactions with objects in space have expanded from working with palpable material to transforming immaterial data. The artist-researcher understands that both analogue and digital perspectives belong to the domain of sculpture in many different ways. Ideas guide processes and artistic freedom belongs inside the symbiosis between *praxis* and *poiésis,* from analogue to digital perspectives and vice versa.

6.4.5 Scaling and Duplicating

The meaning of an object is also influenced by the object's scale, which impacts both the significance of objects and their spatial interactions with the environment. The scaling and duplicating of forms is important in sculpture practice. Digital technology greatly facilitates scaling and duplicating. The ease with which 3D software tools allow artists to interplay with objects' scale enables artists to visualize and anticipate the formal and spatial interactions of objects with a specific environment.

6.5 RP and Other Transformative Processes

As proposed previously, the concept of transformation is key to the artist-researcher's practice: transformation of ideas, forms, digital data, and analogue matter. With *Vulnerable: The Salmon Project*, casting the fish form in aluminum was embedded in the idea. The artist-researcher envisioned that the liveliness of a cast aluminum salmon form would bring to the work the *presentness* conveyed throughout the concept.

This chapter has presented the themes introduced in the interview addressing the artist-researcher's contextual background and a creative process exposed to 3D digital technology. More importantly, the artwork's conceptual perspective has been shown to inform a creative process that explores art and technology through a questioning of the vulnerability of the natural environment in relation to a living condition. This chapter concludes with an invitation to view the works in the exhibition presented in support of the dissertation. The show includes *Vulnerable: The Salmon Project* (Figures 1, 2, 23.1, and 23.2); *Entre l'Arbre et L'Écorce* (Figures 12.2, 22); *Digital Landscape* and *Vulnerable,* digital prints and neon light (Figures 22, 25); *New Media_Old Medium*, Z-Corp print and record player briefcase (Figures 26.1, 26.2).

Figure 25. Claire Brunet. *Vulnerable* 2010, digital print and neon light.

Figure 26.1. Claire Brunet. *New Media_Old Medium*, 2013. Z-Corp print and record player briefcase. Close up view.

Figure 26.2. Claire Brunet. *New Media_Old Medium*, 2013. Z-Corp print and record player briefcase.

CONCLUSION

Sculpture installation works reflect artists' spatial explorations through the representation of concepts and objects conveying social, cultural, political, ecological, and technological values of the time in which we live. Art movements reflect the influences of artists at moments in time; temporality, physicality, and spatiality characterize a continuously redefined sculpture installation art. Creative explorations of concepts reflecting the artists' interactions with a digital medium are experienced inside an expanded concept of space and time. Artistic works develop from analogue and digital interactions between the artist and the medium. The artists' relations to objects in space are influenced by a 3D digital and technological context, inside which the immateriality of a simulated concept challenges the artists' spatial experiences of objects in space.

The focus of this project was to understand the ways in which a 3D digital and technological context extends sculptors' spatial boundaries and influences artists' conceptual and practical approaches to the creative process. Attention to artists' interactions with a digital medium and its influence on the aesthetics of their artwork was also scrutinized. Various facets of experienced creative knowledge were described and communicated in the thesis. This section will provide an overview of each chapter. A narrative overview, as well as a criticism, of the research process, is also presented. In addition, future projects and research directions, inspired by the way that theory, methods, and practice interconnect with the Research Creation process conclude this section.

The study brings out new information on how 3D digital technology and a digital medium influence creative processes that lead to artistic production. The dissertation makes a contribution to the domain of sculpture and installation art within the technological developments taking place in artists' studio labs and at universities all around the world. The study contributes to an understanding of the influence of a computerized context and artists' interactions with a digital medium on their creative process and the aesthetics of their artwork. The study also informs applications of 3D technology, such as 3D modelling, 3D scanning, and RP, and their influences on artists' visual language.

The interviewed artists are influenced by the spatial context of the software interface. The visual language expressed in their works was shaped by their interactions with a digital medium, which are subject to the interface elements of the 3D software. The close proximity of the sculpture concepts and the sculptural objects inside a computer context linked to automated fabrication modes expands the artists' visual,

spatial and temporal explorations. The artists' interactions with objects in space are affected by a software interface, which influences their concepts and the production modes of their artwork. The artist-medium relationships are influenced by a digital spatial-temporal interaction, leading to a sensory knowledge that adapts to the technological advances of the world in which we live.

The influence of digital technology on the arts, design, and architecture is manifested from multiple perspectives but more specifically through a concept of digital convergence (Kittler, 2010). Technology has primarily influenced the domains of photography, video, cinema, design, and architecture. In sculpture practice, artists' spatial boundaries are expanding from analogue to digital. A growing interest in exploratory approaches to digital mediums is affecting sculptors' visual language and the conceptualization and modes of creation of 3D artworks. This technological growth is encouraged through research labs implementations in research creation development inside academic institutions. In sculpture practice, 3D explorations are redefined by sculptors' interactions with material and immaterial forms. In today's hypermodern times, the tangibility of works of art extends to less tangible artworks. Artistic expression continually leads to new approaches to the representation of ideas, reflecting artists' perception of, and interactions with, the world in which they live.

Chapter 1 presented theoretical and philosophical perspectives on a constant knowledge growth from Alberti's (2004) representation of objects on a plane—perspectival spatial representation—to Lambert's (1759) interest in developing instruments to facilitate artists' creative freedom. Today spatial-temporal boundaries are reconfigured by a 3D digital and technological context, and by CAD or RP technologies

reflecting and adapting to the immediacy embedded in the value of an epoch defined as the time of the "here and now" (Lipovetsky, 2005). Artists' creative process is affected by digital mediums, and from analogue hands-on modes to digitization, a computerized environment "touches on" (Nancy 1996) artists' creativity. Today, a visual representation of the distance travelled by a person, or an object, can move from 2D to 3D and be materialized through RP technology.

Extensions of spatial boundaries from historical to hypermodern times continually influence the ways artists perceive and interact with space and time. From a gravitational to a simulated gravity-free context, the expanded perspectival frame of the 3D software environment affects conventional ways of interacting with objects in space. From a 2D image to a 3D object, the digital medium incites artists to revisit the specificity of all artistic mediums. This challenges not only the specificity of the medium, but also the artist-medium relationship. Artists' creative process and artwork's visual aesthetics are influenced by technological modes of production.

Chapter 2 laid out the focus of the study. Many aspects of the influence of 3D technology on artists' creative process are understood through research creation exploration and the responses from the artists who participated in the case study interview process. The two central questions of the study bring to light artists' sensory experiences of a creative process moving from a hands-on analogue approach to a 3D scanning digitizing processes. The study also informs on how the artists' interactions with a digital medium are more often initiated from the digitizing of their analogue sculptures. From analogue to digital, artists' creative freedom and spontaneity is affected by the constraints experienced when interacting with an immaterial digital sculpture

inside the 3D software platform. The study looks into technology from the perspective of the artists' creative environments but knowing that artists' creativity must transcend the digital and technological limitations that the medium itself encompasses. Artists' conceptual frameworks are affected by ideas that do not intend to qualify as strictly digital. An understanding of the ways in which software knowledge or technical assistance facilitate the interactions between the digital medium and the artists brings to light ways that both can enhance artists' creative experiences and the ease with which artworks' conceptualization and production modes are addressed from a digital and technological perspective influencing the aesthetics of their artwork.

Artists' conceptual interrogations find answers through creative explorations of mediums inside a computerized spatial context. The study infers that by transposing an analogue sculpture into a code, the form's malleability is augmented. This brings to play a phenomenon of digital convergence through which any sources of coded data visual qualities can appropriate the 3D attributes of sculptural objects inside a 3D software platform. The influence of a digital and technological context on the artists' visual language is manifested through the artists' ease with which after digitizing the artwork data they can engage with a 2D image (drawing, photograph, or text) and move the work from 2D to a 3D sculptural form. The aesthetics of the artwork is also influenced by the perspectival framework of the 3D software interface, as the artist conceptual frame of reference is inspired by its spatial configuration and the digital sculpture representation is then easily deformed to regain a material form inside a real or analogue spatial context. Each artist investigates the digital medium from a different conceptual standpoint and the ways the sculptors' interactions with the digital medium influence their artworks'

aesthetics depends on the project's conceptual direction and also on the artists' sensory responses to the digital environment. Creative constraints experienced by artists influence their creative process. Specifically, the Research Creation project's experiential approach to a 3D digital and technological context increased the understanding of creative directions and comprehension of the structure, and therefore the malleability and volatility, of digital objects.

Chapter 3, in which the research, methodology, methods, and procedures were presented, introduced the ground on which the research context was situated: a hypermodern worldview that brought to the research a temporality that is in line with the social and cultural changes that a digital medium triggers. This methodological context situated the research methods inside a social and temporal frame of reference in line with the Research Creation approach. A growing understanding of digitizing processes in relation to the creation of sculptural objects was experienced. Artistic practice experienced through technological advancement fostered a comprehension of diverse creative ways to engage with 3D digital object representation and their transposition into sculpture work.

The case study led to the collection of data through the voices of artists. The interview design presented perspectives on the ways the research data was collected. The research's method of inquiry emphasized the influence of a digital medium and looked at artistic concept and process through technologies such as: 3D scanning, 3D modelling, and rapid prototyping (RP) or automated modes of production.

The study infers that these digital processes affect artists' relationships with object in space. Artists explore a spatial dimension where the notions of materiality and temporality are linked to a computer environment and where their creative process is subject to the influence of a digital context. The digital context technological qualities affect the artists' sculpture production strategies traditionally guided by analogue processes.

The Research Creation project had a profound influence on the researcher; those technological means to artistic creation have now become part of the researcher's creative process. The artworks presented in the exhibition propose artistic concepts addressing environmental issues through sensory interactions with a digital medium influencing the aesthetics of the artworks. The works' conceptual content is shaped through a creative process subject to the influences of a 3D digital and technological mode. The exploratory direction of the Research Creation project has also brought to the researcher an understanding of a digital medium, which has inspired future projects exploring the plurality of artistic mediums.

Chapter 4 analysed the interviews with each artist. The researcher's intention was to focus on each participant to better capture each artist's exclusive creative approach to a digital medium and to understand how the artists' interactions with the digital medium influenced the aesthetics of their artwork. This method facilitated the understanding of how each artist's contextual background and life experience not only brings to the study various perspectives on artists' creative intentions but has also influenced their sensory approach to 3D technology. It also informed how artists' creative approaches are affected by their level of software knowledge and software interface familiarity. Looking at the

ways in which each sculptor experiences creativity within a 3D digital context allowed for a comparison to be framed between participants, including the researcher. Responses from the interviews informed how the aesthetics of the participants' artwork was influenced by interactions with a digital medium, through which creative constraints and participants' age factor seem to be interrelated to a certain extent. The selection of participants of the same age group affected the study. Results from a younger generation of artists or computer "natives" would have brought a different point of view to the research. It would certainly have made a difference on the repetitive aspect of participants' responses to the interview, which illustrated a tension between conceptual thinking and practical application of 3D technology in their artworks. Inside a 3D software spatial context linked to computer-automated sculpture fabrication processes, artists experienced a sculpture production mode dependent on technological support.

The findings from the Research Creation project and case study were discussed in Chapter 5. The discussion focused on the ways the artists engage with a digital medium and computerized environment, which triggers unforeseen artistic impulses. It is interesting to see how the concept of experiencing the unexpected inside a 3D digital context is dependent on the artists' openness to creative exploration of a digital sculpture medium. The artists' openness is often affected by the technological constraints they experience inside the 3D software platform.

Artists interact with a digital medium that becomes a medium of translation of ideas and the artist-researcher, from a conceptual understanding of the work, discussed the influences of a digital spatial and technological context on the artists' creative process and artwork visual qualities. Digitizing strategies, and in particular 3D scanning,

play a key role in the manner in which artists interact with a gravity-free environment, freeing artists' minds from physical and gravitational constraints. This brings to light a perspective on digitized objects, which facilitates the understanding of its structure geometry. Artists engage with a porous object, made of a medium without any define size, volume, or thickness. This object code is arbitrary; therefore it allows the original medium specificity (data source) to converge with or be transposed into any another medium. This concept of digital convergence is also presented as that of a plurality in the arts that the coded medium encourages. The study infers that artists' conceptual investigations are often inspired by the plural condition of the digital medium.

Artists use the technology to scale up or down their original sculptures and for some the technology is only used and perceived as a tool that facilitates sculpture production. They also see the technology as a moulding process, where the simulated representation of a sculpture form (positive) is used to outline its negative space and design a digital mould. Within a digital spatial dimension, artists are exposed to a mutable medium. Creative strategies of art making are influenced by the expediency of software tools and the expeditious properties of RP processes. Artists experience a shift in their creative process; time-based mediums (such as cinema or video) now extend their visual qualities to sculptural concepts, where movement in space can materialize into an art object. Sculptors' interactions with a digital medium influence their ideas, artwork process, and aesthetics.

Artists' interactions with objects in space are now subjected to a digital context inside which 2D and 3D mediums merge. It brings 2D and 3D modes of representation closer, affecting an artwork's aesthetics subject to artists' sensory experiences of the

passage of an artwork concept from analogue to digital, and from 2D to 3D dimensions. Artists' creative intentions are influenced by a digital medium dependent on a computerized technological support.

Creative constraints become creative stimuli. The unpredictability of outcomes is coherent with the unexpectedness of creative activities. It is challenging to navigate and to maintain spontaneity while using the software interface. Assisted by technicians, artists experience creativity through an exchange of ideas combined with unexpected actions that influence their work direction. Under such conditions and in spite of an openness to collaboration, using 3D digital technology is not understood as being a very intuitive process, and to acquire knowledge through trial and error can become frustrating to the artists' creativity. The study infers that technicians' assistance should be experienced as an extension of the artists' minds.[89] The collaboration with technicians seems to greatly influence the creative process: close working relationship with them enhanced artists' interactions with the digital environment. Current technological advances are taking a more cognitive approach to software programming, which may lead to greater creative freedom.

Interactions with 3D digital technology at an early age may also influence the ease with which artists engage creatively with the software interface environment. However, this study is limited by the generational representation of the selected case study artist-participants' age group. All participants were born in the 1950s and did not grow up with computers; they belong to a category of people that the study defines as computer non-natives. The selected participants' ages influences the level of creative freedom artists experience as well as their need for technical assistance.

Artists' conceptual thinking and practical approaches to the creative process are influenced by spatial-temporal interactions with a computerized creative context. Strategies of making inside this accelerated space-time context bring closer concepts and processes compared to traditional analogue production modes. The human-machine relationship reduces physical, labour-intensive work and cuts down sculptors' work production time, and automated fabrication frees up artists' minds from physical constraints. The space-time inside which an idea develops digitally and the work exists materially theoretically collapses. In spite of their openness to a digital medium, the artists envisioned sculpture practice as the production of a material or analogue sculptural output.

Chapter 6 summed up the conceptual framework and themes covered in the interviews, as presented through the artist-researcher's voice. The artist-researcher's profile, artworks' direction, and contextual background show what led the artist-researcher to pursue this research. The Research Creation project, *Vulnerable*: *The Salmon Project*, conveys a temporality that connects past events with a *presentness* that questions a future condition. This projection in time addresses not only the conceptual framework of the sculpture installation but also its mode of production. From analogue to digital means, the work explores a 3D digital and technological context that influences the artist-researcher's creative process. Framed around a hypermodernist worldview, the work reflects on how today's technological advances influence not only society but the cultural values carried through creative activity.

The Research Creation project led to an understanding of a digital medium and extended the artist-researcher's interactions with objects in space. What distinguishes the

artist-researcher's approach to 3D digital technology from that of the artist-participants is a deeper comprehension of the medium's structural qualities and its spatial environment. Prior to this research, the artistic concepts of the researcher were primarily shaped by a material form. This material form has expanded, conveying the impalpability of a digital medium. Creative interactions with a digital medium have not only influenced the formal aspect of the artwork but have changed the semantic of "form" to that of "content of information." The digital medium has influenced the facture of the artwork; the sculpture form data can shape into music (for example) and at the same time its visual appearance can also remain a digital representation of a form projected in space (a collaboration stemming from the Research Project will be presented as *Convergence Between Digitized 3D Objects and Audio Signal Processing* at SCANZ 2015). As university studio arts programs adapt to the ways in which digital technology affects artists' creative process, a growing technological approach to sculpture practice is expected to influence future generations of artists and the visual aesthetics shaped by a digital medium.

This last section of the conclusion presents the artist-researcher's views on the study, which include a critic of the methods of inquiry and a projection on what may have been done differently. In addition, the artist-researcher brings her perspective on the future of sculpture installation art. It restates the manner in which research creation brings new challenges to other generations of artists. Questions are also raised about the future of objects in sculpture practice. This research contributes to a deeper understanding of what is at play when artists are influenced by a 3D digital and technological context from which they interact with a digital medium inside a simulated spatial environment.

There are some weaknesses associated with this project related to the limited scope of the case studies and the relationship between the Research Creation and the case studies. The weaknesses of the case studies include the small number of participants, the lack of generational diversity, the length of the interview questionnaire, the lack of spontaneity in conversation, the length and overall structure of the interview questionnaire, and the case study inquiry limited time frame. The participants also belonged to the same age category and their exposure to digital technology came later in life, which affected how familiar they are with the digital context and how much they could extend on the subject. Interviews could have been more naturalistic through leading a conversation instead of bringing pre-determined questions. A conversational process may have yielded a two-way exchange of ideas and perspectives. Likewise, the questions were over-structured and did not prompt responsive and in-depth recounting of experiences. The interview structure would have benefited from more fluidity. The case study time frame was short and lacked the ability to gain multiple dimensions of the artists' work experiences and creative process. The researcher was unable to observe artists working with the digital medium to see how they changed or did things differently over time.

The Research Creation approach and its background could have played a more central role in this research by emphasizing the experiential nature of the researcher's own creativity and practice. The study could have focussed more on ways to deepen the expression of the researcher's own experience as a sculptor. Future works will address the expression of this concept further. The research perspective was not able to honour the complexity of the artist-researcher's experience with 3D digital technology. Access

to other research methods, such as life history research, may have been more appropriate to combine with the research creation focus to bring the emphasize on the individual artist's (researcher's) creative experience.

The conclusion of this research may stimulate a future generation of artists to further explore creative directions through digital means. These directions address a digital medium through the translation of art forms constantly migrating from a material to an immaterial dimension and where tangibility and intangibility inhabit the art object. Moreover, it is hoped that these conclusions encourage artists to question how objects adapt to technological advances in sculpture practice.

Questioning the future of objects forces one to situate the change that digital technology engenders on objects; as within 3D digital technology, the object moves from *its* to *bits*.[90] This change from a material object in real space to an immaterial digital object inside a computerized context invites one to extrapolate on the autonomy of the immaterial object, which is also perceived as data information. Mark Hansen's (2006) writings describe Shannon's information theory model that proposes that information is moving, "towards fully autonomous circulation," stating:

> . . . Shannon's model: as the basis for the technical de-differentiation that constitutes the logical culmination of the historical decoupling of information from communication, Shannon's model allows Kittler to postulate an informational posthistory. From the standpoint of the optoelectronic future, the human or so-called Man—as well as the entire range of so-called media effects said to comprise a media ecology—must be revalued as the purely contingent by-product of a preparatory phase in the evolution of information toward fully autonomous circulation. (Hansen, 2006, p. 77)

A parallel can be made between the autonomy of information-communication and that of coded information embedded in digital objects. Supposing that a sculptural object is a

component of a larger sculpture installation concept, that object has the capacity to be fully autonomous inside the artwork dynamic and to interact with the viewer. In reference to Shannon's theory proposing that information is heading "toward fully autonomous circulation" in the context of a digitized sculptural object (as coded information), the future of digital sculpture brings about the autonomy of the object.[91] Similarly, a digital sculpture evolves independently from the object it conveys; the digital object is autonomous in relation to the manner in which the artwork is being circulated or diffused.

Moreover, envisioning that the expanded autonomous object interacts with the viewer in an unpredictable manner, its autonomy makes the object react to situations in relation to the code that it inhabits within a given platform. Therefore, much like drones,[92] the object is influenced by the numerous influences that it encounters. The following questions arise: What are the future directions of sculpture installation art? Does the concept of autonomous system bring an object to be totally autonomous from its creator? These questions invite future research on the influence of a digital object (medium) on sculpture installation art. The interaction of an object in space brings about the autonomy of the sculptural object from not only the spatial context within which it interacts (the environment including the viewer), but also from the artist who imagined and created this object/concept (its creator).

From another point of view, the concept of autonomy, characteristic of digital data, is also linked to the discrete nature of digitization that makes the medium no longer medium-specific. Artistic concepts are now, from a digital perspective, independent of their medium. The artwork's digital state does not define the medium's specificity; artists experience a *postmedium* (Krauss, 1999), a mutable coded data and a digital medium that

theoretically encompasses all mediums. The concept of plurality in the arts also leads to future creative directions that encourage interactions between all disciplines and between various data source, mediums, and media in artistic practice.

Not only is the sculptural object expanding from formal consideration to the representation of movement in space and not only can it be translated into other forms such as sound waves,[93] but the object in itself is also expanding from a visual representation to a fully autonomous object. From Shannon to Kittler and Hansen to Krauss, the ways in which one looks at a digital medium is influenced by technological advances that induce the merging of all disciplines and encourage collaboration within other domains of research.

This research stimulates future projects that build on the knowledge acquired through this study. Upcoming ideas engage with creative exploration of simulated forms addressing not only the digital object but also the concept of plurality in the arts as presented in the research. One project is an outcome of the researcher's participation in the Balance-Unbalance Conference 2013, held from May 31 to June 2, in Noosa, Australia. As a consequence of the paper presented addressing this PhD research, a collaborative project took root. The project, titled *Convergence Between Digitized 3D Objects and Audio Signal Processing*, will be presented at the SCANZ 2015: water & peace event starting on January 17, 2015 in New Plymouth, New Zealand. It involves collaborative work between the researcher and two other artists, a composer of electroacoustic music and a music technologist and research fellow from Queensland Conservatorium in Brisbane, Australia. The project concept, linked to the theme of water, conceptually aims to convey environmental concerns and awareness of the condition of

natural resources. The artists translate the code of a digitized object into music. The research group's objective is to explore creative ways to engage with the concept of plurality in arts, crossing boundaries between a digital sculpture medium and music. Transposing nature creatively using the data collected from the 3D scan of digitized elements, artists combine visual projections in the natural environment with sound inspired by the transposition into music of the data collected through 3D digital technology.

The study intends to advance research in technological development, based on the creative exploration of natural and simulated environments that challenge artists' perceptions and relations to space, time, and materiality. This research also presents to future generations of artists an openness to a more sustainable approach to sculpture practice given that materiality is now embedded in immateriality. The study addresses today's artistic directions within a social context in which the ubiquity of computerization necessitates a re-positioning of the ways artistic knowledge is transmitted. Most interestingly and importantly, in sculpture installation art practice, artists' interactions with a digital medium and digital modes of production go beyond technical and technological characteristics to bring to light, through a sensory knowledge, the limitless creative capacity and abiding source of inspiration resulting from artists' interactions with different spatial-temporal and material dimensions.

Endnotes

[1] The group exhibition included works by Claire Brunet, Future Retrieval, Guillaume Lachapelle, Neri Oxman, and Suzan Shantz.

[2] Rooted in modernism, the concept of hypermodernity is linked to technology and its impact on spatial-temporal environments (Armitage, 2000).

[3] The sculpture installation concept proposes a referential loss of natural resources but the artist's intention is not to reveal the past; rather, the artist draws on Heidegger's concept of time and uses the past to reveal a present within a perspective on the future. In Heidegger's concept, the past is not a present that has past but a past that is in the process of being. Time belongs to a past action that projects on a presentness through a state of having been [seinem Gewesensein]. Heidegger draws a perspective on a future that takes up on the past's being [das Vergangensein] or "a futuralness [Zukünftigsein] which one resolves to embrace through grappling with the past" or through a state of having been (Heidegger, 2011, p. 80). As the viewer faces the sculpture, a "state of having been" is revealed. The artwork is intended to make the viewer experience a historical investigation that enters the present (Heidegger, 2011).

[4] The terms *artist-researcher* and *researcher* are used to refer more specifically to the artist-sculptor authoring this dissertation.

[5] The terms *sculptor* and *artist* are used interchangeably to refer to all of the artist-participants in this study.

[6] In the context of this research, the word *plurality* is understsood as *pluralism* and addresses the plural condition of a digital support in relation to the specificity of a traditional medium (Krauss, 1999). In the context of this research, medium specificity is re-gained with rapid prototyping modes of production (CNC milling and 3D printing).

[7] Chapter 6 presents the data collected from the artist-researcher's responses to the themes developed in the interviews.

[8] As Friedrich Kittler (2010) described in the book *Optical Media* when addressing Lambert's (1759) concept of free perspective, "'Free' was supposed to imply that the art of perspective taught to painters by Brunelleschi and Alberti had been very unfree. With fictional images, which removed the technical mediation of the *camera obscura*, the painter first had to abandon his inherited two-dimensional medium and think himself into the strange technology of architecture" (p. 94).

[9] See Andersen (2007, p. 635) and Lambert (1759, p. 647).

[10] "The Digital Atelier began as a Research and Development component of the Johnson Atelier, a nonprofit sculpture institution, which was founded by J. Seward Johnson, Jr., in 1974. In 1998, the Digital Atelier was established with the purpose of expanding the availability of 3D technology to artists for use in creating large-scale and complex sculpture. As part of the nonprofit mission, the goal of Johnson Atelier and Digital Atelier was to adapt the technology typically used in commercial industry in order to advance techniques available to manufacture art. Since its inception, the Digital Atelier has been on the forefront of developing laser scanning, CNC milling and coating technologies that specifically cater to artists, architects, museums and the entertainment industry" (Lash, 2013).

[11] The research addresses sculpture and installation art practices, which comprise both the production mode of sculpture forms and the artwork's integral concept displayed within a spatial environment. Therefore when addressing both the form and concept display, we use the term *sculpture installation*.

[12] The author Jean-Luc Nancy (1996) specified that, "one must understand 'to touch on' in the sense of shaking up, disturbing, destabilizing, or deconstructing. Art touches in this manner on that which, of itself, *phusei,* naturally, establishes the synthetic unity and the continuity of a world of life and activity" (p. 18).

[13] Benjamin (2008) illustrated the impact of mechanical reproduction on how an artwork can now be experienced by different people and from different locations at the same time.

[14] The plurality of the Muses where each Muse represents a specific medium—visual arts, music, dance etc.—and its relationship and opposition to the general philosophical concept of *art*, as commented by Krauss (1999, 305). See also Benjamin (2004).

[15] "Heidegger also leaves quite open, and even prescribed, the plurality of the arts as the only effectivity of such a remote 'essence' (one which also encompasses, according to other passages, the necessity of the work as 'thing'." On this subject, see Alexander Garcia Düttmann, Das Gedächtnis des Denkens [Frankfurt am Main: Suhrkamp, 1991), p. 22 off.)" (Nancy, 1996, p. 104).

[16] With regard to how the word *technique* addresses the arts, Nancy (1996) stated: "Thus the arts are first of all technical. They are not technical 'first of all' in the sense that they comprise an initial part, procedure, which is capped by a final part, 'artistic' accomplishment" (p. 24).

[17] This is in reference to automated fabrication technologies, such as RP 3D printing and CNC milling.

[18] "The *flâneur* was, first of all, a literary type from the 19th century, essential to any picture of the streets of Paris. It carried a set of rich associations: the man of the idler, the urban explorer, the connoisseur of the street. It was Walter Benjamin, drawing on the poetry of Charles Baudelaire who made him the object of scholarly interest in the twentieth century, as an emblematic figure of urban, modern experience. Following Benjamin, the flâneur has become an important figure for scholars, artists and writers" ("Flâneur," n.d.).

[19] Nicholas Negroponte is an American Architect who founded the MIT Media Lab with Jerome B Wiesner in 1985.

[20] Negroponte (2008) refers to stock market share price data or news report data as "less prosaic materials" (p. 61).

[21] Wheeler (1990) proposes that "it from bit" symbolizes the idea that every item of the physical world has an immaterial source and all physical things are information-theoretic in origin.

[22] In reference to Duchamp's ready-mades, such as *Fountain*, submitted for the Society of Independent Artists exhibition in 1917.

[23] Chapter 1: Theoretical Framework elaborates on the concept of production and reproduction through different philosophical platforms.

[24] This claim is supported by arguments that are developed in Chapter 1 in relation to Benjamin's (1968), Baudrillard's (1983), Manovich's (2001), and Wands's (2006) views on the digital medium and the impact of softwarization in the arts.

[25] Note from Wheeler (1990): [79] Discovered among graffiti in the men's room of the Pecan Street Cafe, Austin, Texas.

[26] Note from Wheeler (1990): [80] G. W. Leibniz: Animadversiones ad Joh. George Wachteri librum de recondita Hebraeorum philosophia, c. 1708, unpublished; English translation in P. P. Wiener (1951), Leibniz Selections (New York: Scribners) p. 488.

[27] Note from Wheeler (1990): [81] A. Einstein: as quoted by A. Forsee in Albert Einstein Theoretical Physicist (Macmillan, New York, 1963).

[28] "A point cloud is a set of data points in some coordinate system. In a three-dimensional coordinate system, these points are usually defined by x, y, and z coordinates…. Point clouds may be created by 3D scanners" ("Point Cloud," n.d.).

[29] Applied to the domain of digital art, Kittler's (2010) concept of digital convergence yields a theory of the obsolescence of the image—a radical suspension of the image's (traditional) function to interface the real (information) with the human sensory apparatus (p. 72).

[30] Mark Hansen (2006) further develops Kittler's premise that the medium is pertinent only where there is plurality of media and writes, "This epoch of media differentiation is precisely what is now coming to an end in the context of digitization; with the possibility for universal convergence of media, i.e., translation of all media into each other through a digital universality, the concept of the medium is becoming obsolete" (p. 275).

[31] See section 3.3.2: Notions of Interactivity.

[32] In this research, the method is differentiated from the methodology. The method includes the ways in which the data are collected and leads to descriptions, explanations, and interpretations. The methodology addresses a more philosophical approach based on what arguments the data support (6 & Bellamy, 2012).

[33] Jacques Derrida's concept of deconstruction is not about the dismantling of the structure of a text but a demonstration that a text is already dismantled in its original form.

[34] For strong points of view on different aspects related to the concept of digital language, see Manovich (2001).

[35] See section 3.6: Research Creation Data Collection Method.

[36] In "Research Degrees in Art and Design," Timothy Emlyn Jones explained that, "The issue of how new knowledge may be embodied in or represented by art or design objects (by which I mean objects-of-attention rather than exclusively material artifacts) remains an alternative way for giving account of practice outcomes as research outcomes" (p. 33–34).

[37] Responsive interviewing invites interview structure flexibility. It allows the interviewer to adjust questions in response to the interviewee's feedback, which is linked to the their personality and work direction. Through gathering narratives, descriptions, emotional reactions, and

interpretations, this research describes a creative process that the participants identify and recognize as their own. The spontaneity carried through responsive interviewing and the depth captured through each interview structure make this mode of inquiry interesting, adaptable, and inviting to cooperation, respect, and thus ethical considerations (Rubin & Rubin, 2012).

[38] See Chapter 6: Research Creation.

[39] This model is proposed by Sandra Weber (2008), who makes the following observation: "As the norms and expectations for communicating research results change, a growing number of scholars are turning to image-based modes of representation, creating art to express their findings and theories" (p. 49).

[40] Geomagic Studio is a software used for repairing and transforming 3D scan data into accurate polygon and CAD models for reverse engineering, rapid prototyping, and analysis (Geomagic, 2013).

[41] The concept of the artwork is further explained in Chapter 6.

[42] Located in Lawrenceville, New Jersey, the Digital Atelier specializes in sculpture production using 3D technologies (3D scanning, CAD,and RP technology). Since 2001, the Digital Atelier has been operated by John Lash, a former director of the Johnson Atelier, and his team. As stated on their website: "The Digital Atelier began as a Research and Development component of the Johnson Atelier, a non-profit sculpture institution, which was founded by J. Seward Johnson, Jr., in 1974. In 1998, the Digital Atelier was established with the purpose of expanding the availability of 3D technology to artists. . . . Since its inception, the Digital Atelier has been on the forefront of developing laser scanning, CNC milling and coating technologies that specifically cater to artists, architects, museums and the entertainment industry" (Lash, 1998).

[43] The Forêt Nomade exhibition was presented at: *Centre d'exposition de Val David*, *Collectif de l'Atelier de l'Île–Forêt Nomade Veltava Metsä,* January 2009–2010, Val David, Quebec; the Montreal Science Centre, *Entre les Branches et Forêt Nomade*, October 2008, Montreal; and the Canada Science and Technology Museum, *Forêt Nomade*, Ottawa, March–September 2008.

[44] The print project titled *Entre l'Arbre et l'Écorce* was created by using a Roland Pixform software, a Picza LPX-250 3D laser scanner (box scanner), and an MDX-20 CNC router.

[45] While in architecture and design, computerization has influenced concepts and productivity and has brought new methods of prototyping and improving project development since the late 1980s, the implementation of 3D digital technology in the field of sculpture has lagged; see section 1.1.1: Creative Freedom.

[46] Images of Kiki Smith's current projects are shown at the Walla Walla Foundry website at: http://www.wallawallafoundry.com/projects/smith.html (Walla Walla Foundry, n.d.).

[47] In her comment, Kiki Smith referred to CNC routing technology, which does not allow for high definition but necessitates hands-on finishing work to regain the "gracefulness" conveyed through the original artwork.

[48] "Non-uniform rational basis spline (NURBS) is a mathematical model commonly used in computer graphics for generating and representing curves and surfaces" (Non-uniform rational B-spline," n.d.).

[49] "A point cloud is a set of data points in a coordinate system. In a three-dimensional coordinate system, these points are usually defined as X, Y, and Z coordinates and are often intended to represent the external surface of an object" ("Point cloud," n.d.).

[50] "A polygon mesh is a collection of vertices, edges, and faces that define the shape of a polyhedral object in 3D computer graphics and solid modelling" ("Polygon mesh," n.d.).

[51] "STL (STereoLithography) is a file format native to the stereolithography CAD software created by 3D system. This file format is supported by many other software packages; it is widely used for rapid prototyping and computer-aided manufacturing" (STL (file format), n.d.).

[52] See section 4.1.3: Current Experience of 3D Technology.

[53] RP processes include CNC milling and 3D printing, both of which are computer-assisted fabrication processes.

[54] Extract from notes taken during Evan Penny's talk and presentation of his works displayed in the retrospective exhibition presented at the AGO on November 7, 2012. The work was part of a ten-year retrospective exhibition titled: "Evan Penny: Re Figured," held from September 20, 2012 to February 10 2013 at the Art Gallery of Ontario in Toronto (Penny, 2012b).

[55] As recalled by David Moss in the context of Penny's exhibition at the Columbus Museum of Art (CMA): "Despite the fact that the image has a digital life as a photograph, and the photograph referent is very digital, the objects themselves are absolutely handmade" (Art, 2007).

[56] Referring to the literature review presented in Chapter 1, the postmedium is a re-defined medium that speaks about digital data—a data medium inciting to a plurality in the arts, a medium linked to that of an "aesthetic convergence" as proposed by Kittler (2010) or of a "plural condition" as suggested by Nancy (1996) and Krauss (1999) in reference to Benjamin's (2004) concept of the Muses.

[57] Charles Hartshorne (2011) stated that, "by *creative* Wieman does not mean merely productive of novelty. He is trying to conceive the optimal form of such production, that mode of exchanging thoughts and feelings that produces rich experience and tends to increase the capacities of the participants for being creative in this optimal sense" (p. 131).

[58] As presented on the Hexagram Concordia (2002) website: "Established in 2002 with grants from the Canadian Foundation for Innovation and the Quebec provincial government to provide state-of-the-art equipment, labs and technology infrastructure for faculty and graduate research, Hexagram-Concordia has evolved into a dynamic environment for research-creation and knowledge mobilization."

[59] See section 1.3: From Benjamin to Manovich: From Individualism to Perspectivism.

[60] Benjamin (2008) illustrated the impact of mechanical reproduction on how an artwork can now be experienced by different people and from different locations at the same time.

[61] This is in reference to Muybridge's (1830-1904) study of movement. Today, Gould and other sculptors, such as the American artist Geoffrey Mann (section 1.11), study movement through 3D modelling software interface and other 3D digital technology.

[62] This concept of distance proposed by the physicist Robert Logan is presented in section 3.3.1: Digitization.

[63] To view the works, consult the following website: http://hugueschарbonneau.com/trevor-gould-survol-survey/

[64] As proposed by Margaret Boden (2004), through creative activity, everyone uses heuristics, "whether we have heard the word or not. . . . In other words, heuristics form part of the computational resources of our minds. . . heuristic is a form of productive laziness. In other words, it is a way of thinking about a problem, which follows the paths most likely to lead to the goal, leaving less promising avenues unexplored" (p. 65).

[65] Digital rendering provides artists with a broad selection of simulated surface finishes suggesting what the sculpture output could look like.

[66] Section 3.6 presented a detailed description of the data collection method for the Research Creation project. The case study interview data analysis was presented in Chapter 4. Chapter 6 addresses the artwork's conceptual framework and the themes explored in the interview questions from the researcher's standpoint.

[67] The study addresses animal representations of vertebrates and invertebrates.

[68] The French translation is meant to accentuate the concept as the researcher identifies with French Canadian culture.

[69] See section 4.1.3: Kiki Smith Smith's Current Experience of 3D Technology.

[70] The merging of mind and matter refers to the potential of digital medium to materialize through RP technology. A 3D digital representation of an idea or concept on the computer screen is also potentially an object in real space, as the data is materialized through RP processes.

[71] See section 1.5.2 : Medium Convergence

[72] See the following bibliographic note in Krauss' (1999) article: "See Benjamin, 'The Theory of Criticism;' Selected Writings, 1913-1926, ed. Marcus Bullock and Michael W. Jennings (Cambridge, Mass., 1996), p. 218. The relationship (and opposition) between the plurality of the Muses, with each Muse the genius of a specific medium – visual art, music, dance, etc., – and the general, philosophical concept of Art is explored by Jean-Luc Nancy in "Why Are There Several Arts and Not Just One," The Muses, trans. Peggy Kamuf (Stanford, Calif., 1996), pp. 1-39" (p. 305).

[73] The word *extension* is used in reference to McLuhan's (1964) concept of technology as an extension of man.

[74] In reference to recent research development in the field of *Robotique Dévelopementale* as presented by Vincent Padois (Radio Canada RDI, 2013).

[75] This concept stems from recent research developments at the *Institut des Systèmes intelligents* in Paris in the domain of robotique dévelopementale (Radio Canada RDI, 2013).

[76] See section 3.6: Research Creation Data Collection Method.

[77] An ongoing correspondence between Fournelle in Quebec and artists from EAT in New York resulted in the first experimental foundry studio in Quebec, la Fonderie Expérimentale et Collective (FEC), founded by Fournelle in 1967. The philosophy of FEC is based on a search for direct means of artistic creation focused on the foundry process, where technology becomes a "means of expression" as opposed to a more traditional approach focused on the concept of re-production. André Fournelle collaborated with EAT from 1970 to 1976.

[78] The Johnson Atelier Technical Institute of Sculpture (JA) was established in 1974. In the eighties, American sculptor Herk Van Tongeren was the director. The Atelier collaborated with international sculptors, such as Julian Schnabel, Marie Sol, George Segal, Georgia O'Keefe, Louise Bourgeois, Louise Nevelson, and others. The JA apprenticeship program selected young artists from all around the world based on artistic excellence.

[79] During that period, the artist-researcher also joined the New York Experimental Glass Workshop (NYEGW), where she engaged with research and experimentation combining glass and metal casting. Her research in artistic creation was conditioned by material transformation through sculpture production.

[80] In reference to Heidegger's (1962) concept of time.

[81] As stated by Heidegger (2011), "The past is not a present time that has passed by; rather, the past's being [das Vergangensein] is set free only through its state of having been [seinem Gewesensein]. The past reveals as that definitive state of one's having been that is characteristic of futuralness [Zukünftigsein], a futuralness which one resolves to embrace through grappling with the past" (p. 80).

[82] In his concept of time, Heidegger (2011) situated nature thus: "Nature is favourable or unfavourable, but as such it is in fact not dependent on our ordinary concern. That the surrounding natural world [*Umweltnatur*] 'is-always-already-there' is evident in the fact that there is no need to create it [*Herstellungsunbedürftigkeit*]. But the presence [*Anwesenheit*] of 'nature' also comes to apparency [*Vorschein*], according to its most robust presentness [*realsten Vorhandenheit*], . . ." (p. 16). In the work *Vulnerable: The Salmon Project*, the concept of presentness expresses a temporality that connects past events with a questioning of a future condition "with respect to the present as something potentially present [and which also suggests to] not let that-which-is-not-yet-present *come straight towards one into the present*" (Heidegger, 2011, p. 48; emphasis added).

[83] "Martin Heidegger argued in *Being and Time* that it is temporality that gives rise to history. All things have their place and time, and nothing past is outside of history" ("Historicity," n.d.).

[84] According to Heiddegger (2011), the concept of being "futural" means "to be 'temporal' [*'zeitlich' sein*]. Here, temporal does not mean 'in time' but time itself" (p. 49).

[85] Again referencing Heidegger's (2011) concept of time: "On the other hand, what has been lost, i.e. what has disappeared from what is currently available, what failed and therefore could not be forced into the present . . . To be 'unable to get over' . . . 'a loss' means: to wish for a thing's ongoing availability in the present. When one is anxious, the concern as such remains within the realm of one's care [*sorge*], in other words of being-in, which is secured and reassured thanks to its ability to access what is available" (p. 54).

[86] The scanner operator's competency, knowledge, and comprehension of the scanning process influence the scan data quality. Scanning strategy is important; the scan data quality influences the workability of the data object.

[87] Importantly, barring the accent, the spelling is identical in both French and English.

[88] This quotation, extracted from the Project Gutenberg website, stresses the particularity of computerized technology as a transmitter and receptor of information, on which information can subsequently be duplicated indefinitely.

[89] Marshall McLuhan (2001) envisioned technology as an extension of humans, but in the context of this study the McLuhanian concept extends from technology to technological knowledge as an extension of humans. Therefore, the technician's technological knowledge becomes an extension of the artist's mind.

[90] In reference to Wheeler's (1990) theory addressed in Chapter 1: Theoretical Framework.

[91] Today, with the emergence of drones, there is a rapid expansion of technological development that evolves towards more autonomous systems of all sorts.

[92] In reference to Radio Canada (2013a), RDI Émission Enquètes, we state: the rapid expansion of technology is moving towards more autonomous systems.

[93] In reference to the upcoming Research Creation project persented in the next paragraph.

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APPENDIX A

Appendix A.1

Template for Developing Research Focus

<table>
<tr>
<td>Purpose of the Inquiry
Digital technology plays a role in the communication of ideas and their translation into formal expression. The study:
Explores how a digital and technological context extends artists' spatial boundaries and influences sculptors' ideas and relationship with object in space.
Explores tri-dimensional perspectives addressing a computerized context and digital medium in sculpture installation art.
Explores the ways in which 3D digital technology influences artists' traditional analogue strategies of making and the artist-medium relationship.
Explores, through a Research Creation project and case studies interviews, digital and technological means to create through 3D modeling, 3D scanning, and rapid prototyping (RP) modes of production.</td>
<td>From Modernity to Postmodernity, as proposed by Jean François Lyotard:
The object of this study is the condition of knowledge in the most highly developed societies. The term postmodern is used to describe that condition. The word "designates the state of our culture following the transformations, which, since the end of the nineteenth century, have altered the game rules for science, literature, and the arts" (Lyotard, 1984, p. 71).

The study's methodological framework moves away from the word postmodern and proposes a hypermodern viewpoint to bring to context the socio-cultural and technological perspectives of a time of digital media and the ubiquity of digital mediums.

From a Research Creation project and case studies interviews methods of inquiry, the study questions the influence of a 3D digital and technological context in a sculpture practice where sculptors interact with a digital medium.</td>
<td>Hypermodern Worldview: carrying on with the concept of modernity and postmodernity, the study adds a spatial-temporal and material dimension linked to a digital and technological socio-cultural context. The research situates a sculpture practice inside an extended concept of space-time where a digital medium and computer-automated fabrication affect artists' creative process. The conceptual framework of a Research Creation project is shaped by a concept of time and a presentness (Heidegger, 2011), also identified as the time of the "here and now" (Lipovetsky, 2005). The artist-researcher is influenced by a digital and technological mode of artistic creation in line with the socio-cultural values carried by a hypermodern time.</td>
</tr>
<tr>
<td colspan="3">Through the phenomenon of digitization, an object is no longer perceived as a continuous form but as a discrete whole that can have more than one interpretation. A digital convergence between artistic mediums is experienced and shapes the venue of a "medium as such" (Krauss, 1999), a digital medium inciting a plurality in the arts.</td>
</tr>
<tr>
<td colspan="3"><u>Central Research Questions</u>
In sculpture practice, how does a 3D digital and technological context extend sculptors' conceptual and practical approaches to the creative process? How do sculptors' interactions with a digital medium influence the aesthetics of their artwork?</td>
</tr>
<tr>
<td>Concept
Theory question A) How does a 3D digital and technological context influence artists' conceptual and practical approaches to the creative process?</td>
<td>Precept
Theory question B) How does a 3D digital and technological context extend sculptors' spatial boundaries?</td>
<td>Effect
Theory question C) How do sculptors' interactions with a digital medium influence the aesthetics of their artwork?</td>
</tr>
</table>

Appendix A.2

Artist's Creative Approach

Description of the artwork category	Contextual background leading up to 3D digital technology	Artwork's theoretical framework and meaning of the work
Figurative	Developing ideas or concepts moving from 2D digital images to 3D forms	Cultural/historical
Conceptual	Exposure to a computer environment at an early age	Referential
Political	Developing ideas or concepts that naturally address digital processes/are not suited to analogue processes	Social issues
Social	Exposure to 3D RP lab in university context	Human condition
Feminist	Exposure to 3D technology from an artist studio production context or private studio production	Mythological
Environmental	Growing interest for technological development in the arts	Nature condition
Other (Data post-processing software)	Other	Other

Appendix A.3

Interview Design

Informant Questions: Artist's Creative Approach

Theory Question A How does a 3D digital and technological context influence artists' conceptual and practical approaches to the creative process?	**Theory Question B** How does a 3D digital and technological context extend sculptors' spatial boundaries?	**Theory Question C** How do sculptors' interactions with a digital medium influence the aesthetics of their artwork?
Artist's Creative Approach	Artist's Creative Approach	Artist's Creative Approach
Artist-concept: At what stage of the creative process do artists' ideas begin to interact with technology?	Do artists combine analogue and digital approaches when they develop their artwork concept?	**Artist-Idea:** Are artists' original ideas generated from an analogue or digital perspective?
Do artists develop their concepts directly in digital space or do they first establish what they will be creating from an analogue approach?	Do artists combine analogue and digital approaches in the production of sculpture projects?	How and in what direction do artists' ideas develop: analogue, or digital, or digital and analogue, or analogue and digital and analogue?
How does 3D software interface influence digital concept development?	How is artists' creativity influenced by digitizing processes, and how do artists' interactions with digital sculpture influence their relationship with the spatial environment?	**Artist-creativity:** Do artists feel they can experience "the unexpected" as they create in digital space or do they feel limited by a mathematically controlled space?
How do artists perceive and relate to data object and data collection digitizing processes?	How does a 3D digital and technological context influence the artist-medium and artist's object-space relationship?	How does the selected software influence the artists' visual language?
Artist-environment interaction: Do artists perceive digital space as a creative space?	Do artists use the technology only to facilitate sculpture processes?	How do artists experience and interact with the digital medium in their creative process? How does it influence the aesthetics of their artwork?

Appendix A.4

Artist's Technological Approach

Type of software used by participant	Type of 3D scanner used	Type of data structure
Photoshop	2D scanner	Pixel based bitmap
Illustrator	2D scanner	Vector
Rhino	FastSCAN laser scanner	NURBS model generated by 3D software
3D Studio Max	Other hand-held laser scanner	Polygon mesh generated by 3D scanner
Geomagic	Romer rotary laser scanner	Vector structure of 3D scan data; post-processing software
Autocad	Desktop laser scanner	Point cloud
Z-Brush	Photographic-white light scanner	Mesh generated by a photographic white light scanner
Other (Data post-processing software)	Other	Other

Appendix A.5

Interview Design

Informant Questions: Artist's Technological Approach

Theory Question A How does a 3D digital and technological context influence artists' conceptual and practical approaches to the creative process?	**Theory Question B** How does a 3D digital and technological context extend sculptors' spatial boundaries?	**Theory Question C** How do sculptors' interactions with a digital medium influence the aesthetics of their artwork?
Artist's Technological Approach:	Artist's Technological Approach:	Artist's Technological Approach:
Artist-Software interface interaction: Do artists work with a software interface to create their artwork? Are they assisted by a technician?	**Artist- 3D scanning interaction**: Do artists work with 3D scanning to appropriate or reproduce objects through digitizing? Do artists require technician's assistance to interact with the digital medium?	Do artists play, manipulate, and transform 3D scan data? How and to what extent? Do artists' combine, juxtapose, or use several digital objects in the same sculpture concept?
Artist-RP interaction: Do artists prepare their data files for RP 3D printing or CNC milling?	Do artists manipulate the data files inside the 3D software interface? Are artists' assisted by a technician?	Do artists re-work the 3D print? How and why?
Artist-environment: Do artists combine digital and analogue perspectives in the artworks' conceptualization process?	**Artist-process**: Do artists combine analogue and digital spatial interactions in the fabrication process of their artwork?	**Artist-artwork**: Do artists use the technology mostly to facilitate duplicating and scaling?
Do artists first use RP technology and further develop their project through combining other transformative processes, such as the lost wax process for metal casting or other processes?	Do artists transpose their concepts from an analogue to digital to analogue spatial context and use other transformative processes, such as the lost wax process for metal casting?	Do artists use 3D printing to get a prototype of their sculpture concept during the artworks' production mode?

APPENDIX B

B.1 Interview Questionnaire

Semi-structured in-depth interviews: *Responsive interviewing*

Interview time frame: 60 to 90 min.

Interview format: Interview beginning – Contextual background; Middle – Creative process; End – Conclusion.

Interview structure: open-ended questions.

Now I am switching on the tape recorder.

First, let me introduce myself, and the purpose of my research. I am an artist sculptor, currently enrolled in a Research Creation Ph.D. program at Concordia University. I am studying the influence of a 3D digital spatial context on sculpture installation art practice. My research is based on a case study approach in which I have selected three professional artist sculptors to answer questions addressing their relation to and interaction with 3D digital technology. I am grateful to you for accepting to be one of the three participants in this case study interview process.

I would like to thank you for freely consenting and voluntarily agreeing to participate in this study and for accepting to contribute to my research by taking part in this interview process.

Would you please read and sign the official consent form reviewed and approved by the Concordia University Ethics committee.

This interview aims to identify the influence of a 3D digital and technological context on your creative process, and hence on your sculpture and installation art projects. With a view to better situating your artistic profile within the context of this interview I

will begin with questions about your work direction and lead up to your current use of 3D digital technology.

Contextual background: looking into the context of the artist's practice leading up to his or her present use of technology.

1.0 I would like to start this interview by asking you to present a brief overview of what has been the focus of your work over the past years.

A. What ideology or position does your work embody? Is your work focused on: political issues? environmental issues? social issues? historical referent, mythology, or cultural tradition based concepts? the human condition? conceptual art ideology? feminist art? or other?

B. In what category of representation does your work belong? figurative? abstract? animal art? or other?

2.0 Would you briefly describe the context in which you started to work with 3D digital technology? We will get into more detailed or specific questions later on during the interview.

A. How did you start to work with 3D technology? Why did you adopt digital technology in your art practice?

B. Probe: Were you exposed to a computer environment at an early age? When did you feel that your ideas implied a need for a 3D digital technological approach?

3.0 What is your current experience of 3D digital technology?

A. Are you working on specific works that involve the use of specific technology?

B. Creative process: How do your ideas develop? Now I will ask a series of questions in order to better understand how digital technology affects or interacts with your creative process.

4.0 (ACA) looking at your creative process, at what stage do you start to interact with technology? Is it when you conceive the artwork or later on in the process?

A. (ACA) What methodology do you follow when you develop your concept? Is it analogue *or* digital? Analogue *and* digital? Or analogue-digital-analogue?

Probe: Does your idea start from a 2D digital image or platform and develop further into a 3D form or sculpture concept? Do you start working from an analogue 3D platform, which then moves in digital directions? Is the concept meant to remain digital? Or is it meant to regain an analogue form?

B. (ACA) Do you combine analogue and digital approaches when you conceptualize the artwork?

A. (ACA) Is your original idea based on an analogue or hands-on interaction to space, material, and process or based on digital spatial perspectives?

B. (ACA) If your original idea is based on a digital perspective, does it develop from a 3D software interface spatial environment? Or do you first establish what you will create from an analogue perspective, a palpable approach, and then move on to a digital spatial context?

C. (ACA) Could you briefly resume the ways in which the 3D digital environment interacts with your creative process?

5.0 (ACA) When you develop your concept do you already plan or anticipate what the work fabrication process will be like? Do you already know if you will combine both approaches, analogue and digital, and if you will use Computer Control Fabrication (CCF), such as 3D printing or CNC milling? How does the artwork fabrication planning develop?

What software do you use? The following questions will focus on the type of software interface you use and how digital tooling may affect both your concept and process.

6.0 (ATA) Do you use any kind of 3D software?

A. What software do you use?

B. When you do use a 3D software interface, are you assisted by a technician as you create your artwork within the software interface?

C. Or, do you require a technician's assistance only if you cannot obtain the visual representation expected?

Probe: How does the assistance of a technician affect the creative process in regard to doing things? Does it enable you to better achieve your goals? Do you feel dependent on a technician's assistance?

7.0 (ACA) Does the software interface influence the ways in which you develop your concept? Is your concept influenced by the software tools?

A. (ACA) Would you describe how the 3D software interface influences the visual aesthetics of your work?

B. How does the software interface influence the meaning of the artwork?

How do you situate digital technology in your work as an artist? I would like to hear from you about how you relate to the many ways in which digitized forms can be used considering that digital data can translate into various media such as photography, film and video, music, sculpture and others (in reference to the concept of plurality carried by the digital medium).

8.0 (ACA) In what ways do digitizing processes and the mutability of the data medium or its capacity to translate into various art forms affect or influence your creativity?

Do you export data forms from one medium to the next? For example, do you translate 3D scan data of an object into film or into a musical code? Do you explore the interplay between different forms of data visualization?

A. Does technology inspires your work? How so?

Probe: Now we will look into digitizing processes in more depth, and the ways in which a digital spatial environment may influence your creative process.

9.0 (ACA) Do you feel that you can experience "the unexpected" when you are working in a digital spatial environment?

A. Or do you feel limited by a mathematically controlled space in which you feel that a "creative accident" cannot happen?

10.0 (ACA) Looking at digitized forms, what type of data structure do you work with: NURBS or polygon models generated through 3D modelling? Polygon mesh

triangulation from 3D scanning? Point cloud from 3D scanning? Polygon mesh generated through photographic white light scanning technology? Other data structures?

A. How do you perceive data objects?

Probe: How do you interact with digital space and the digitizing process?

A. (ACA) In what ways does 3D digital space influence your relationship with forms and objects?

B. How would you describe your relationship to data forms and object?

C. In what ways does the digitizing process influence your artist-medium relationship?

11.0 (ACA) Do you perceive digital space as a creative space? Do you think 3D digital space is a creative spatial environment?

12.0 (ACA) Do you work with 3D digital technology only to facilitate sculpture processes? Or are you interested in its creative exploratory dimension?

3D Printing. Now we will look into how Rapid Prototyping Technology could be conceptually creative and how it could be used in creative ways.

13.0 (ACA) Do you use 3D printing additive technology to visualize your work before moving further within your concept? (Do you first 3D print a prototype of your project?)

14.0 (ACA) How do you see 3D printing connected or linked to your creative process?

(ACA) When you use 3D printing, is the print material your final sculpture outcome?

A. Do you sometimes use the 3D print as the final sculpture or never?

B. If you do use it as the final outcome, what factors influence this choice?

We will further explore aspects of digital technology through a list of digitizing tools you may use. What type of scanner do you work with? What type of 3D scanning technology do you use? Handy Scan? FastSCAN? Other hand-held scanner? Romer rotary scanner? Desktop scanner (Nextengine or other desktop technology)? Photographic white light scanner? Environment scanner or other digitizer devices?

15.0 (ATA) Do you work with a 3D scanner to appropriate or digitize forms?

Probe: Do you work with a technician who assists you with the process? Does it enable you to work freely? Or do you feel dependent on "hand-holding" assistance? How does assistance affect your relationship with the artwork?

16.0 (ATA) Do you manipulate, transform, and digitally play with scan data or digital objects?

Probe: In what ways and to what extent do you transform the original scan data? Do you work with a technician who assists you with the process? Does it enable you to work freely? Or do you feel dependent on "hand-holding" assistance? How does the technician's assistance affect your relationship with the artwork?

17.0 (ATA) Do you prepare your data file for 3D printing or CNC milling yourself?

A. Do you work with a technician who assists you with the process? How does the technician's assistance affect your relationship with the artwork?

18.0 (ATA) Do you send your data file to a technician or a service bureau?

Probe: Are you assisted by a technician? Do you work with a "service bureau"?

19.0 (ATA) When you produce a 3D print (3D print object or CNC milled form), do you re-work the printed form surface?

A. If you do so, would you explain in what ways you transform the original print?

Probe: For example, do you usually print the sculpture in sections and assemble the sections manually later? Do you re-work the form for aesthetic reasons? Does re-working the original become part of your creative process?

20.0 (ATA) If you combine both perspectives, digital and analogue, during the conceptualization process, how do you envision the work output?

A. Do you think that sculpture installation work can exist digitally or does it have to have a physical content?

B. Do you think that sculpture installation art is more analogue than digital or can it be both?

21.0 (ATA) Do you envision that your artwork can remain a data object or NETART? Or, do you always materialize it through automated fabrication technology?

22.0 (ATA) Do you use 3D digital technology mostly for scaling and duplicating purposes?

23.0 (ATA) When you use RP processes, do you combine them with other transformative processes, such as "the lost wax process" for metal casting?

A. (ATA) If you do combine RP or automated technology and metal casting, do you envision the cast metal sculpture as the final output right at the beginning of the conceptualizing stage? Or is casting the sculpture a fabrication strategy distinct from the conceptual phase?

B. (ATA) When you do combine RP technology with metal casting, how do you see the transfer from RP print to bronze, aluminum, or cast iron affecting the visual aesthetics of the artwork?

Conclusion: The interview closure focuses on artists' projections or future artistic goals. It addresses anticipated ideas on the ways in which artists can push the boundaries of technological developments in creative ways.

24.0 I would like to know if you anticipate what your upcoming ideas or concept may address.

A. What would be the meaning or significance of the work?

B. In what ways will 3D digital technology data collection, manipulation, or materialization be addressed?

C. Could you briefly describe the projected work aesthetics?

D. How will the anticipated artwork build upon existing sculpture installation projects from a technological and creative perspective?

25.0 What are your views on the future of sculpture practices in relation to technological advancements?

Thank you very much for your input into this study, I will end this interview here and will now turn off the tape recorder.