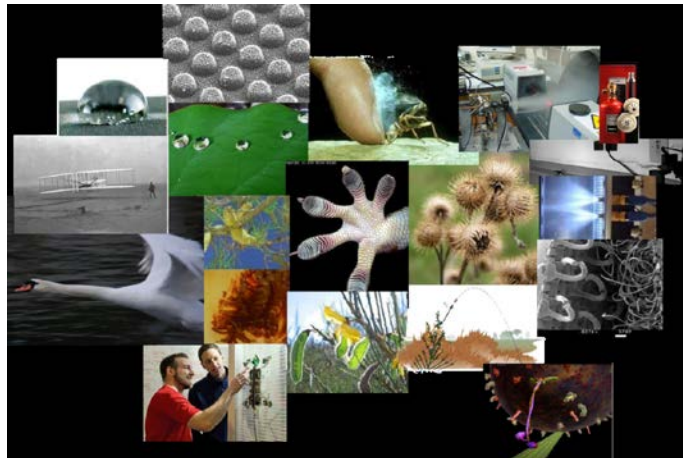


The Extraordinary Bombardier Beetle: Learning Design from the Created World

The innocuous looking bombardier beetle is one of the most remarkable creatures - it is able to fight off any spider, frog, ant or bird that comes too close by blasting the attacker with a powerful jet of hot, toxic fluid. Prof Andy McIntosh and a team at Leeds have built an experimental rig mimicking the major physics of the beetle ejection system and that knowledge is revolutionizing industrial spray technology, in particular fuel injectors, and pharmaceutical drug delivery systems such as nebulisers. The bombardier beetle sends out a repeated blast of hot caustic fluid, steam and water a considerable distance at 500Hz. This has recently inspired Prof McIntosh in designing a fire extinguisher with Liberty University, Virginia for fighting forest fires based on this technology.

Andy McIntosh holds an Emeritus Chair in thermodynamics at the University of Leeds, and has lectured and researched in these fields for over 30 years. He has a PhD in combustion theory from the aerodynamics department of what was then Cranfield Institute of Technology (now Cranfield University), a DSc in Applied Mathematics from the University of Wales, and worked for a number of years at the Royal Aircraft Establishment. He is a Fellow of the Institute of Mathematics and its Applications, the Institute of Energy, the Institute of Physics and the Royal Aeronautical Society. A chartered mathematician, engineer, and author of 200 papers and articles, his research has been in combustion in fluids and solids. His work has also included investigations into the fundamental link between thermodynamics and information, and in the last few years he has been involved in research in the area of biomimetics where the minute combustion chamber of the bombardier beetle has inspired a patented novel spray technology. He now lectures widely on origins, has authored the books *Genesis for Today* (Day One, 6th Edition, 2017) and *A Verse by Verse Examination of Genesis 1-11* (Day One, 2016), and has contributed to a number of other books including *Wonders of Creation – Design in a Fallen World* (co-authored with Stuart Burgess and Brian Edwards, Day One, 2017), *Origins – Examining the Evidence* (Truth in Science, 2011), *In Six Days* (Master Books, 2009), and *Should Christians Embrace Evolution?* (IVP, 2009). He is co-director of the UK education think tank Truth in Science and is married with 3 children and 6 grandchildren.

For his research on the Bombardier Beetle and its use for a novel spray system, this work was awarded the 2010 Times Higher Educational award for the Outstanding Contribution to Innovation and Technology.



Biomimetic collage of ideas – including lotus leaf, bombardier beetle, knobcone pine, gecko foot, burdock plant, Scottish broom, Wright Flyer, and walking molecules (Kinesin)

I. Biomimetics – quite what is it?

A. Some famous examples

1. Velcro and Burdock plant
2. Gecko Tape / Gecko robots
3. Self-cleaning glass and Lotus leaf
4. Wright Flyer
5. Kinesin

B. Implications to Design

C. Pitfalls in Design argument

1. Non-fixity of species
2. Dangers of assumption of continuity
3. Predator-prey relationships

II. Bombardier Beetle

A. Where it is found

B. How does it work?

1. Valve system

a. Ingenuity – not just one valve...

2. Chemical system

a. Catalysis 101....

b. What a famous person from Oxford did not understand...

c. A wee bit of chemical thermodynamics...

3. And where does this Chemistry set come from?

4. Twin carburetors!

C. So what did we copy?

D. Computer Modelling

E. Experimental prototype

F. Scaling up....

G. Applications

1. Fuel injection systems
2. Pharmaceuticals
3. Fragrancers
4. Fire suppression systems
5. Fire extinguishers
6. Engineering par excellence in the Beetle

Some Quotes:

“Scientists discover the world that exists; engineers create the world that never was”
Theodore Von Karman, Aerospace Engineer, UCSD

Rom 1:20 “For the invisible things of him from the creation of the world are clearly seen, being understood by the things that are made, even his eternal power and Godhead; so that they are without excuse.”

In a lecture in 1847 Michael Faraday stated:

“...And therefore our philosophy [here used as we would now say ‘our science’], whilst it shows us these things, should lead us to think of Him who hath wrought them; for it is said by an authority far above even that which these works present, that ‘the invisible things of Him from the creation of the world are clearly seen, being understood by the things that are made, even His eternal power and Godhead.’ ”

“Michael Faraday”, W.L. Randell, Leonard Parsons (London), and Small, Maynard & Co., (Boston, USA). 1924, pp. 132-133.

FURTHER NOTES

Suggested Readings:

Eisner, T. *For the Love of Insects*, The Belknap Press of Harvard University Press, 2005

Beheshti, N. and McIntosh, A.C. (2007) “A biomimetic study of the explosive discharge of the Bombardier Beetle.” *Int. J. of Design & Nature and Ecodynamics*, 1(1), pp.61-69.

Beheshti, N. and McIntosh, A.C. “The bombardier beetle and its use of a pressure relief valve system to deliver a periodic pulsed spray” *Bioinspiration and Biomimetics (Inst of Physics)*, 2, pp.57-64, 2007.

McIntosh, A.C., Combustion, fire, and explosion in nature - some biomimetic possibilities. *Proc. IMechE, Part C: Journal of Mechanical Engineering Science*, 221(C10), 1157–1164, 2007

McIntosh, A.C. and Beheshti, N, “Insect inspiration”, *Physics World (Inst of Physics)*, 21(4), 29-31, April 2008.

McIntosh, A.C., and J. Lawrence. 2018. The extraordinary design of the bombardier beetle- A classic example of biometrics. In *Proceedings of the Eighth International Conference on Creation*, ed. J.H. Whitmore, pp. 268–276. Pittsburgh, Pennsylvania: Creation Science Fellowship. <https://doi.org/10.15385/jpicc.2018.8.1.27>