HOW AND WHY I CREATED THIS FUR BALL

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ABSTRACT

This paper discusses my interdisciplinary approach to art-making and provides context for thinking about the intersection of art and science. I have focused on what led to the creation of *Multi-Coloured Fur Sphere*, 2010. This image seems as though it was inspired by biology; however, the influence is less direct than it may appear. The paper has two main parts: *How* and *Why*. The first gives an overview of the more practical aspects of my work. The second part places what I am doing within a broad historical and cultural context. Modernism had a polarizing effect upon fields of study and post-modernism did not mend this. I see my work as part of a movement toward an idea of science that acknowledges our connectedness to the world we study and an idea of art that is free to use tools usually associated with science, such as mathematics and logic.

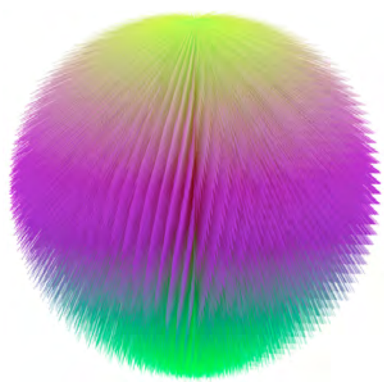

Fig. 1. *Multi-Coloured Fur Sphere*. 2010, Laura De Decker, giclée print, © Laura De Decker.

HOW

I have taken courses in art and science and am interested in epistemological issues relating to their intersection. I am curious about what I can achieve if I combine my creativity with the precision of science, logic and mathematics. I want to create something far from anything I have ever seen, something akin to the wonderment of nature, but constructed. *Multi-Coloured Fur Sphere* (Fig. 1) probably best illustrates this desire.

Johannes Itten's ideas, about "harmonious relative areas for the complementaries" after Johann Wolfgang von Goethe's writing and about aesthetic subjectivity interested me. [1] I started two series of paintings exploring aesthetic color combinations – striped paintings and the other composed with variations in composition – using tri-colored palettes. The idea behind these projects excited me but I felt I had to be more scientific to arrive at the result I was striving to reach. Conducting a quantitative experiment requires control. I had to find ways to more readily observe, manipulate, record, quantitatively describe and analyze visual information: I decided to use Red-Green-Blue (RGB) values on a computer.

I purchased Visual Basic computer programming software to make art, but without an exact idea of what I would do and little knowledge of how to use it. Computer programming was attractive to me because it allowed an opportunity to work with color both quantitatively and qualitatively. Using manuals and help files, I started designing a psychophysical experiment computer program guided by the "scientific method" as I knew it from science class. Building on ideas from my painting series, I created a "virtual" experiment where aesthetic data was collected (Fig. 2).

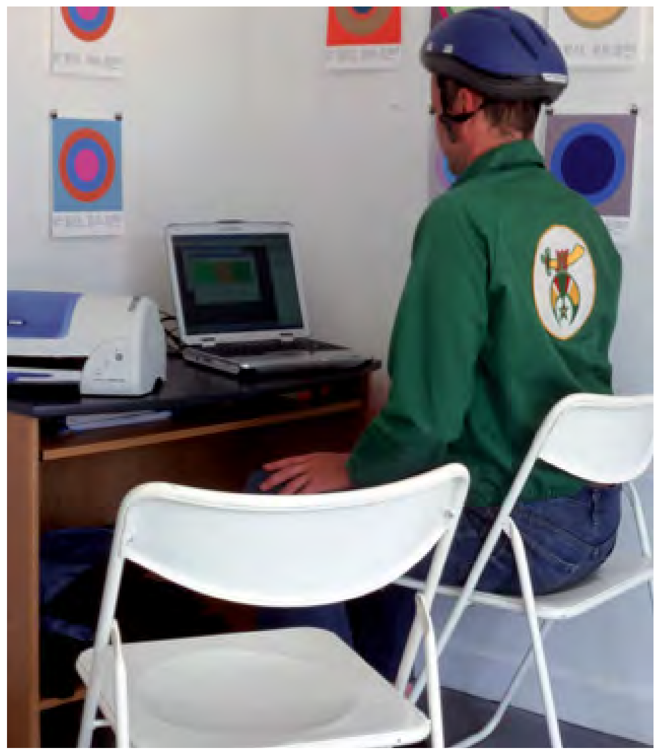

Fig. 2. *Phase 2: Inoculation*, 2002, Laura De Decker, Interactive Installation, Ministry of Casual Living, Victoria, BC, © Laura De Decker, Photo by Laura De Decker.

The experiment's first phase involved two computer-generated random-colored swatches on either side of an interactive swatch for participants to aesthetically complete the color combination by modifying the center color. I created a button in the program's user interface to cycle through all 16,777,216 RGB colors. Problems with this approach were trying to balance speed with the need to observe, limitations of the Cartesian model to show continuity of color relationships and technically how to improve the program's reaction time. I had to decide what order to nest the loops of computer code. For example I could cycle through all the blue values with every increment of green and in turn cycle through all the green values with every increment of red. There were abrupt changes when a looped variable in the program's code returned to zero. This pulsing effect of RGB values cycling through made it difficult to see the color in context with similar colors. What has become even more evident to me is the amount of subjective input required in designing an experiment.

I wanted the participant/subject to more seamlessly navigate through color values, so I created sliders for red, green and blue. This changed the program from an empirical experiment relying more on observation and discovery of the selected color, to an artistic tool for producing a desired preconceived color.

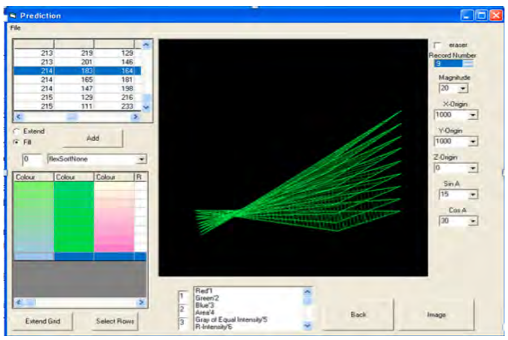

Fig. 3. *Form for Graphing and Predicting Aesthetic Colour Combinations*, 2002, Laura De Decker, interactive application, © Laura De Decker.

The experiment's second phase displayed a color combination from the first phase in a circular target composition, which preserved juxtapositions from the first phase. I chose the left color from phase one as the outer ring color, the second as the inner ring color and the third as the center color. The subjects were asked to adjust the ratio to suit their aesthetic sense.

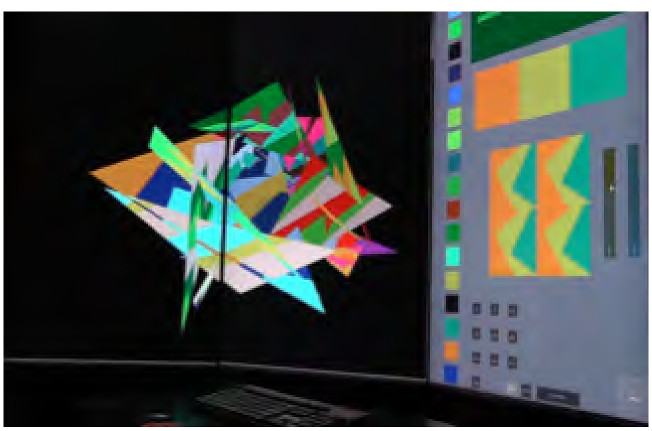

Fig. 4. *Triangulator*, 2013, Laura De Decker, interactive application, Christie Digital Personal Immersive Environment (PIE), © Laura De Decker, Photo by Stefan A. Rose.

I graphed the aesthetic data along RGB coordinates; each aesthetic record formed a triangle. I calculated color combinations based on the collected data and generated information by interpolating and extrapolating recordsets (Fig. 3). Several subjects preferred a generated color combination based on their original records over their actual choices. The experiment became more of an extravagant color selection tool than a psychophysical experiment. The process made me enthusiastic about potential possibilities for investigating form in relation to color. There were other familiar possibilities for designing a color selection tool using color attributes such as lightness or value, hue and saturation and I knew color could be described in other color spaces. The color combinations were collected as data.

The images were printed with corresponding numerical information and displayed in the gallery. A decade later I used my program as a prototype for creating a real-time version with TouchDesigner using a multi-computer display system (Figs. 4,5) – a process which provided further insight on how I will proceed with future developments in graphing aesthetic color data.

Fig. 5. *Triangulator*, 2013, Laura De Decker, application, © Laura De Decker, Photo by Stefan A. Rose.

In breaking down my creative process into manageable parts by setting parameters and moving between sketches, code and visual feedback, I create images as a way to focus and develop knowledge visually. Some images require more rigorous methods than others, such as *Model for 16 777 216 Colours* (Fig. 6) that maintains many color attribute relationships within a single image. I was surprised by how value gradients of colors enhanced the 3D effect of the form. I used a combination of Cartesian and spherical coordinate systems allowing for more dynamic visual relationships in terms of both color and form. Mapping color to a sphere was appealing because it allowed multiple axes for navigation, rather than the three axes using RGB or four using Cyan-Magenta-Yellow-blacK (CMYK).

Graphing 3D virtual objects onto a 2D surface and developing a hybrid coordinate system led me to figuring out ways to transform the color model from a cube to a sphere so each color would have unique coordinates corresponding to their position. This process made me consider details in visualizing patterns and develop consistent language to describe each color's spatial location, so I can transition or animate from one form to another. (Figs. 7, 8) The process involved many sketches (Fig. 9) to determine what transposes to where.

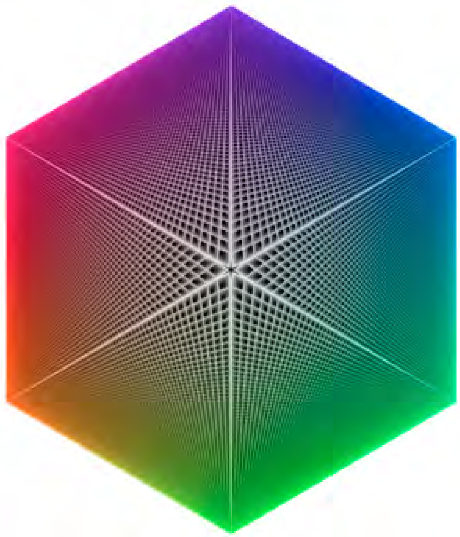

Fig. 6. *Model for 16 777 216 Colours*, 2007, Laura De Decker, giclée print, © Laura De Decker.

Fig. 7. *April 4 from Project 365*, 2011, Laura De Decker, digital file, © Laura De Decker.

Multi-Coloured Fur Sphere (Fig. 1) came out of a more playful exploration of diverse approaches to graphing spherical forms. I was interested in the plurality of architectural hybrid spherical forms constructed of Euclidean geometry. Working directly with the entire code, rather than as discrete computational objects, was essential for producing variants of form and allowed me to more intuitively alter the code. *Wind-Swept Sphere* (Fig. 10) and *Finned Sphere* (Fig. 11) resulted from this process as evidenced by formal similarities in some of their apparent features. For example, *Wind-Swept Sphere u*ses a nested loop whereas there is an extra incrementing loop nested in the code for the other two creating a tightly wound helix. Subsequently when I wanted to animate *Wind-Swept Sphere* I added the extra loop so it could coil. (Fig. 12) For *Multi-Coloured Fur Sphere* (Fig. 1), I mapped color using common variables. I typed in RGB values incorporating variables used in graphing the form in a way that I guessed might be interesting. The colors related to variables that described the form: the red value increases toward the top and from the vertical axis, green correlates to distance from the equator and blue corresponds to distance from the vertical axis. For the first time in my process, I used color to enhance the features of the form rather than the form to display color.

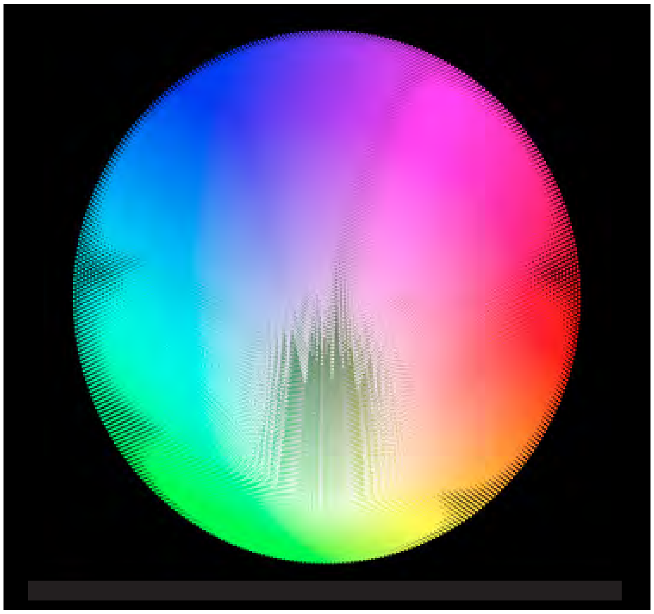

Fig. 8. *Untitled*, 2012, Laura De Decker, digital file, © Laura De Decker.

My strategy became to be fluent in writing code rather than to create my own graphics software. However, I find sketching with pen rather than keyboard to be helpful in my creative process. The challenge is to make the names of things most intuitive, balancing a need for both comprehension and flexibility since my focus shifts – for example from the boundaries of spaces to the spaces themselves. Slightly vague but consistent language seems to work best. The code for a 2D print can be mathematically modified so the coordinates for a 3D model version of the 2D image can be deduced from my code. In a sense the object of my work can be defined in several ways as: 2D image, virtual object (Figs. 13-15), code or an idea.

In the quest for precision, interesting questions arise. Areas for further research include subjectivity in graphing 3D forms on 2D surfaces. There is a shifting threshold for what can be calculated, for the rest I rely on my eye. A seemingly simple question like how to distort a disk in space to account for perspective can be an increasingly complex problem. Questions like this led me to doubt that the epistemological framework for art and science was as explicit as it seemed, given everywhere I turn eventually requires my subjective interpretation.

WHY

Background

Multi-Coloured Fur Sphere (Fig. 1) stood out because this fur ball gave me an aesthetic experience like the feeling of learning something new and surprising or when something clicks or comes together. Sometimes there isn't a prelude to what the programmed image will look like, in contrast to painting, so I see it more in the way one would encounter someone else's work or nature.

I want to bring together things often deemed opposite such as object and subject, art and science and theory and practice. In trying to articulate my own position and epistemological framework, laying the groundwork for my interdisciplinary practice, I came across others who had broadened their scope in search of similar intersections from other fields.

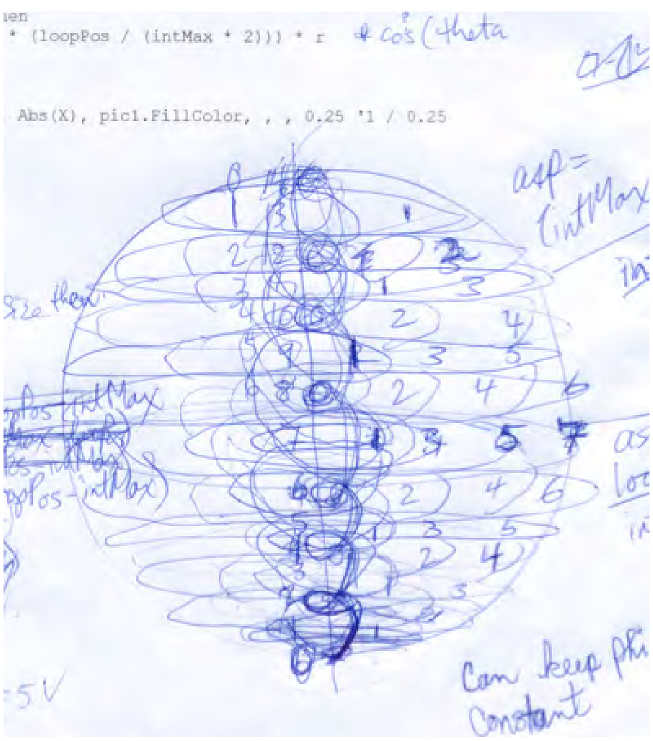

Fig. 9. *Untitled*, 2010, Laura De Decker, preliminary sketch and notes, © Laura De Decker.

Pre-Modernism

Herman Weyl's *Philosophy of Mathematics and Natural Science* discusses the importance of symbols in the development of mathematics with regard to Indian and Buddhist literature that delights in possibilities of combining mathematical operations (i.e. addition, multiplication and exponentiation) to produce very large numbers using a position system, in contrast to today's well-known base-ten position system: "the human mind for the first time senses its full power to fly, through the use of the symbol, beyond the boundaries of what is attainable by intuition." [2] Eastern analytic geometry translated geometry into algebra using fractions and irrational numbers, making it useful for measuring in addition to counting; the Greeks had reverted back to the algebraic traditions of the Sumerians, Indians and Arabs because they were, "deterred from this step because they took the discovery of the irrational seriously." [3] Iain McGilchrist in *The Master and his Emissary: The Divided Brain and the Making of the Western World* writes that after a thousand years the idea of the sphere re-emerges in the West during the Renaissance. [4] This coincides with Leonardo Da Vinci's curiosity-driven hands-on mastery of material and subject matter at the core of his contribution to both art and science: "Leonardo's anatomy thus proceeded from questions which even the medical schools of the time had not asked: for example, what happens beneath the skin when a man steps forward, kneels, stretches out his arm and grips a rod?" [5] The Renaissance led to the Enlightenment and the post-classical West made achievements in geometry independent of the East, "only after the science of space, through Descartes' *Géométrie* (1637), became subjected to algebraic calculus." [6] However, Cartesian philosophy was criticized for its diminishing affect on culture: Vico Giambattista was critical of narrow focus at the expense of cultural wisdom. [7]

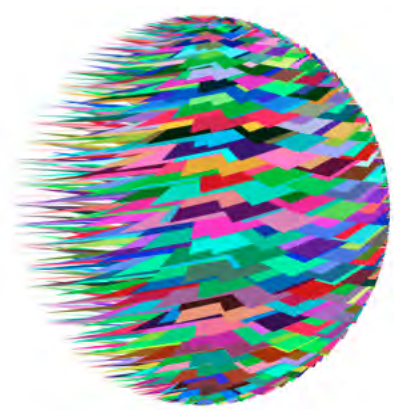

Fig. 10. *Wind-Swept Sphere*, 2009, Laura De Decker, giclée print, © Laura De Decker.

Isaac Newton's *Opticks* and Goethe's *Theory of Colours* are often considered emblematic of the dichotomy between quantitative and qualitative methods in science. While Goethe might be most celebrated for his epic play Faust, he felt his *Theory of Colours* was most significant because it countered the ripple effect of Newton's discoveries which were drastically transforming the world: "He believed it his duty to set everybody straight." [8] However, it was Newton's followers who had neglected the subjectivity of color. [9] Bruce Elder's *Harmony and Dissent: Film and Avant-garde Art Movement*s *in the Early Twentieth Century* points out: "Goethe challenged Newton's assumption that colour is an intrinsic property of light; […] he contended that colour emerged as a condition of light's environment." [10] Brian Cantwell Smith's *On the Origin of Objects* notes, John Maynard Keynes referred to Newton as, "the last of the magicians, the last of the Babylonians and Sumerians." [11] Although most scientists of Goethe's time saw little value in Goethean science, today his approach is taken more seriously. [12] Goethe also understood the power of mathematics and geometry but cautioned people from ignoring other approaches to scientific study of colour, including aesthetics. Regarding the theory of colours, "progress has been incalculably retarded by having been mixed up with optics generally, a science which cannot dispense with mathematics; whereas the theory of colours, in strictness, may be investigated quite independently of optics." [13] Goethe's work not only provides empirical observation of color from many field perspectives; his aphoristic writing communicates insight about his world in eighteenth and nineteenth centuries. [14] He had found ways to express the limitations of a burgeoning modernist way of thinking which had become increasingly objective at the cost of subjectivity.

Modernism

Weyl sees physics as foundational to biology: "As long as progress from simple to more complicated configurations remains the methodologically sound way of science, biology will rest on physics and not the other way around." [15] Smith contradicts this notion of the modernist "hierarchy of nature" point of view which he finds cramped: "[it] views everything as built up out of the formal ingredients of particle physics, held together with the abstract epoxy of set theory, logic and mathematics, stakes a claim to realism and foundationalism, but (at least at first blush) does so at the expense of pluralism and irreduction." [16] The notion of the "death of the author" and "death of painting" was a symptom of this way of thinking. [17] Rudolf Arnheim explains why the reductionist model is too simple, "what I have called 'modular thinking' is defeated by the fact that as we ascend the scale from the atomically small to the astronomically large we encounter levels of near-chaos, which disrupt the continuity of order." [18] What was good about modernism was its realism – that we share one world. [19] A closer look at history contradicts stereotypes of modernism and reveals its nuances.

Early twentieth century vanguard artists were interested in ideas that went beyond the mechanistic world-view often associated with modernism. For example Lawren S. Harris and Wassily Kandinsky were interested in ideas of underlying universal laws that connected everything, found in theosophy and theories about the fourth dimension. [20] Both Eastern (in relation to Hinduism and Buddhism) and Western ideas were incorporated into The Theosophical Society created by Helena Blavatsky in 1875 in New York. [21] Elder outlines threads between generations of artists: "[Viking] Eggeling and [Hans] Richter's ideas about colour and form were influenced by Blavatsky, [Rudolf] Steiner, [Charles] Leadbeater and, above all, Kandinsky (especially by Kandinsky's version of Goethe's colour theory)." [22] He makes the case that key movements of modern art, "the project to develop an abstract art based on a conception or pure visuality and Constructivism," have a complex relationship with what modernism came to mean. [23] As Elder states, some artists saw cinema as a way of regaining a more holistic understanding of the world: "a universal, transcendental art might yet come forth, might yet reunite the arts, might yet re-enchant the world […] and so sway the mind toward a creator-unity immanent in nature – that a new art might yet come forth that could fully express the artist's mind." [24] The ability to communicate experience so directly was an artistic counterpart to modern science. The concept of modern aesthetics and philosophy of art was part of a trend in aspirations for grand theories – a shift away from technical concerns toward general ideas. [25]

Fig. 11. *Finned Sphere*, 2010, Laura De Decker, giclée print, © Laura De Decker.

McGilchrist describes modernism's features as: excess consciousness and explicitness with regard to what should be intuitive and implicit, depersonalization and alienation from body and emotion, disruption of context, fragmentation of experience and loss of sense of 'betweenness.' [26] He suggests the dominance of left-brain thinking as the culprit for the apparent chasm between art and science, since he describes the left-hemisphere value as, "making explicit, but this is a staging post, an intermediate level of the 'processing' of experience, never the starting point or end point, never the deepest or the final, level." [27] Progress is more organic: "advances of science are often the result of chance observations, the obsessions of particular personalities and intuitions that can be positively inhibited by too rigid a structure, method or world view," and "Technological advances [are often] the results of local enthusiasts or skilled artisans attempting empirically to solve a local problem." [28]

Combining technical capabilities and curiosity allows for the most surprising breakthroughs. Whether referencing the advent of cinema or computers, technical knowledge and creative approaches were required for these new technologies and standard methods had not yet been developed. This grappling with media and methods engages right brain thinking: "Problem solving […] may become harder if we become conscious of the process." [29] In Jasia Reichardt's *The Computer in Art,* with rare exception the general theme seems to be that artists who were interested in creating art using computer programming learned to do programming rather than rely on a collaborator. [30] The Tokyo Computer Technique Group (CTG) thought, "one of the major underlying possibilities of computer art is that the 'artist' actually designs a system – a method of producing a given repertoire of forms and generating patterns." [31] Input for the system could come from a 'random' or a sensory source. From the artist's perspective, it was difficult to create something artistic without having an understanding of the technology itself. Likewise it was hard to create art without being subjective. Haruki Tsuchiya, systems engineer for CTG, stated in a letter to Reichardt, "While producing computer art, I found myself staying still as an engineer, but not the same as before." [32] He later wrote: "I would like to be a man, not artist, not engineer, a man." [33]

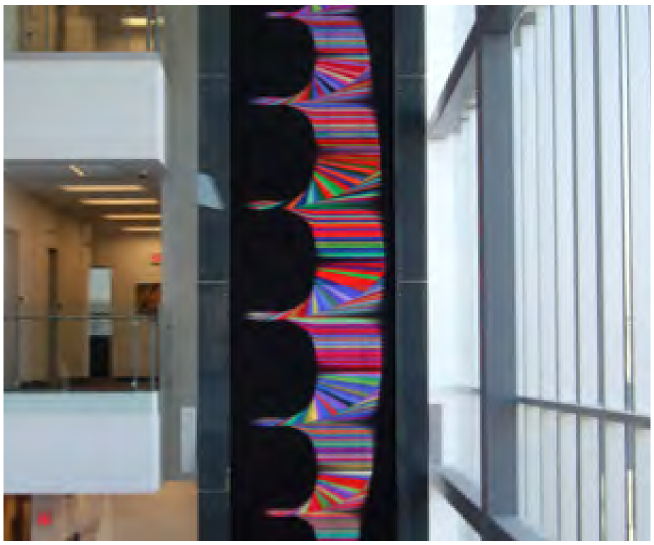

Fig. 12. *Wrestling with Wind-Swept Sphere*, 2013, video animation on Christie MicroTiles, © Laura De Decker, Photo by Stefan A. Rose.

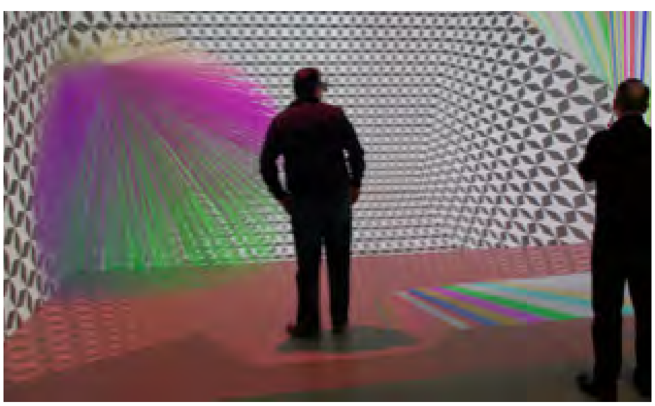

Fig. 13. *Composition with Multi-Coloured Fur Sphere*, 2013, interactive model, Christie Digital Cave (CAVE), © Laura De Decker, Photo by Stefan A. Rose.

Post–Modernism

Modernism was seen as a dead-end and post-modernism a reaction against linear and reductionist ways of thinking. McGilchrist writes, "The art of the past is 'placed,' ironised or rendered absurdly incongruous. And if art can be anywhere or anything – literally a pile of garbage, perhaps – this aims to abolish the beautiful, without needing even to say 'everything and everywhere is equally beautiful.'" [34] He goes on: "Through these assaults of the left hemisphere on the body, spirituality and art, essentially mocking, discounting or dismantling what it does not understand and cannot use, we are at risk of becoming trapped in the I-it world." [35] Smith has a more sympathetic understanding of the post-modernists' plight: "Certain forms of post-modern criticism avoid foundationalism, but sacrifice realism in the process and curiously enough remain reductionist, particularly with respect to categories of text, discourse, sign and the like." [36] Arnheim is also critical of the basis for reductionist thinking: "Such reasoning, however, has to be met with caution. It is modular thinking, based on the oversimplified assumption that the macroscopic world is a mere multiplication of a smallest unit." [37] Genetics gives a sense of chaos and the magnitude of the challenge of unraveling such complexity.

Transposable elements get inserted into DNA, move around and can have some sort of effect, but seem to be inconsequential and create spacing in the genome. [38] Eric Lander uses a metaphor to illustrate why transposable elements' relationships to the rest of the genome is complicated, by imagining stacks of papers in a messy attic as being such elements: "you put a cup of coffee down on top of a stack of papers, those papers may be utterly irrelevant, but now they're holding up that cup of coffee […] And if you were to just […] get rid of them, the cup of coffee would come crashing to the ground." [39] These otherwise useless pieces of code have become part of the context for genes of interest. These spaces happen to be very useful in interpreting genes, along with some ingenuity from expertise in other fields. For example, a graduate student of computer science found a sequencing error that changed the interpretation of two genes into one gene, based on comparison between sequences from other species. [40] What seems extraneous to the subject matter of focus can become significant for developing methods of research and exemplifies the complex relationship between method and subject matter.

Knowledge including scientific knowledge relies on observation: "The subjectivity of sense qualities must be maintained in two regards, one philosophical, the other scientific." [41] Biology is usually associated with detailed categorization and use of comparative qualitative data, in comparison to physics' search for unifying laws and its use of quantitative data. Weyl references Stuart Mill: "if we wish to learn the effects of a cause we may experiment; but if we wish to learn the cause of an effect we have to rely purely on observation." [42] For example, biophysics researchers looked to the world they knew for hypotheses to determine how motor protein Myosin V – a molecule that transports organelles – moves along long thin structures within cells called actin filaments. Researchers came up with two different models to explain this motion: hand-over-hand like a monkey swinging through trees or like an inchworm. [43] An experiment was designed using strategically placed fluorescent labels on parts of the protein to help rule out one of the prospective models by visual analysis. [44] By working on a problem from both sides it was confirmed, as the title of the publication indicates, “Myosin V walks hand-over-hand.” [45]

Science, mathematics and logic are sometimes oversimplified and misunderstood. Weyl quotes Immanuel Kant: “mathematics possesses a content that is secure independently of all logic and therefore can never be based upon logic alone.” [46] Smith states the consequences of a participatory metaphysics on mathematical practice “will disrupt its boundaries, splitting what has seemed an integral study into a web of cross-cutting currents that not only interpenetrate with others inside the mathematical realm, but that weave and course through the rest of society’s intellectual practice as well.” [47] In *The Trouble with Physics: The Rise of String Theory, the Fall of a Science and What Comes Next,* Lee Smolin writes of his interactions with Paul Feyerabend, “he argued – convincingly, in my view – that science would grind to a halt were the ‘method’s’ rules always followed.” [48] McGilchrist echoes this sentiment: “Virtually every great physicist of the last century […] has made the same point. A leap of faith is involved, for scientists as much as anyone.” [49] Smolin acknowledges science’s interconnectedness with other disciplines and life: “The scientific community is thus both an ethical and an imaginative community.” [50]

Fig. 14. *Composition with Multi-Coloured Fur Sphere*, 2013, detail with 3D position-tracking glasses, © Laura De Decker, Photo by Stefan A. Rose.

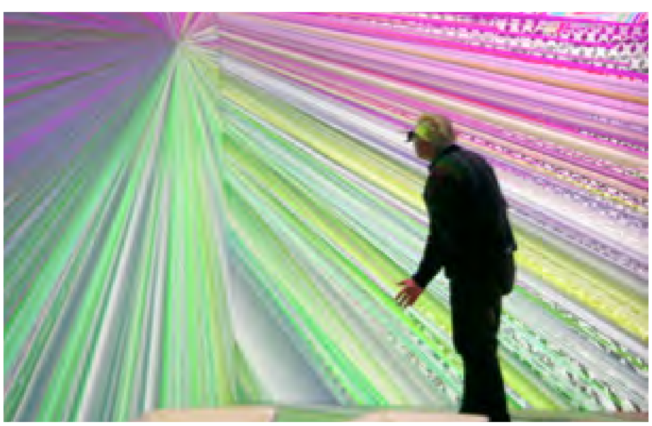

Fig. 15. *Composition with Multi-Coloured Fur Sphere*, 2013, © Laura De Decker, Photo by Stefan A. Rose.

Arnheim expresses a need for balance between scientific analysis and artistic expression: “As long as the analysis of rational shape remains a tool of the fully developed mind it can help to make perceived order explicit. When it replaces vision and stifles expression it becomes a game in vacuo.” [51] Whether using a scientific model or language, it must be remembered that it is a tool, an abstraction of reality. Post-modernism’s legacy is pluralism. [52]

CONCLUSION

Several authors recognize the pervasive cultural divide between science and art. Weyl states, “what is darkest for theory […] is the most luminous for the understanding from within; and to the elementary inorganic processes, that are most easily approachable by theory, interpretation finds no access whatsoever.” [53] The schism is not between art and science: Smith characterizes it as being between the “academic–cum–intellectual–cum–technological” and “the curious, the erotic, the spiritual, the playful, the humane, the moral, the artistic, the political and the sheerly obstreperous” and continues, “That is the divide that tears us apart; not the walls between this and that academic department.” [54] McGilchrist writes, “Ultimately what we cannot afford to keep deferring is a regrounding of both art and science in the lived world.” [55] They also give us some insight into how to proceed with interdisciplinary activity.

Smith is devoted to finding a balance between realism and constructivism by developing a new metaphysical foundation for an epistemological outlook that doesn’t fall into reductionism. In reference to Keynes he states, “the problem with current computer science […] is […] that we are *post-Newtonian,* in the sense of being inappropriately wedded to a particular reductionist form of scientism, inapplicable to so rich an intentional phenomenon […] Maybe, instead, we need a new generation of magicians.” [56] He proposes a participatory successor metaphysics that takes the best of modern and post-modern metaphysics and gets rid of the problematic aspects. [57] In this metaphysical model material objects occupy a middle ground between the typical notion of the physical and intentional world: “registration and materiality, on this metaphysics, play a role that syntax was asked to play in the prior metaphysics.” [58] Smith asks “how does one describe the content of the vague and tentative sketches that are so crucial in early stages of architectural design, for example?” [59] This relates back to my use of vague but consistent language as a way to distance myself from too strict a definition in terms of computational objects. Smith writes: “coding up the details of task-specific domains is the job of users of object-oriented languages, not of their designers.” [60] Compositional achievement is the domain of both subject and object. [61] “If registration is participatory, so too must theory construction be.” [62] In other words, theory and practice intersect.

McGilchrist discusses our ability to look beyond the epistemological systems we use: “we may be willing to accept the existence of a reality beyond language or rationality […] because our mind as a whole can intuit that aspects of our experience lie beyond either of these closed systems.” [63] The perception – as opposed to the categorization and naming – of color is associated with the right fusiform area of the brain. [64] In addition, maybe an awareness of the brain’s tendencies would facilitate an openness to develop a more holistic view. There is hope for societies plagued by over abundant left-brain thinking, which is more indicative of the West: They can learn from parts of the East. [65]

Weyl finds the combination of color and geometry significant: “Epistemologically it is not without interest that in addition to ordinary space there exists quite another domain of intuitively given entities, namely the colors, which forms a continuum capable of geometric treatment.” [66] My fascination with color has been a springboard into improving the communication between both hemispheres of my brain and developing knowledge. The subject matter has served as a starting point to more complex ideas and a guide for my intuition.

Even though *Multi-Coloured Fur Sphere* (Fig. 1) was created using math and logic, it was constructed as much as it was found and created the content to relate to the interdisciplinary ideas discussed in this paper. We actively adopt imperfect ways of gauging the world since we are never really separate from what we perceive. Perhaps that is just part of the limitation or beauty, of being human. What we will never understand completely, we nonetheless get to use and experience.

ACKNOWLEDGEMENT

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