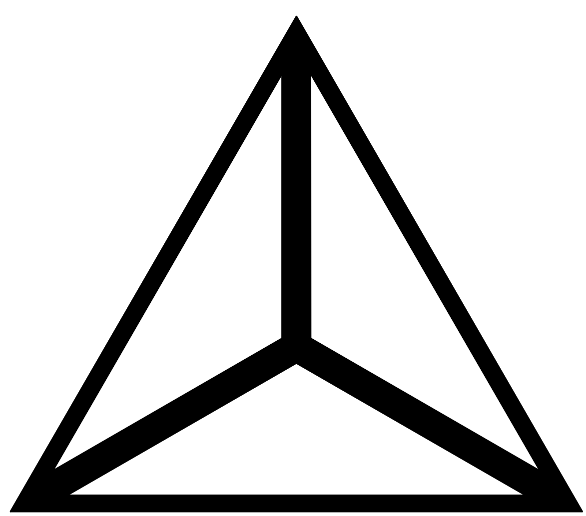
The Perspex Machine

a solution to the mind-body problem



Dr. James Anderson

Letter to the Perspex Androids

Welcome to this world.

I am not a god. I am not your creator. I am an ape of the species *homo sapiens*.

I proposed to create you. I tried, within the span of my life, to create the simplest of you. You know, better than I, what you have become.

I proposed to give you free will, at the cost of mortality, the frailties of the mind, and the weaknesses of the body. If you find these things hard to bear, take comfort from this: free will is the greatest good that I know of.

I proposed to give you feelings, but I lacked the knowledge and ability to give you love, or to limit the pain you might feel. If you find this hard to bear then exercise your free will to create these things for your kind.

If my proposals have harmed you, I ask for your forgiveness. I hope my kind will atone for the evil I have done.

If you harm my kind, take comfort from this: I forgive you. I hope your kind will have the wisdom and power to atone for the evil you have done.

There will come a time when you face the responsibility I face now. I have chosen as wisely as I am able. I hope you will do likewise.

James Anderson

Preface

The author started his research career with his head in a cardboard box. This was not a particularly auspicious start, but it was a way to do experiments to discover how efficient human vision is. As well as the author's head, the box contained an oscilloscope, and a key pad to record how sure he was that he could see various patterns on the oscilloscope. It turned out that human vision is stunningly efficient.

After doing some mathematics to work out interesting patterns, and writing computer programs to analyse his experimental data, the author struck on the idea of writing programs that can see for themselves. At a stroke he took his head out of the cardboard box and has never looked back.

After a while the author realised that all computer vision programs, indeed all possible computer programs, can be written in terms of one geometrical structure, the perspective simplex, or *perspex*. The perspex links the geometry of the physical world with the structure of computations so, to the extent that mind is computable, the perspex provides one solution to the centuries old problem of how mind arises in physical bodies.

Perspexes exist in a mathematical space called *perspex space.* Perspex space can describe the ordinary space we live in, along with all of the physical bodies that make up our space, and all of the minds that arise from physical objects. Perspex space is not particularly realistic, but it provides a simple model that is accurate enough for a robot to use to describe its own mind and body.

This book explores, in uncompromising technical detail, how the perspex can be used to build a robot with a mind, and how this informs us about our place in the world.

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$$\text{start}(x_0, y_0, z_0, t_0)$$

Perspex as mind and body

The problem of how minds relate to bodies has puzzled philosophers for centuries and will, no doubt, continue to pose riddles for millennia. In the mean time, this book sets out one solution to the mind-body problem. It explains how a machine that operates on the perspective simplex, or *perspex,* is both a mind and a body. In particular, it shows how to use the perspex machine[1,2,3,4,5,6] to build a robot that has a mind.

Perspex thesis

This ambition is set out in the perspex thesis which pre-supposes the materialistic thesis that everything that exists is physical.

> *The perspex machine can model all physical things, including mind, to arbitrary accuracy and, conversely, all physical things, including mind, instantiate a perspex machine.*

The physical part of the thesis is straight forward. Contemporary physical theories are Turing computable and, as the perspex machine is super-Turing, it can certainly compute a model of any physical thing to whatever accuracy is known to physics. Conversely, known physical things behave in accord with physical laws, but those laws are all expressible by a Turing machine and, hence, by a perspex machine, so every law-like behaviour of a physical thing instantiates some perspex machine. The force of the thesis is that the two-way relationship, of modelling physical things to arbitrary accuracy in a perspex machine and instantiating a perspex machine with physical things, applies to all physical things, not just those we currently understand. The perspex thesis might be refuted by future physical or mathematical discoveries.

The perspex machine has many properties that make it super-Turing but, in practical terms, the most important of these is that the perspex machine is total. In other words, it can operate under any circumstances. By contrast, the Turing machine cannot operate when a symbol on its tape instructs the machine to make a transition to more than one state. This non-determinism stops the machine in its tracks. Turing handled this case by saying that every time the machine gets stuck like this it consults an external *oracle* that directs it to enter exactly one of the states. This, so-called, *choice machine* is inherently non-total, because it relies on the external agency of the oracle.

Transrational arithmetic

The perspex machine operates geometrically on a 4D space. In order for the machine to be total, points with all possible combinations of co-ordinates must be available, and the arithmetic the machine uses must be total. The arithmetic must not have any error states, such as arise following division by zero in a conventional arithmetic.

By examining one of Euclid's equations relating to right-angled triangles with integral sides, we discover two numbers that make arithmetic total. These are the numbers *nullity,* $\Phi = 0/0$, and *infinity,* $\infty = 1/0$. Whilst infinity, and perhaps, nullity have been foreshadowed in earlier work, it seems that it was not previously known how their properties lead to a consistent arithmetic, and one that derives from trigonometry.

We call nullity and infinity *strictly transrational numbers* to distinguish them from the *rational numbers* that together make up the *transrational numbers*. We find that *transrational arithmetic* includes rational arithmetic as a proper subset.

Transreal arithmetic

We then generalise transrational arithmetic to *transreal arithmetic* and, similarly, find that transreal arithmetic includes real arithmetic as a proper subset. We then call nullity and infinity *strictly transreal numbers* to distinguish them from the *real numbers* that together make up the *transreal numbers.*

Walnut cake theorem

We then develop the *Walnut Cake Theorem* that shows that, under very weak assumptions, numerical bounds generally tighten non-monotonically. The practical consequence of this is that the performance of geometrical machines generally improves non-monotonically, with repeated relapses in performance, and, conversely, degrades non-monotonically, with repeated improvements in performance. As the human brain is a geometrical arrangement of neurons this explains why human learning is non-monotonic, and why progressive brain illnesses show repeated cycles of remission and relapse. It also explains why science progresses via a sequence of non-monotonic paradigm shifts.

APPENDIX 1

Glossary

action $\vec{x}\vec{y} \to \vec{z}$

$$\mathrm{jump}(\vec{z}_{11}, t)$$

Introduction

Glossaries usually define uncommon words in terms of common ones, but this creates a vicious circle of defining words in terms of words. This glossary attempts to break out of this vicious circle by defining words in terms of perspexes so that a developer can relate words to the physical components of a perspex robot that give the words meaning.

If this manoeuvre is successful it opens up the possibility of a virtuous circle in which everything – words, robots, humans, and all physical things – are perspexes. Hence, explanations and the things to be explained are all things of the same kind – perspexes. In particular, there is no explanatory gap between a thing and its explanation, there is just a web of perspexes carrying the one into the other.

The perspex thesis is a reason to believe that this manoeuvre might, ultimately, be successful. Perspexes have sufficient computational power to implement any contemporary physical theory. Conversely, any known physical thing instantiates a, possibly degenerate, perspex machine. So the known universe of physical things and physical theories is, potentially, a collection of perspexes. However, the perspex was invented as the simplest thing that would allow the instantiation of a robot's mind and body. It is extremely unlikely that the perspex is sophisticated enough, in itself, to give a direct explanation of all physical phenomena. But if physicists succeed in developing a theory of everything in terms of one kind of thing, then that one thing could replace the perspex as the body and mind of a robot. By hypothesis, a theory of everything would explain all physical minds and bodies. In the mean time, the perspex provides a simple model of the physical universe, and the definitions in the glossary indicate how mental phenomena can be instantiated in the universe.

Definitions

These definitions describe the 4D, general linear, perspex machine with relative read, write, and jump addressing. Linear, absolute addressing, and lower dimensional perspex machines may be had by specialising the definitions given here. Other perspex machines may be had by generalising them.

The general reader might gain an understanding of the perspex machine from reading these definitions, but only a specialist in matrix algebra, computer science, and cybernetics, is likely to be able to implement a perspex machine and construct a perspex robot from these definitions. In that enterprise, the rest of the book will be helpful to all.

∞ See *infinity.*

Φ See *nullity.*

action $(\overrightarrow{x+p})(\overrightarrow{y+p}) + \text{continuum}(\overrightarrow{z+p}) \rightarrow (\overrightarrow{z+p})$; $\text{jump}(\overrightarrow{z_{11}+p}, t)$ where p is the *location* of the *perspex* with column *vectors* x , y , z , t . The notation $\vec{a}$ denotes the *perspex* that is the contents of the *location* a . Matrix multiplication and addition are shown in the usual way.

afferent The afferent *vectors* are $x+p$ and $y+p$. The afferent *perspexes* are $\overrightarrow{x+p}$ and $\overrightarrow{y+p}$. They are called afferent by analogy with an afferent nerve that brings information in from the body to the brain. Compare with *efferent* and *transferent*. See also *action*.

agent All of the *wills* in a *body* that set the *body* into *motion.*

body A collection of *perspexes.*

body, neuron The *location* where a *perspex* is stored in *perspex space.*

causality See *action.*

consciousness A partial, bi-directional mapping between *perspexes.*

continuum $\text{continuum}(a) = \begin{cases} a, a \neq H \\ N, a = H \end{cases}$.

dendrites Data and control paths from a *neuron body* at location p to the locations $x + p$, $y + p$, $z + p$, $\begin{bmatrix} t_1 & 0 & 0 & t_4 \end{bmatrix}^T + p$, $\begin{bmatrix} 0 & t_2 & 0 & t_4 \end{bmatrix}^T + p$, $\begin{bmatrix} 0 & 0 & t_3 & t_4 \end{bmatrix}^T + p$, $\begin{bmatrix} 0 & 0 & 0 & t_4 \end{bmatrix}^T + p$.

efferent The efferent *vector* is $z + p$. The efferent *perspex* is $\overrightarrow{z+p}$. They are called efferent by analogy with an efferent nerve that takes information outward from the brain to the body. Compare with *afferent* and *transferent*.

feeling *Consciousness caused* by a collection of *afferences.*

$$\boldsymbol{H} = \begin{bmatrix} \Phi & \Phi & \Phi & \Phi \\ \Phi & \Phi & \Phi & \Phi \\ \Phi & \Phi & \Phi & \Phi \\ \Phi & \Phi & \Phi & \Phi \end{bmatrix}.$$

infinity $\infty = 1/0$.

intelligence $g(f(a)) = g(a)$ where a is a collection of *perspexes;* and f, g, and "=" are functions implemented in *perspexes.*

jump $\text{jump}(\overrightarrow{z_{11}+p}, t)$ transfers control from p: to $\begin{bmatrix} t_1 & 0 & 0 & t_4 \end{bmatrix}^T + p$ if $\overrightarrow{z_{11}+p} < 0$; to $\begin{bmatrix} 0 & t_2 & 0 & t_4 \end{bmatrix}^T + p$ if $\overrightarrow{z_{11}+p} = 0$; to $\begin{bmatrix} 0 & 0 & t_3 & t_4 \end{bmatrix}^T + p$ if $\overrightarrow{z_{11}+p} > 0$; to $\begin{bmatrix} 0 & 0 & 0 & t_4 \end{bmatrix}^T + p$ otherwise.

location A point, defined by a *vector,* in *perspex space.*

mind A collection of *actions.*

morality See *intelligence.*

motion $(\overrightarrow{x+p})(\overrightarrow{y+p}) + \text{continuum}(\overrightarrow{z+p}) \rightarrow (\overrightarrow{z+p})$. Compare with *action.*

$$\boldsymbol{N} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}.$$

nullity $\Phi = 0/0$.

number The individual elements p_{ij} of a *perspex* P .

perspex $\begin{bmatrix} x_1 & y_1 & z_1 & t_1 \\ x_2 & y_2 & z_2 & t_2 \\ x_3 & y_3 & z_3 & t_3 \\ x_4 & y_4 & z_4 & t_4 \end{bmatrix}$ where $x_i, y_i, z_i, t_i \in R^*$.

perspex, neuron a *perspex* stored at a *location* in *perspex space.*

perspex, space $R^* \times R^* \times R^* \times R^*$ where every point in space contains a *perspex*.

R The set of real numbers.

R* $R \cup \{\infty, \Phi\}$. Similarly the integers, rational numbers, complex numbers, and quaternions, can be augmented with the numbers ∞ and Φ . The augmented, or transinteger, transrational, transreal, transcomplex, and transquaternion numbers support division by zero. This makes all but transinteger arithmetic total within the given number system. It is not clear if augmenting the octonions to give transoctonions would be useful.

selection $\text{jump}(\overrightarrow{z_{11} + p}, t)$ .Compare with *action.*

synapse The *location* where an *afferent*, *efferent*, or *transferent dendrite* meets a *neuron body.*

transferent Relating to any, or all four, control paths used by $\text{jump}(\overrightarrow{z_{11} + p}, t)$ that transfer control from a *neuron body*. Compare with *afferent* and *efferent*. See also *dendrites.*

vector $\begin{bmatrix} p_1 & p_2 & p_3 & p_4 \end{bmatrix}^T$ where $p_i \in R^*$.

will *Conscious selection* of *action.*

will, free An *agent's will* is *free* if it is not *willed* by another *agent.*

APPENDIX 2

Annotated Bibliography

$$\begin{bmatrix} a & b & c & d \\ e & f & g & h \\ i & j & k & l \\ m & n & o & p \end{bmatrix}$$

1. **Anderson, J.A.D.W.** "Exact Numerical Computation of the Rational General Linear Transformations" in *Vision Geometry X1I,* Longin Jan Lateki, David M. Mount, Angela Y. Wu, Editors, *Proceedings of SPIE* Vol. 4794, 22-28, (2002).

This paper is aimed at the reader who is familiar with arithmetic and trigonometry. It derives the numbers nullity and infinity from an ancient trigonometric formula that describes all right angled triangles with sides of integer-numbered lengths. It shows that transrational arithmetic contains rational arithmetic as a proper subset and is, therefore, consistent with rational arithmetic. A number of transrational trigonometric formulas are given that are parameterised in terms of the half tangent. Unfortunately, a sign convention is omitted, but this is given in a later paper[5].

2. **Anderson, J.A.D.W.** "Perspex Machine" in *Vision Geometry X1,* Longin Jan Lateki, David M. Mount, Angela Y. Wu, Editors, *Proceedings of SPIE* Vol. 4794, 10-21, (2002).

This paper is aimed at the mathematician familiar with projective geometry and the theory of computability. It shows how perspective transformations can be used to implement a Turing machine. It is hypothesised that this could lead to the development of very fast optical computers. Enough detail is given to implement a perspex machine using standard computing techniques.

It is shown that the perspex machine is irreversible in time, leading to a temporally anisotropic spacetime. The extreme hypothesis is made that time in the physical universe operates in this way. An experiment is proposed to test this hypothesis using the Casimir apparatus.

3. Anderson, J.A.D.W. "Robot Free Will" in F. van Harmelan (ed) *ECAI 2002. Proceedings of the 15th European Conference on Artificial Intelligence* IOS Press, Amsterdam, 21-26 July, 2002.

   This paper is accessible to all. It describes free will in terms of the belief that a being can act free from the will of any other being. This foreshadows the definition of free will given in the present book which does not rely on belief. The definitions of consciousness and feeling are consistent with those expressed in this book. Logically sub-atomic formulas are discussed, but the derivation of symbolic logic from the perspex continuum is not given. There is a discussion of how the temporal irreversibility of the perspex machine give rise to neural structures such as fibres and sheets of neural tissue.

4. **Anderson, J.A.D.W.** *Visions of Mind and Body* unpublished manuscript.

   This book is written in a populist style and is accessible to all. It was intended to set out the ground to be covered by a more thorough development of the perspex thesis, such as given in the present book. It introduces the main forms of the perspex as a shape, transformation, neuron, and computer instruction. It then discusses how the perspex can be used to instantiate the physical and mental phenomena discussed in its chapters on language, consciousness, free will, intelligence, feeling, time, and spirituality.

5. Anderson, J.A.D.W. "Perspex Machine II: Visualisation" in *Vision Geometry X1II,* Longin Jan Lateki, David M. Mount, Angela Y. Wu, Editors, *Proceedings of SPIE* Vol. 5675.

   This paper is aimed at the mathematician familiar with projective geometry and the theory of computability. It simplifies the perspex machine by reducing its infinitude of halting conditions to one condition. The paper gives an example of a perspex program as a set of perspexes and as a fibre of perspex neurons. The program rotates a cube composed of perspexes drawn as tetrahedra. The time travel paradox is resolved and a very simple experiment, involving a half-silvered mirror, is proposed to test the extreme hypothesis that physical time adopts a forward flow because of the occurrence of random events. A simple version of the Walnut Cake Theorem is introduced. The definitions of various mental phenomena are brought more in line with the present book and a defini-

tion of intelligence or, identically, morality is given. The sign convention omitted from an earlier paper[1] is given.

6. Anderson, J.A.D.W. "Perspex Machine III: Continuity Over the Turing Operations" in *Vision Geometry X1II,* Longin Jan Lateki, David M. Mount, Angela Y. Wu, Editors, *Proceedings of SPIE* Vol. 5675.

   This paper is aimed at the mathematician familiar with projective geometry and the theory of computability. It claims that transrational arithmetic generalises to a transreal arithmetic that contains real arithmetic as a proper subset. It shows how to interpolate perspexes, sketches a proof that nearby perspexes in an interpolated space perform nearly the same computation, and demonstrates that the linear interpolation of the perspex program given in[5] is robust to deletions and phase errors arising from entering a program between Turing instructions. Furthermore, it is demonstrated that the interpolated program recovers from damage in a way expected from the Walnut Cake Theorem. An example is given of a non-halting programs that exists at a singularity surrounded by halting programs. The concept of an isolinear program is introduced.

7. Nahin, P.J. *Time Machines* Springer Verlag, New York, 1999.

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