King David was open about his trials

Psalm 18

4 The pangs of death surrounded me,
And the floods of ungodliness made me afraid.
5 The sorrows of Sheol surrounded me;
The snares of death confronted me.

But David had great confidence in God

Psalm 18

I will love You, O LORD, my strength.

2 The LORD is my rock and my fortress and my deliverer;

My God, my strength, in whom I will trust;

David could see that God's way is perfect

Psalm 18:30 & 32

As for God, His way *is* perfect;
The word of the LORD is proven;
32 *It is* God who arms me with strength,
And makes my way perfect.

God’s perfect ways in the psalms

Psalm 19:7 The law of the LORD *is* perfect, converting the soul

Psalm 51:7 Wash me, and I shall be whiter than snow.

Psalm 11:7 For the LORD *is* righteous.

Psalm 119:137 …upright *are* Your judgments.

Psalm 149:4 He will beautify the humble with salvation.

Psalm 50:2 Out of Zion, the perfection of beauty.

The importance of knowing God's way is perfect

(1) Individual believers

Job 5:7 Man is born to trouble, As the sparks fly upward

(The Devil wanted Job to doubt God's goodness)

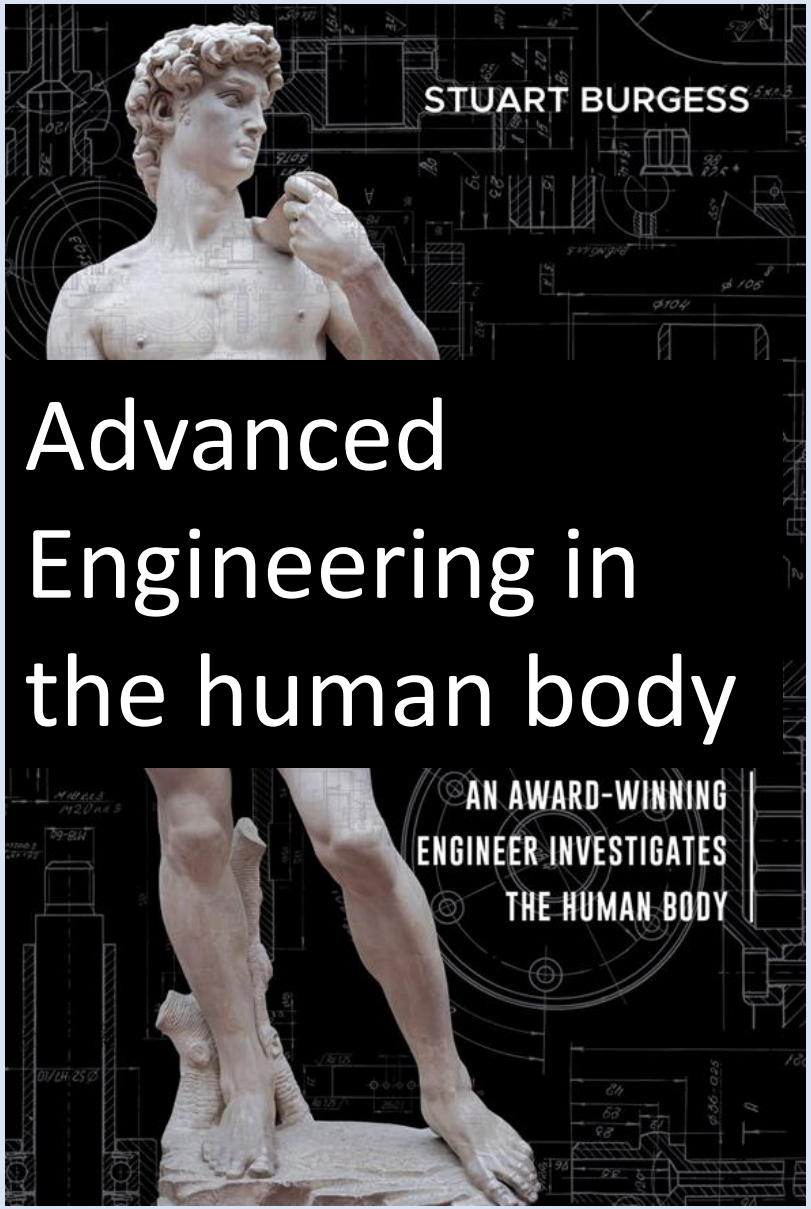
(2) National leaders

Psalm 33:12 Blessed is the nation whose God is the LORD

(3) Evangelism

Psalm 145:4 One generation shall praise Your works to another, And shall declare Your mighty acts.

A revelation!



2021:

Started writing book on the **Design of man**

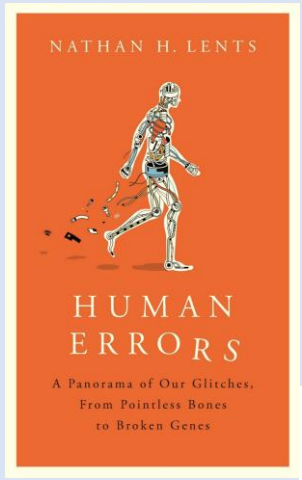
AIMS

1. Show how science supports creation (100s examples of superior design)
2. Expose false science of Lents, Hafer…

Chapters

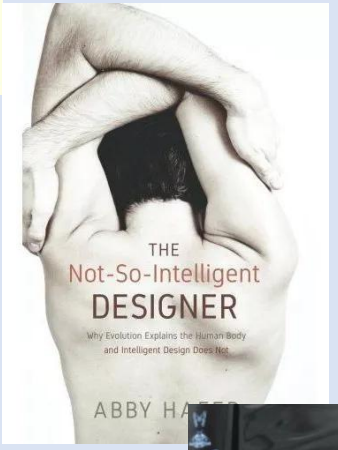
Feet, knees, Wrists, Fingers, Back, Throat, Jaw, Ears, Eyes, Skin, Birth, Blood circulation, Digestion, Muscles, Nervous system

Atheists are desperate to claim bad design



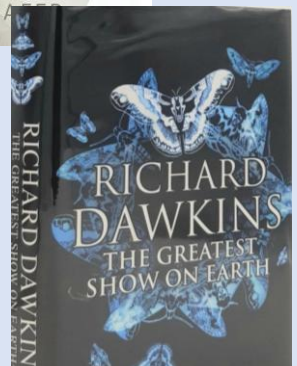
Nathan Lents, *Human Errors*

"The wrist bones and ankle bones are the most obnoxious examples of bones for which we have no use."



Abby Hafer, *The not-so-intelligent designer*

If we were designed why did the Creator [design the throat] so badly.



Richard Dawkins, *Greatest show on earth*

The eye is the design of a complete idiot.

The spiritual battle

Nov 28, 2006,
Daily Telegraph

How Genesis crept back into the classroom

HO/TATE GALLERY

'Pin-up boy for non-believers' goes on the offensive

IF Truth in Science are the new heroes of the creationist movement then Richard Dawkins is the pin-up boy for the country's non-believers.

The Oxford University geneticist is the author of a series of best-selling books, including *The Selfish Gene* and *The God Delusion*, his latest work, described as a sustained polemic against religious faith.

A supporter of atheist groups, such as the National Secular Society and the British Humanist Association, he has long campaigned against attempts to push Biblical theories in school science lessons.

Now, like Truth in Science, he is taking his fight into the classroom, by publishing his own teaching materials.

The academic has establishing a foundation, the Richard Dawkins Foundation for Science and Reason, which will subsidise books, pamphlets and DVDs for teachers to challenge the "educational scandal" of creationism, which has fuelled the rise of "irrational ideas".

A spokesman for the academic said yesterday that two foundations – in England and one in the USA, where "intelligent design" is openly taught in many classrooms – were in their "very early days". However, it is thought the foundations will both apply for charitable status – winning thousands of pounds in tax-breaks – and they are likely to be personally bank-rolled by the author and his supporters.

His foundation will conduct research into what makes some people more susceptible to religious ideas than others and whether they are particularly vulnerable.

He also said he plans to campaign against children being labelled with the religion of their parents.

Prof Dawkins: anti-faith warrior

The academics who are preaching intelligent design

Truth in Science, a group of academics and clergymen, first emerged in September as flag-bearers for the creationist movement.

Last night a spokesman denied it was pushing Biblical creationism on schools, saying that "there is not one mention of the Bible in our materials". However, he admitted the packs the group sent out did promote the more recent revisionist off-shoot of creationism, intelligent design. This is the belief that certain features of the universe, and living things, cannot be explained by "natural selection", but are best explained as the work of an "intelligent designer".

Truth in Science has been denounced by secular groups such as the British Humanist Association. Graham Stringer, the Labour MP for Blackley, Manchester, tabled an early day motion in October calling on MPs to condemn the materials – "full of scientific mistakes and failing to disclose the group's creationist beliefs".

But the group is backed by a number of respected academics.

Its four-man board of directors includes Andy McIntosh, a professor of thermodynamics and combustion at Leeds University, and Maurice Roberts, a former classics teacher and now a minister in the Free Church of Scotland.

The group's advisory council includes Stuart Burgess, professor of design and nature at Bristol University, Derek Linkens, an emeritus professor at the department of automatic control and systems engineering at Sheffield University, and Dr Tim Wells, a senior lecturer in the school of biosciences at Cardiff University.

George Curry, an Anglican minister from Newcastle upon Tyne, and chairman of Church Society, is another backer.

Stuart Burgess: gives group advice

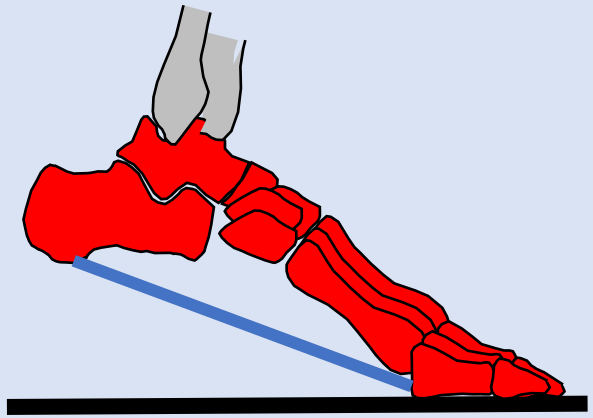
(1) The foot

Advanced engineering

- Flat foot
- 1 or 2 joints

Superior engineering

- Arched foot
- 33 joints



The foot is superbly constructed for ambulation

"Imaging of the Foot," Radiology Key, Jan 17, 2016,

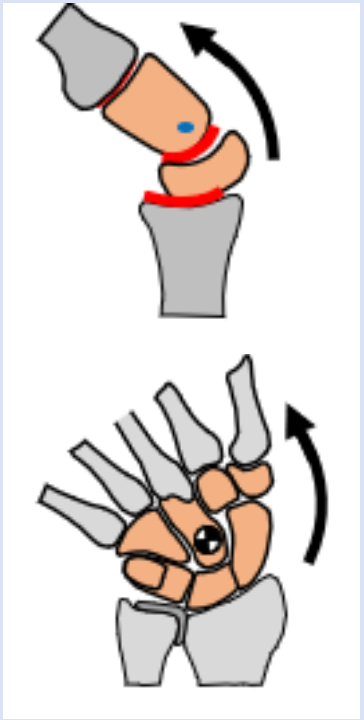
(2) The wrist

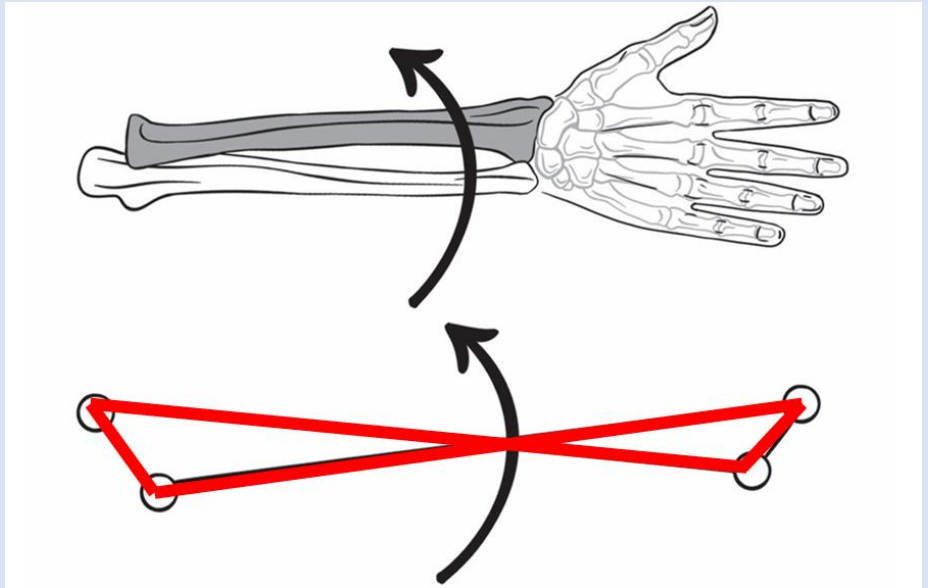
Advanced engineering

Two joints

Superior engineering

Three compact joints





It is remarkable how 8 wrist bones perform 4 major functions
Burgess, Multifunctioning Joints. *Biomimetics* **2024**, *9*, 529.

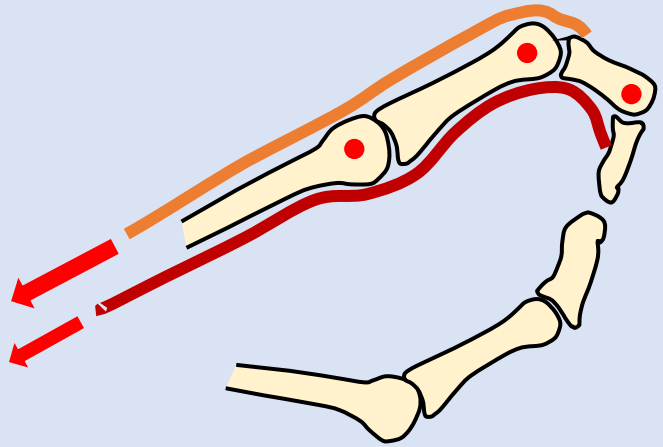
(3) The fingers

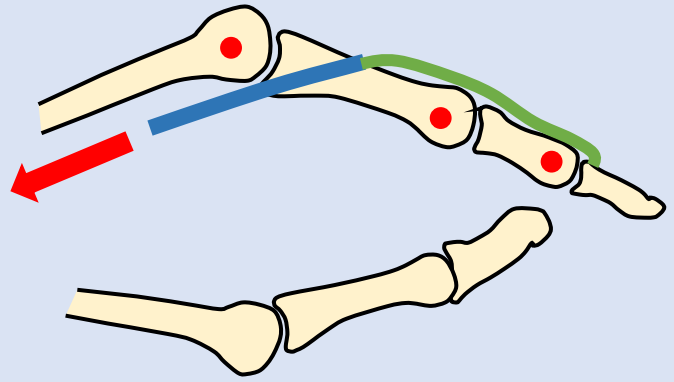
Advanced engineering

Simple flexion

Superior engineering

- Unique push-retract motion
- Unique precision





The fingers perform a symphony of astonishing complexity

Bulli, Translational Research in Anatomy, Vol 35, June 2024

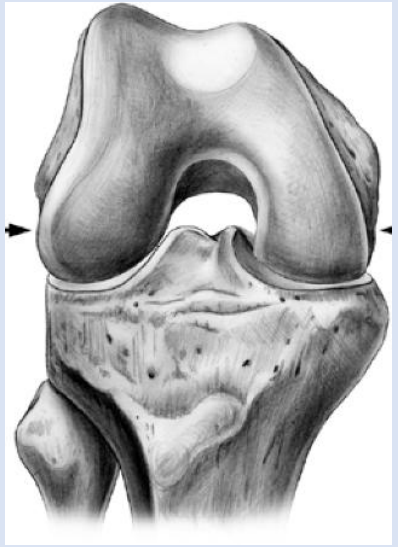
(4) The knee

Advanced engineering

Simple flexion

Superior engineering

- Flexion and rotation
- High range of motion



Knees show no wear after millions of load cycles

Masouras, Journal of Orthopaedics and Trauma

(5) The eye

Advanced engineering

- 20 megapixel resolution
- Bulky

Superior engineering

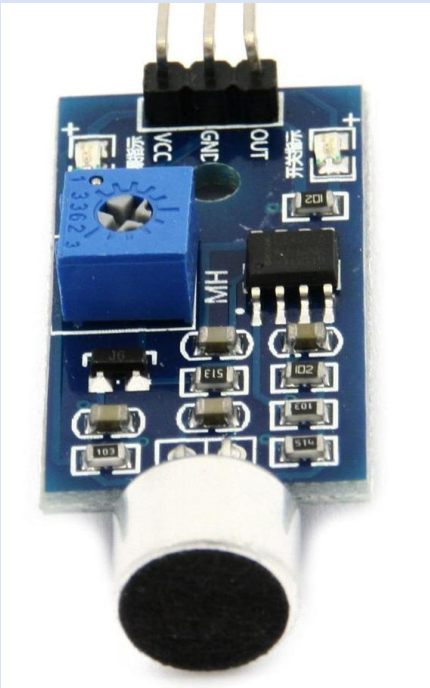
- 52 megapixel camera
- Superior dynamic range

The vertebrate eyes come close to perfect

Baden Current Biology Vol 32, Issue 7, 2022

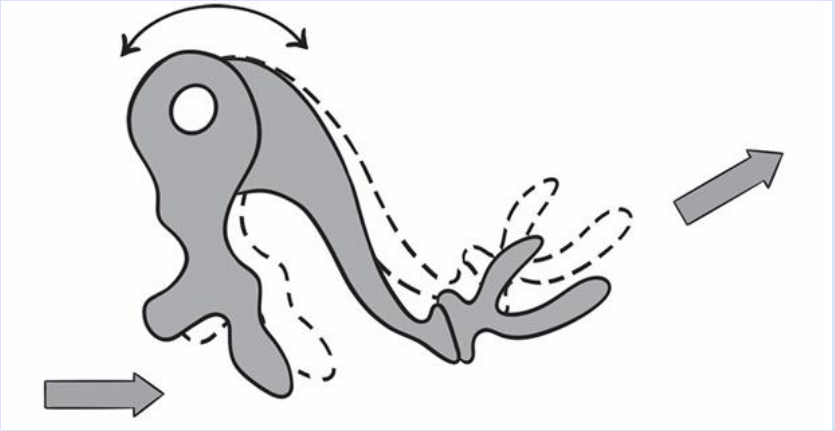
(6) The ear

Advanced engineering



Superior engineering

- Extreme sensitivity
- Acoustic reflex



The human cochlea is of significantly higher resolution of frequency analysis than found in animals

Sumner, Sharper Cochlear Tuning, PNAS 115, no. 44 (2018)

(7) The throat

Advanced engineering

Ultimate engineering

- Multi-functioning:
  eat, breath, voice
- Fine voice

Singers produce great varieties of tonal quality with the use of only one sound generator
Minoru Hiran, a world leading expert in the voice

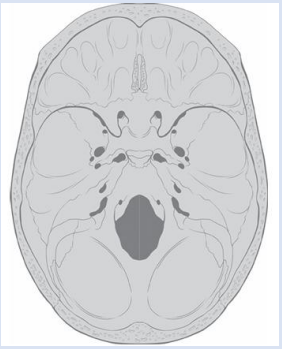
(8) The nervous system

Advanced engineering

- 30 km of wiring

Superior engineering

- 150,000 km of wiring
- Reaches every cubic mm



The human nervous system is vastly more sophisticated than any engineering wiring system
S Burgess, Ultimate Engineering, 2026

(9) The brain

Advanced engineering

- 20MW to power
- 100,000 liters

Superior engineering

- 20W to power and 1 liter volume

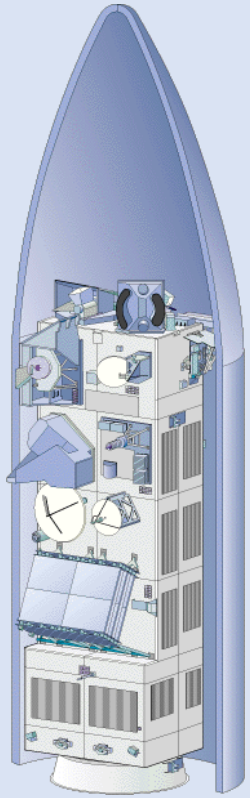
Despite Deep Blue's excellence at chess, it is stupid

Sterling and Laughlin, Principles of Neural Design, 1.

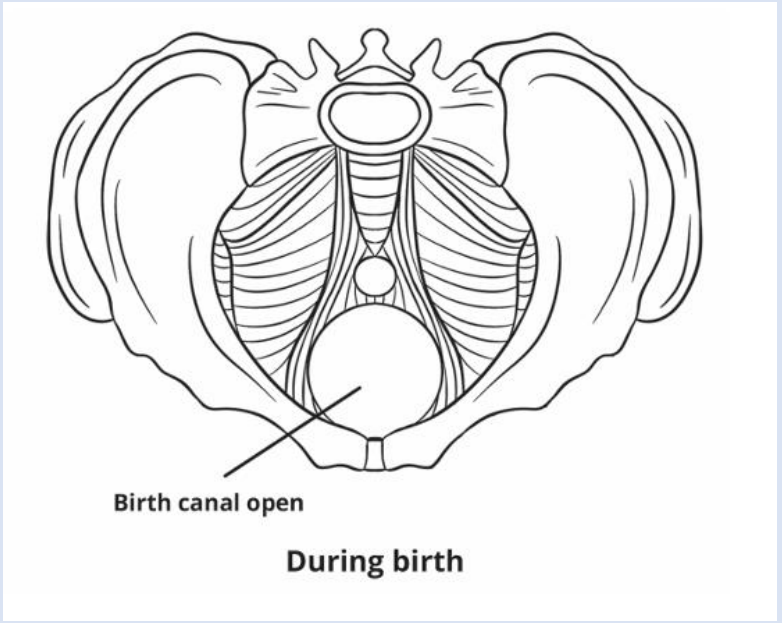
(10) Vaginal birth

Advanced engineering

Satellite orbit ejection



Superior engineering



Relaxin hormone relaxes muscles

The stretch ratio in the pelvic floor muscles can reach an extraordinary 3.26

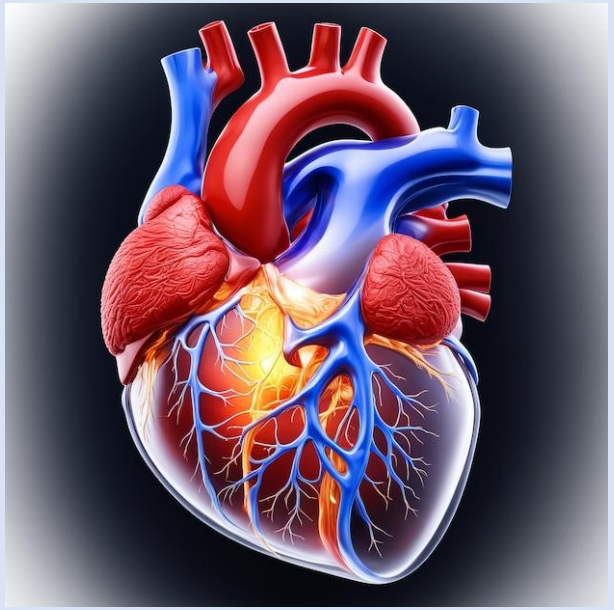
Ashton- Miller Review of Biomedical Engineering

(11) The ultimate heart

Advanced engineering

- Lasts 1 year

Ultimate engineering



- Can last 100 years
- Adaptable

Nothing shows more clearly the perfect engineering of the heart than our own failed attempts to imitate it.

Professor Sian Harding (Cardiac specialist)

Revelation!

Perfect design

Perfection in Creation

Psalm 139:14

will praise You, for I am fearfully *and* wonderfully made;

Genesis 1:31

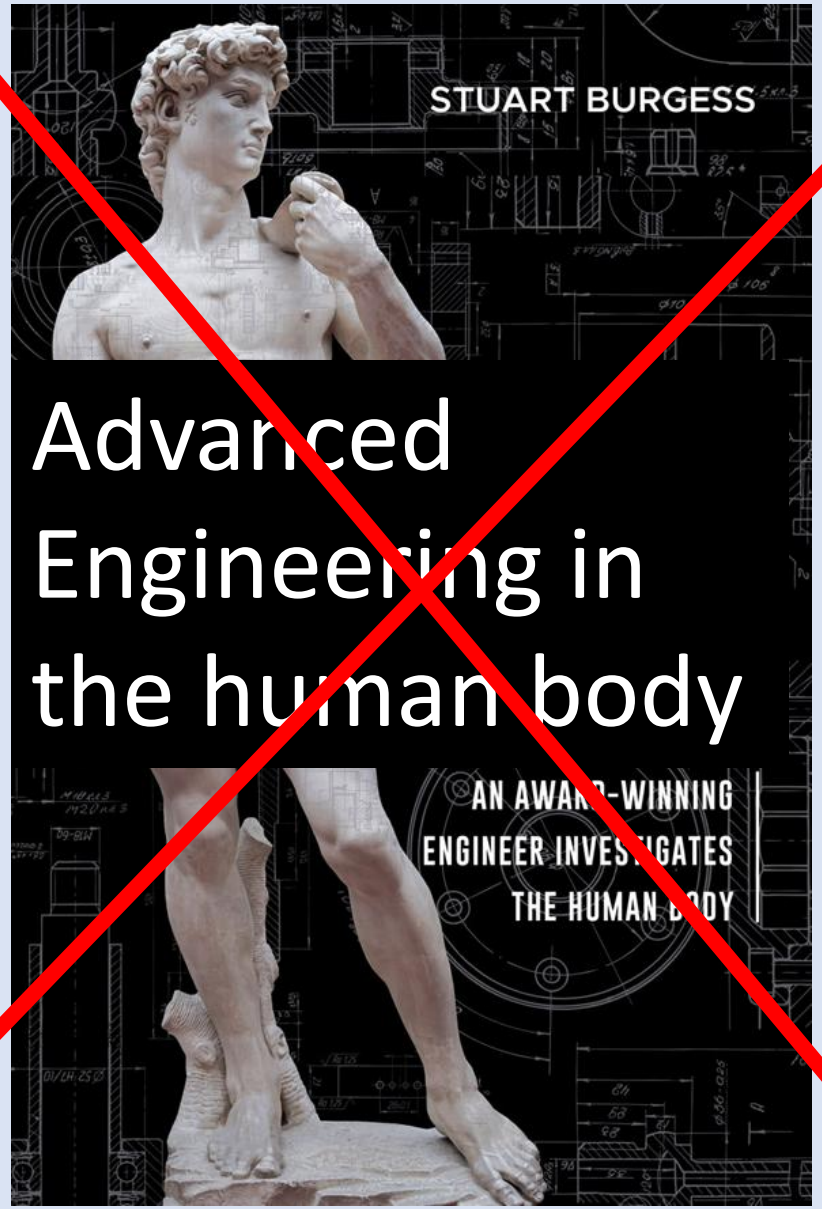
Then God saw everything that He had
made, and indeed *it was* very good

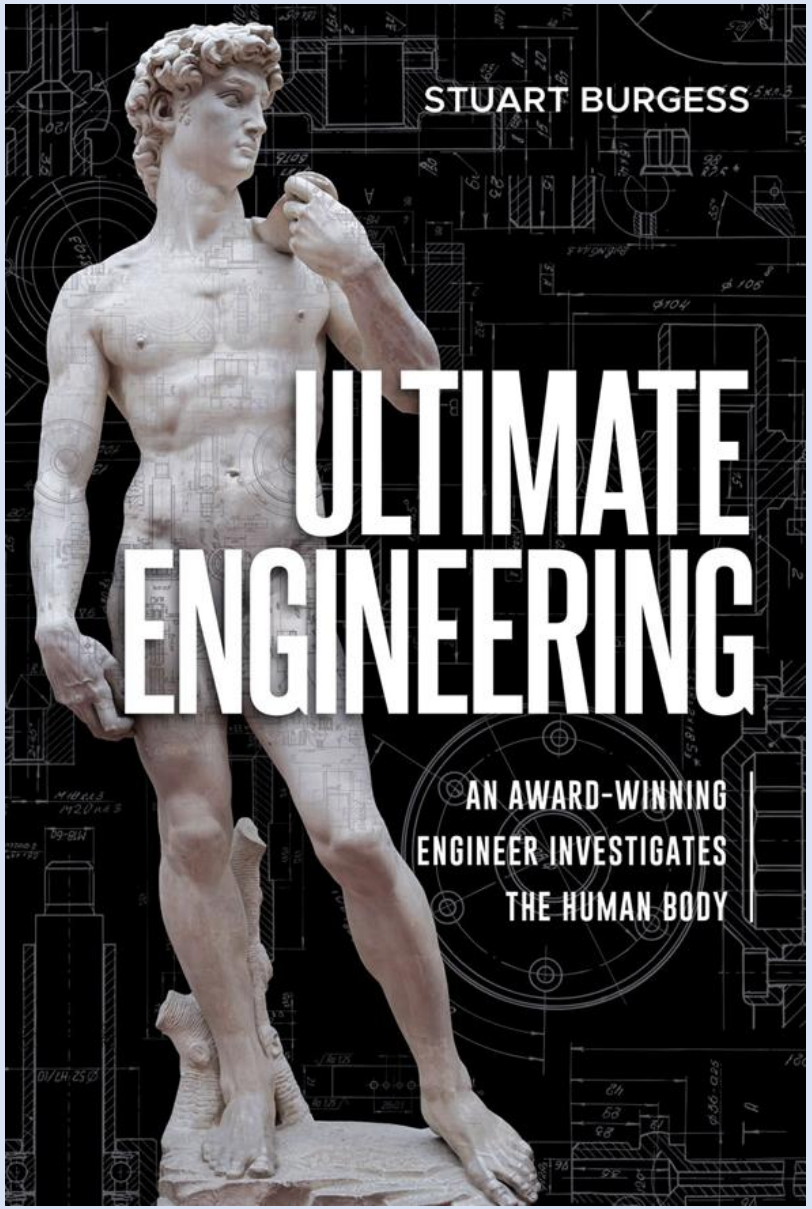
Job 37:14-16

Stand still and consider the wondrous works of God.
Those wondrous works of Him who is perfect in knowledge?

Isaac Watts

There's not a flower or plant below, but makes they glories known

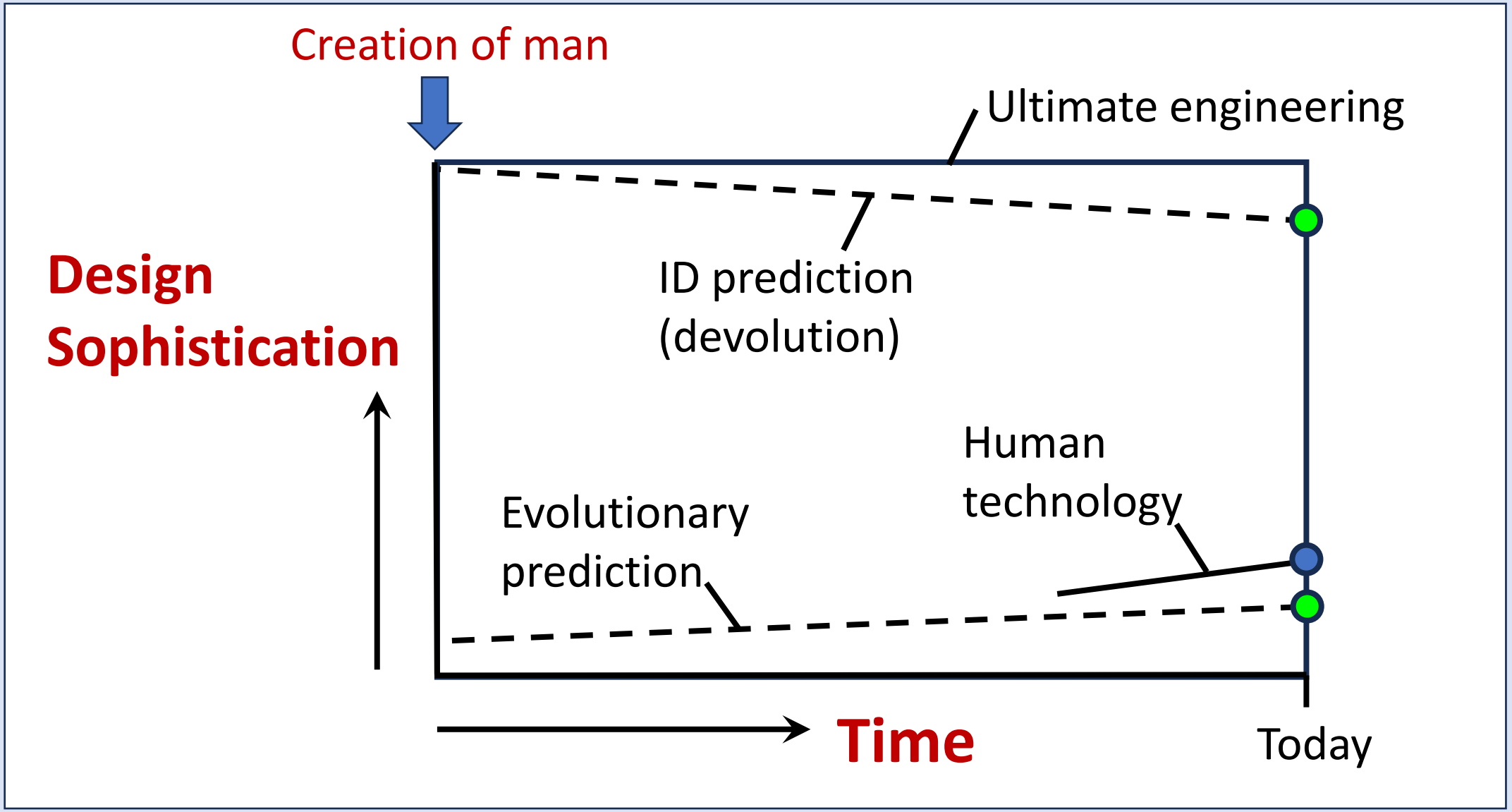

STUART BURGESS
Advanced Engineering in the human body
AN AWARD-WINNING ENGINEER INVESTIGATES THE HUMAN BODY


STUART BURGESS
ULTIMATE ENGINEERING
AN AWARD-WINNING ENGINEER INVESTIGATES THE HUMAN BODY

Three levels of design

DESIGNER	LEVEL OF DESIGN
Evolution	Just good enough + bad design
Human intelligence	Advanced design
Divine intelligence	Ultimate design

ID predicts decay from ultimate engineering

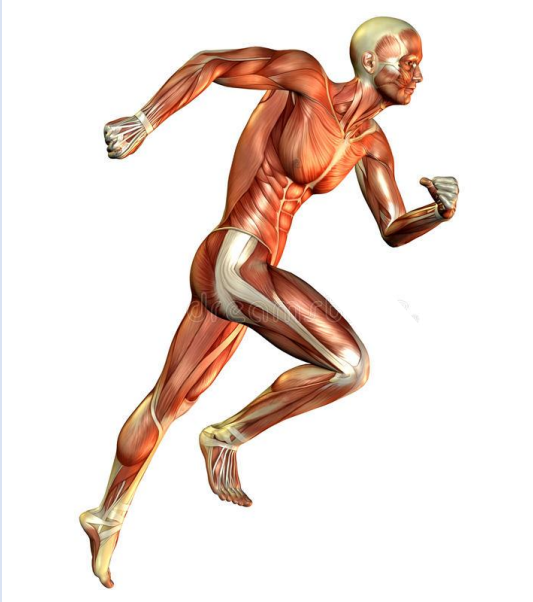


Answering objections: disease and decay

Human body:

(1) Disease is not a design fault

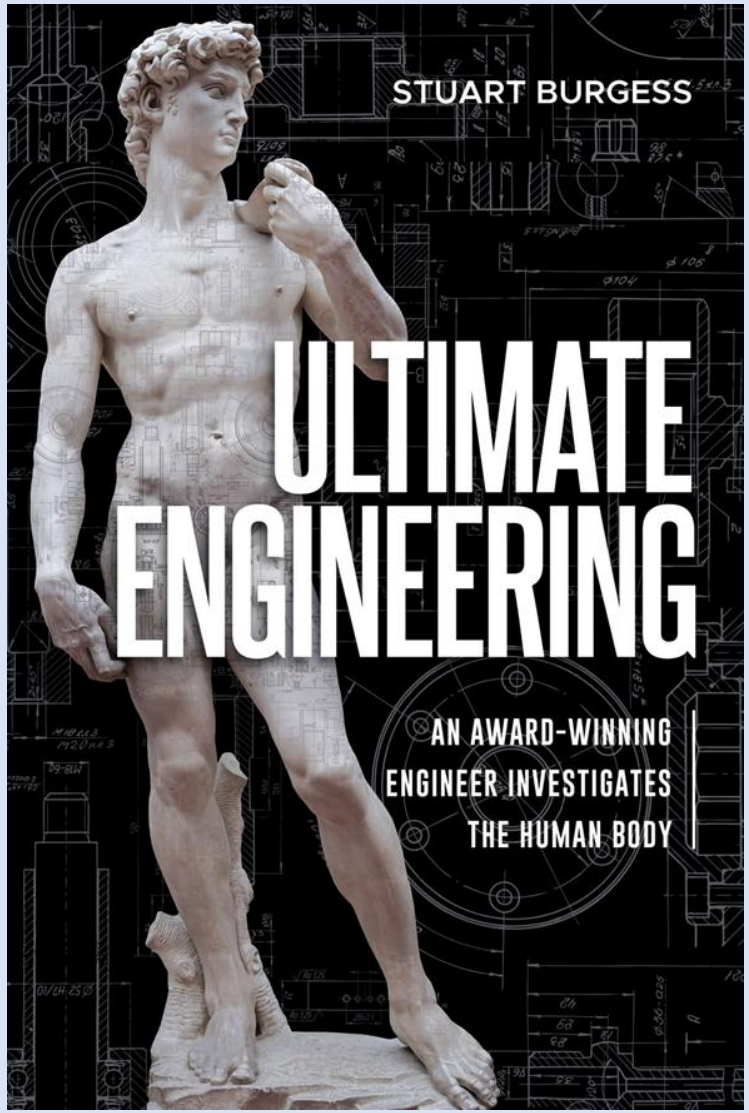
(2) Genetic decay not a design fault



Aston Martin:

(1) Rust is not a design fault

(2) Factory error not a design fault



Reveals

(1) Ultimate Engineering

(2) Ultimate diversity

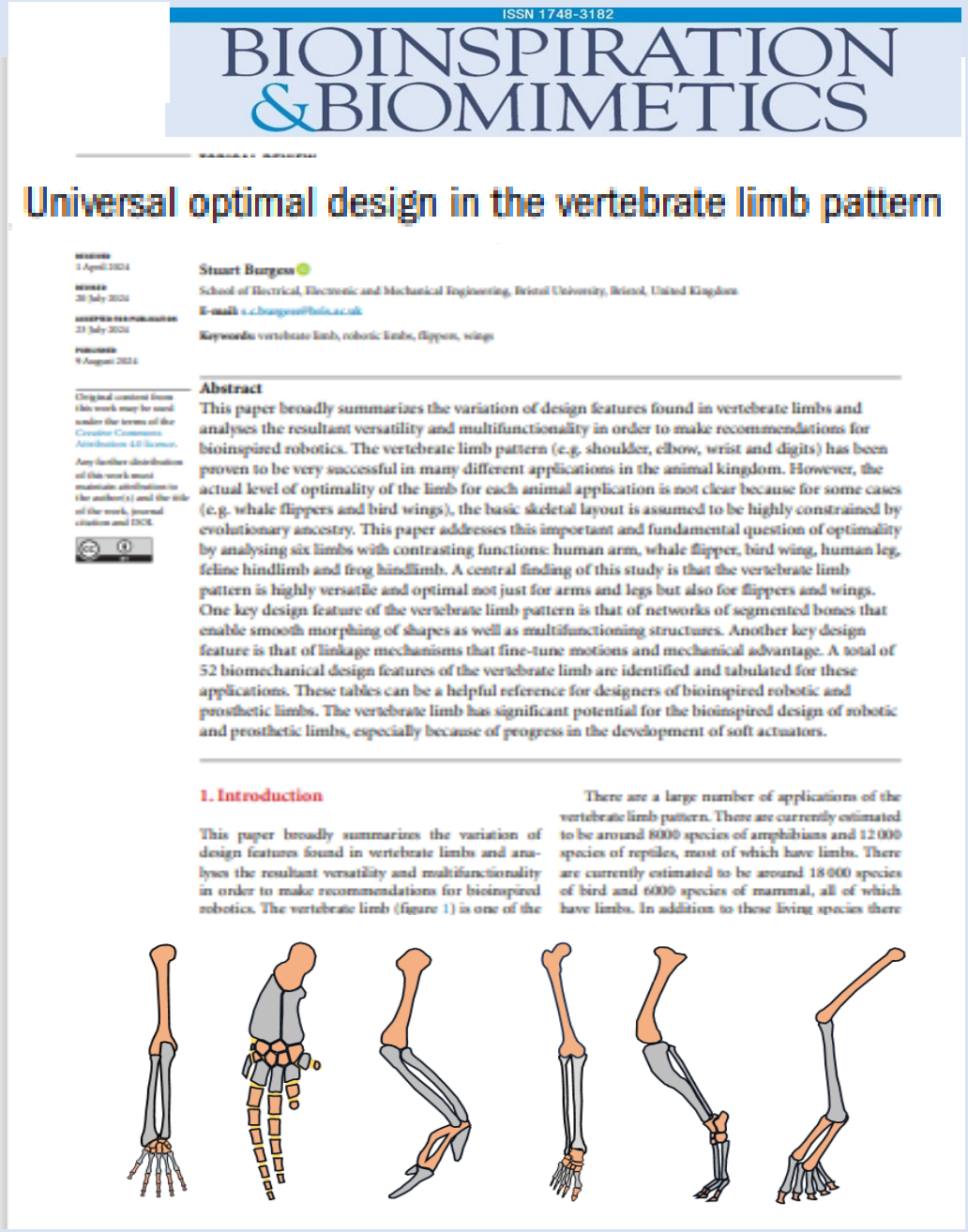
Only ID explains ultimate diversity

Land

Water

Air

Job 9:10 He does wonders without number



ISSN 1748-3182
BIOINSPIRATION &BIOMIMETICS

Universal optimal design in the vertebrate limb pattern

Stuart Burgess
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E-mail: s.c.burgess@bris.ac.uk

Keywords: vertebrate limb, robotic limbs, flippers, wings

Abstract

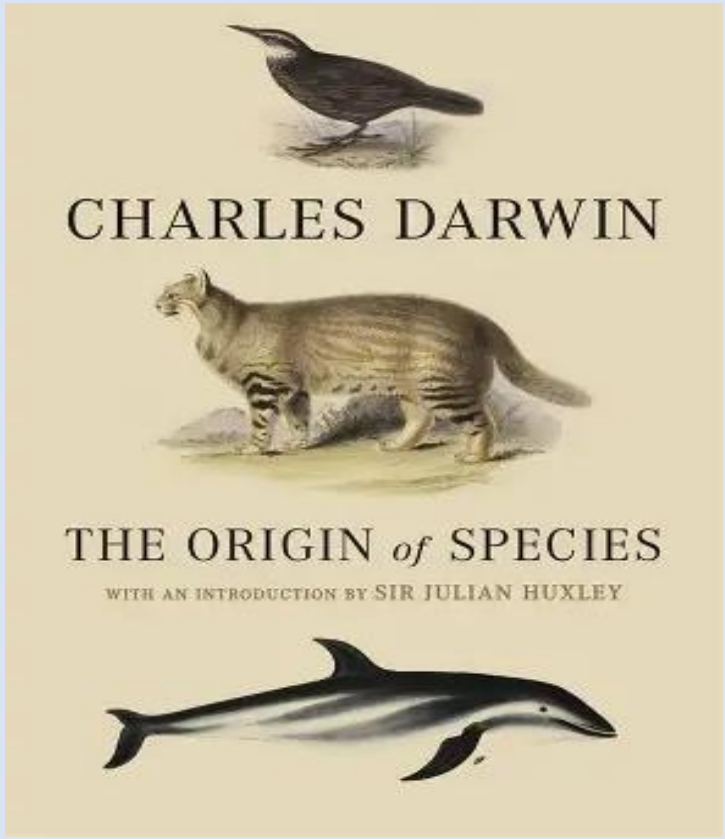
This paper broadly summarizes the variation of design features found in vertebrate limbs and analyses the resultant versatility and multifunctionality in order to make recommendations for bioinspired robotics. The vertebrate limb pattern (e.g. shoulder, elbow, wrist and digits) has been proven to be very successful in many different applications in the animal kingdom. However, the actual level of optimality of the limb for each animal application is not clear because for some cases (e.g. whale flippers and bird wings), the basic skeletal layout is assumed to be highly constrained by evolutionary ancestry. This paper addresses this important and fundamental question of optimality by analysing six limbs with contrasting functions: human arm, whale flipper, bird wing, human leg, feline hindlimb and frog hindlimb. A central finding of this study is that the vertebrate limb pattern is highly versatile and optimal not just for arms and legs but also for flippers and wings. One key design feature of the vertebrate limb pattern is that of networks of segmented bones that enable smooth morphing of shapes as well as multifunctioning structures. Another key design feature is that of linkage mechanisms that fine-tune motions and mechanical advantage. A total of 52 biomechanical design features of the vertebrate limb are identified and tabulated for these applications. These tables can be a helpful reference for designers of bioinspired robotic and prosthetic limbs. The vertebrate limb has significant potential for the bioinspired design of robotic and prosthetic limbs, especially because of progress in the development of soft actuators.

1. Introduction

This paper broadly summarizes the variation of design features found in vertebrate limbs and analyses the resultant versatility and multifunctionality in order to make recommendations for bioinspired robotics. The vertebrate limb (figure 1) is one of the

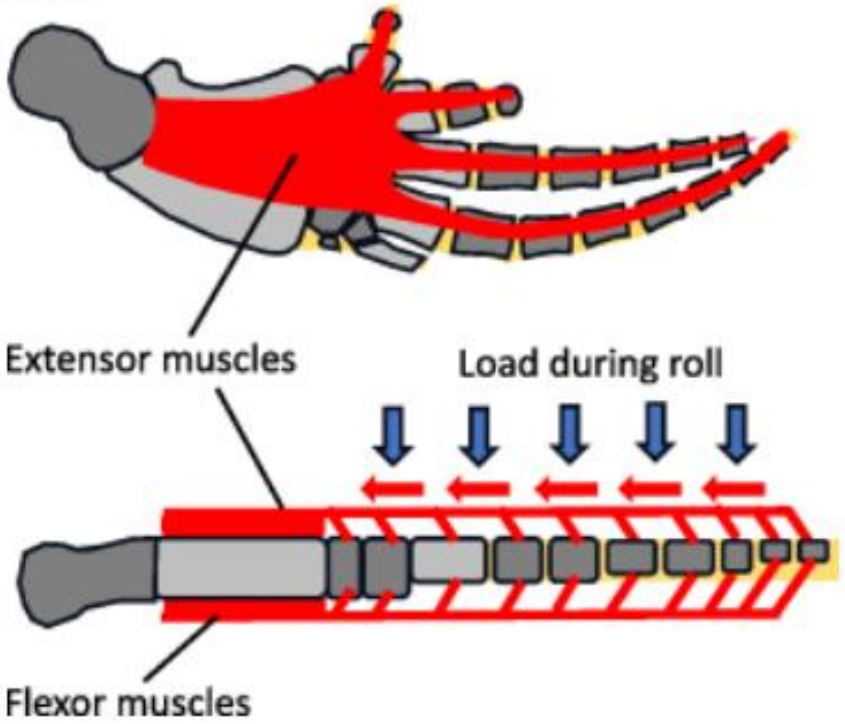
There are a large number of applications of the vertebrate limb pattern. There are currently estimated to be around 8000 species of amphibians and 12 000 species of reptiles, most of which have limbs. There are currently estimated to be around 18 000 species of bird and 6000 species of mammal, all of which have limbs. In addition to these living species there

Refuting Darwin's Homology Argument

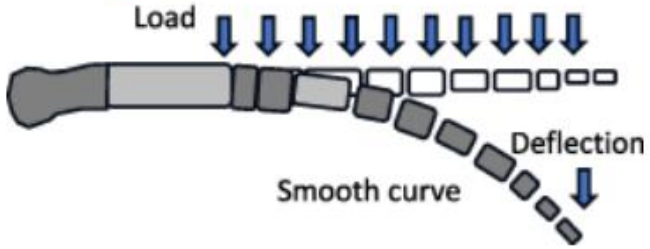


Flipper wrist and fingers are fully functional

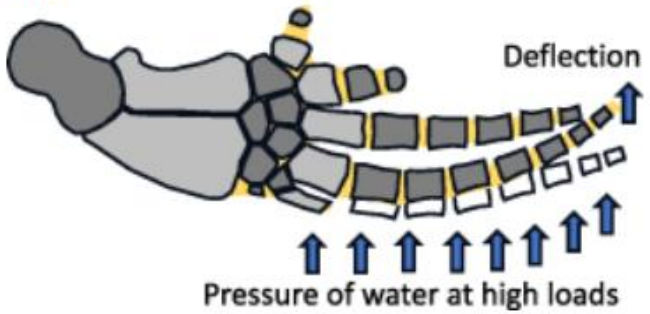
(1) Functional wrist and finger joints [38]



(3) Multiple out-of-plane compliant joints [38]



(4) Multiple in-plane compliant joints [38]



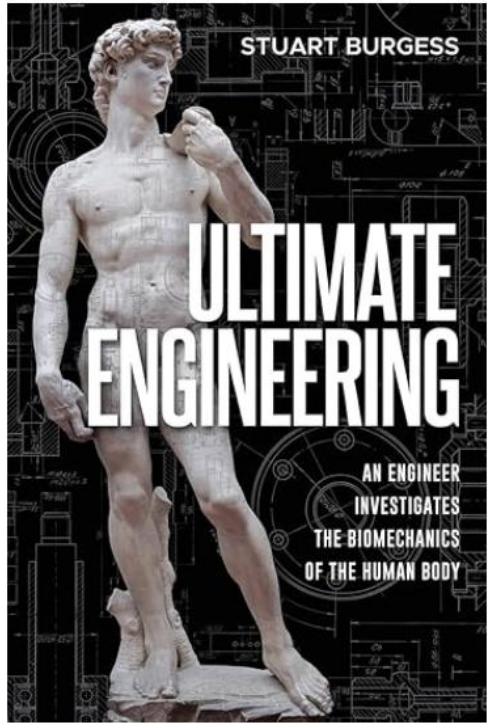
Refuting Darwin's Homology Argument

CONCLUSION

The great versatility of the vertebrate limb pattern challenges the limb homology argument that the skeletal layouts of the whale flipper and bird wing are not what would be expected for those applications and make sense only when seen to be a consequence of evolutionary inheritance.

- Book due on 12 February
- Darwin's birthday
- 25 Feb travel to California and Texas

Books › Health, Family & Lifestyle › Medical & Healthcare Practitioners › Allied Health Professions › Biomedical Engineering



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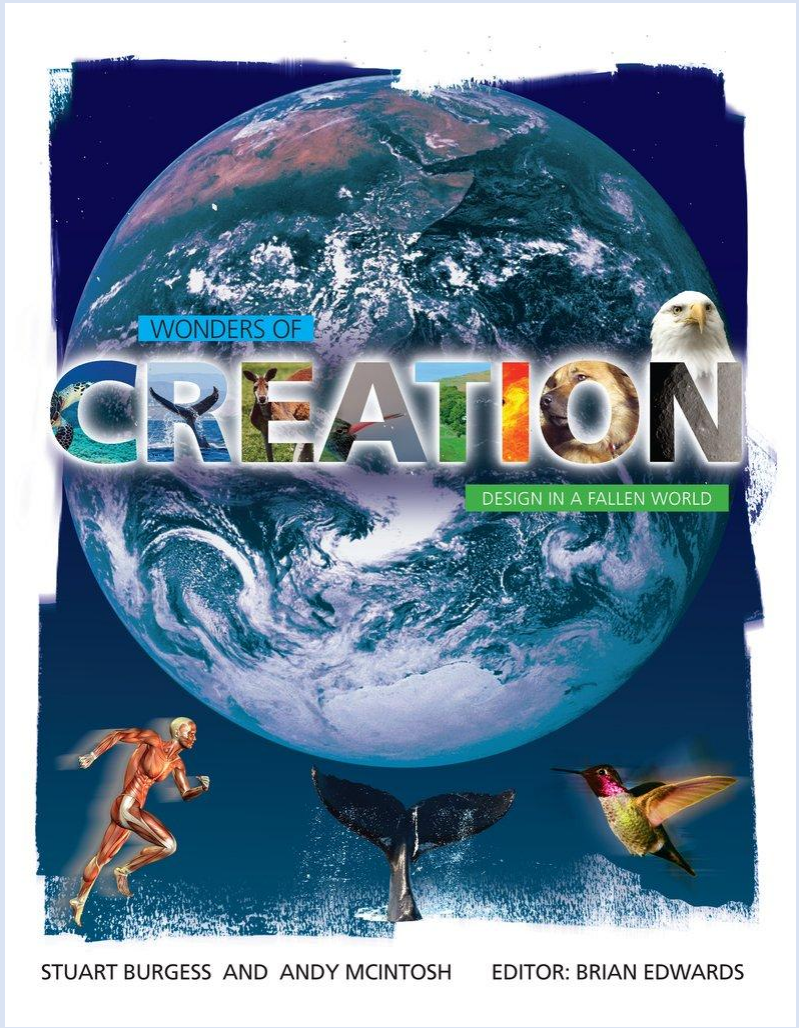
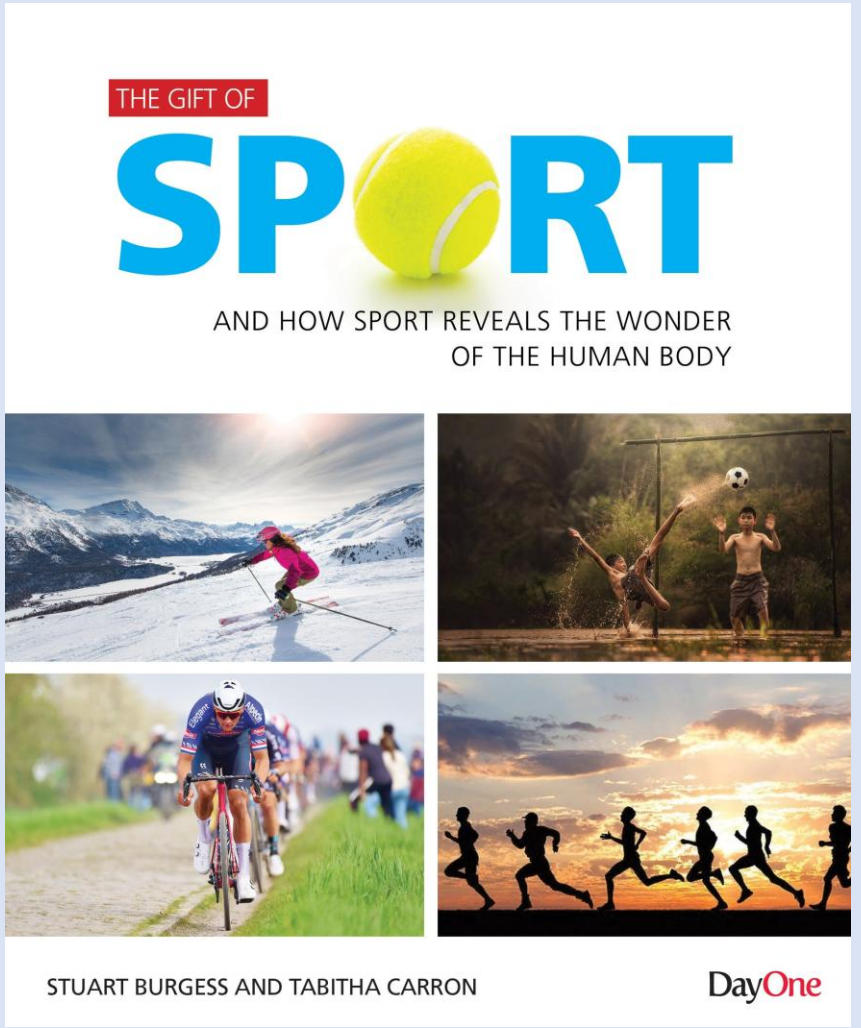




Conclusions

Psalm 111:2

The works of the LORD *are* great,
Studied by all who have pleasure in them.

Psalm 18:30 & 32

As for God, His way *is* perfect;
….And makes my way perfect.

Publications

2023 (Editor's choice)

biomimetics

A Bio-Inspired Arched Foot with Individual Toe Joints and Plantar Fascia

Stuart Burgess *, Alex Beeston, Joshua Carr, Kallia Siempou, Maya Simmonds and Yasmin Zanker

Bristol Robotics Laboratory, School of Electrical, Electronic & Mechanical Engineering, Bristol University, Bristol BS8 1QU, UK; pi18863@bristol.ac.uk (YZ.)
* Correspondence: s.c.burgess@brls.ac.uk

Abstract: This paper presents the design and testing of an arched foot with several biomimetic features, including five individual MTP (toe) joints, four individual midfoot joints, and plantar fascia. The creation of a triple-arched foot represents a step further in bio-inspired design compared to other published designs. The arched structure creates flexibility that is similar to human feet with a vertical deflection of up to 12 mm. The individual toe joints enable abduction–adduction in the forefoot and therefore a natural pronation motion. Adult female bone data was obtained and converted into a CAD model to accurately identify the location of bones, joints, and arches. An analytical model is presented that gives the relationship between the vertical stiffness and horizontal stiffness of the longitudinal arches and therefore allows the optimization of stiffness elements. Experimental tests have demonstrated a vertical arch stiffness of 76 N/mm which is similar to adult human feet. The range of movement of the foot is similar to human feet with the following values: dorsi-plantarflexion (28°/37°), inversion-eversion (30°/15°), and abduction–adduction (30°/39°). Tests have also demonstrated a three-point contact with the ground that is similar to human feet.

Keywords: robotic foot; foot prosthetic; MTP joints; arch stiffness; windlass mechanism; plantarflexion

2024 (Cover paper)

biomimetics

How Multifunctioning Joints Produce Highly Agile Limbs in Animals with Lessons for Robotics

Stuart C. Burgess

School of Electrical, Electronic and Mechanical Engineering, Bristol University, Bristol BS8 1TR, UK; s.c.burgess@brls.ac.uk

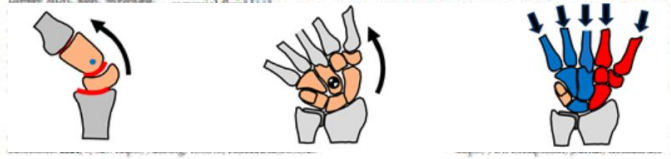
Abstract: This paper reviews how multifunctioning joints produce highly agile limbs in animals with lessons for robotics. One of the key reasons why animals are so fast and agile is that they have multifunctioning joints in their limbs. The multifunctioning joints lead to a high degree of compactness which then leads to a host of benefits such as low mass, low moment of inertia and low drag. This paper presents three case studies of multifunctioning joints—the human wrist joint, knee joint and foot joints—in order to identify how multifunctioning is achieved and what lessons can be learned for robotics. It also reviews the multifunctioning nature of muscle which plays an important role in joint actuation. A key finding is that multifunctioning is achieved through various means: multiple degrees of freedom, multifunctioning parts, over-actuation and reconfiguration. In addition, multifunctioning is achieved through highly sophisticated layouts with high levels of integration and fine-tuning. Muscle also makes an important contribution to animal agility by performing multiple functions including providing shape, protection and heat. The paper reviews progress in achieving multifunctioning in robot joints particularly for the wrist, knee and foot. Whilst there has been some progress in creating multifunctioning robotic joints, there is still a large gap between the performance of animal and robotic joints. There is an opportunity to improve the agility of robots by using multifunctioning to reduce the size and mass of robotic joints.

Keywords: multifunctioning; joints; limbs; muscle

1. Introduction

This paper reviews how multifunctioning joints produce highly agile limbs in animals with lessons for robotics. Animals are well known to have superior performance to robots in the area of locomotion and hand skills [1,2]. One reason for the higher performance is superior control and sensing [1]. Another reason is that of multifunctioning materials [3]. This paper shows that multifunctioning skeletal joints are another key reason for the superior agility of animal limbs. The paper gives examples of how multifunctioning leads to high performance, identifies how multifunctioning is achieved and discusses what lessons can be learned for robotics.

Multifunctioning is widespread in nature. The majority of biological materials are remarkably multifunctional. For example, human skin has many functions including being stretchable, tough, self-renewing, self-healing, self-lubricating and insulating [4]. In addition, skin is host to blood vessels, nerves, sweat glands, hairs and multiple sensors [4]. There have been many studies on the multifunctioning nature of biological materials such as muscle [5], bone [6], nacre [7], feathers [8], plant cuticle [9], cactus spines [10] and



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BIOINSPIRATION &BIOMIMETICS

A review of linkage mechanisms in animal joints and related bioinspired designs

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Keywords: four-bar mechanisms, kinematic amplification, mechanical advantage, multi-functioning, linkage mechanisms

Abstract

This paper presents a review of biological mechanical linkage mechanisms. One purpose is to identify the range of kinematic functions that they are able to perform. A second purpose is to review progress in bioinspired designs. Ten different linkage mechanisms are presented. They are chosen because they cover a wide range of functionality and because they have potential for bioinspired design. Linkage mechanisms enable animal joints to perform highly sophisticated and optimised motions. A key function of animal linkage mechanisms is the optimisation of actuator location and mechanical advantage. This is crucially important for animals where space is highly constrained. Many of the design features used by engineers in linkage mechanisms are seen in nature, such as short coupler links, extended bars, elastic energy storage and latch mechanisms. However, animal joints contain some features rarely seen in engineering such as integrated cam and linkage mechanisms, nonplanar four-bar mechanisms, resonant hinges and highly redundant actuators. The extreme performance of animal joints together with the unusual design features makes them an important area of investigation for bioinspired designs. Whilst there has been significant progress in bioinspiration, there is the potential for more, especially in robotics where compactness is a key design driver.

1. Introduction

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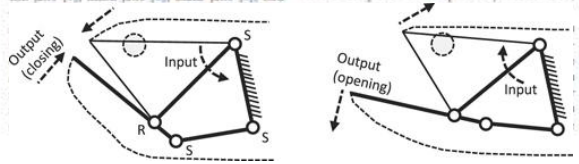
Linkage mechanisms such as four-bar mechanisms are common in animal joints, particularly in fish jaws [1], lizard jaws [2], snake jaws [3], bird

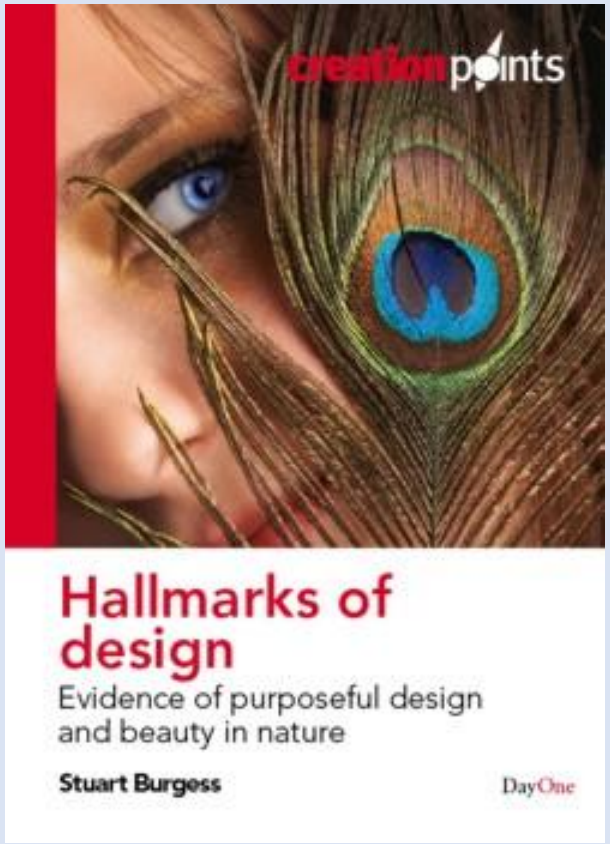
Several types of articulating joints are found in animals such as hinge joints (planar rotation), spherical joints (rotation in any plane), gliding joints (linear movements), saddle joints (biaxial rotation) and condyloid joints (movements in two planes). These joints can act individually, such as when a finger is moved just at the metacarpophalangeal joint, or they can act in tandem such as when all three finger joints move together to curl or straighten the fingers. In the case of linkage mechanisms, a number of joints are constrained to move together via rigid links. When hinge joints are used in a linkage mechanism, the motions are planar. When spherical joints are used,



Prince Charles

‘Why should modern science rule out special creation?’

Reith Lectures, 2000 (Quoted from Hallmarks of Design)



Evolution is bad for science

ID worldview:

Expect sophisticated design

➔ Find sophisticated design

Darwinian worldview:

Expect bad design

➔ Don’t seek sophisticated design

Academic support for my ID worldview

Nature, to some, is divine design; to others it is design by natural selection.

Professor Mike Ashby, FRS, Material Selection in Mechanical Design, 1992

Selwyn College

Bye-Fellow 1994-1997

Clare Hall College

Visiting Fellow 2021