MAXWELL PAPER

MINDFUL AT EVERY STEP: THE COMPELLING MINDSET OF JAMES MAXWELL

Maxwell's name stands next to Newton and Einstein in terms of his enormous contribution to science. Most famously known by the four equations of his namesake, Maxwell brought forth an entirely new way of understanding physical phenomena. Bringing to life Faraday's research, Maxwell went further than Newton's mechanical, point-based foundation. His field models and the partial differential equations that define them allowed foray into electromagnetism and the statistical mechanics of thermodynamics, areas unexplainable by those old approaches. (Goldman 10; Hendry 42-90; 10-12; 1). Maxwell's efforts define modern physics, playing a role in each major development. First came Lorentz's marriage of material points and waves to theorize the electron. Then Einstein introduced his theory of special and general relativity - augmenting Newton's model, which he attributed to insights gained from Maxwell's field theory. The most recent gain, Quantum mechanics arrives by the hand of Einstein and Dirac as the third epiphany of theoretical physics. Still in development, Einstein intimates that quantum mechanics' maturity may be signaled by its ability to be described in the way of Maxwell: free from singularities, and satisfactorily described with fields by partial differential equations (Torrance 32).

The nature of Maxwell's discovery and architecture of his solutions are deeply connected to the development of his psyche, approach to faith, and the environment he was a part of. The root of this study's focus is to therefore examine this shell and nucleus that surrounded and sourced Maxwell's epiphany. His work showcases scientific progress made possible by common, deep-rooted ethic, in an embracing environment, itself allowable by a content and upright society.

The Edinburgh and Glasgow of the 1830s were the diaspora of a Scotland just stabilizing from the rewards and ravages of the Industrial Revolution. During the time of Maxwell (1831-1879), Scotland also began to integrate with the English way of life,

with Scots at the forefront of the British Empire's formation (Checkland 35-37; Goldman 19). While Glasgow was the industrial center, Edinburgh was more professional and service-based. In this developmental period, industry and empire sparred with Scottish ethos and country life. Urban life was still underdeveloped, with city dwellers tending to be sick and underweight relative to their country counterparts. Edinburgh retained more of a balance, and was fortunate to be a creative center (Checkland 38;185). At the heart of England (and the politics of the day) lie its centralized Episcopal church, while the church of Scotland was evangelical. Besides a unilateral appreciation for Bible reading, Edinburgh entertained a manichean tendency, with ideas from Calvinism, rationalism, scientific tolerance, emotionalism, stoicism, and anti-materialism swirling around. Sir Walter Scott and Lord Byron's romanticism was a powerful influence; any dour application of piety never made much headway (Checkland 133-135; Goldman 19). While landlords had the usual socioeconomic benefits of the era, they didn't maintain traditional political control. Spurred on by the human rights violations of the industrial revolution powerhouse, class-related debates around societal processes abounded. While Edinburgh maintained a conservative stance on class, property, and careerism, it responded with an evangelical zeal to good causes and social responsibility efforts (Checkland 68; Goldman 65).

James Clerk Maxwell's family was sprung up by his grandfather's business success and scientific acumen, and maintained by his father's technological intellect and business ventures of his own. Maxwell lived both in the "wilds" of Glenlair and in the semi-capital of Edinburgh. He was independent, like his father, and good natured. James' mother died when he was eight, an immense blow that strengthened the mutual devotion between father and son (Glazebrook 10-13). Endeavoring to learn what "was worth learning", the first attempts to educate him were unsuccessful. In fact, until his Aunt dismissed James' rigid tutor two years in, the boy would make elaborate efforts to escape the sessions (Goldman 28)! Overall, the Father's focused devotion to bring about a quality education for Maxwell was balanced with the boy's freedom and country life (which included

hobbies such as swimming, horse riding, and poetry). Maxwell's first passion was for geometry, and without training discovered a relationship between polyhedra. Soon after came his first published paper, which detailed how to draw perfect oval curves with multiple foci (Campbell 51-54; Roscoe 18). His knack for a geometrical approach proved later to be useful for his physics research and navigation through calculus. Near the end of his high school years, he worked on experiments and papers regarding light and color, rolling curves, and the equilibrium of elastic solids in a quixotic lab. It was recorded that he once even coppered a beetle by the thought that the insect was a good conductor (Glazebrook 24).

On arrival to the University of Edinburgh, he studied mathematics, natural philosophy, and logic. Accounts describe how his base peers received an impression of a monotone and orderly boy, gentle, simple, and usually abstracted from what was going on. His professors' impressions were quite the opposite, describing him as having intellectual originality and force (Campbell & Garnett 64-65)! Freedom was given for Maxwell to perform his own experiments in the university lab and nimbly follow his whimsy throughout the library. That said, it was still school. Writing to his father, Maxwell volunteers that he had to "grind through" the schooling to get to his place (Garnet 158).

From the local university he transitioned to Cambridge. The private tutor assigned to him states that while he was immensely knowledgable for a young man, his learning was in an appalling state of disorder (Goldman 60; Glazebrook 28). It is fair to say he was more intuitive and spirit-driven than intellectual in the academic way. Versus Edinburgh, Cambridge offered Newtonian calculus, which at the time trumped Leibniz to be the standard (Hendry 40; Goldman 83). Incidentally, it also led to Maxwell's induction to the Apostles secret society at Trinity, a formative experience for him (Goldman 64-66). Unlike the meandering, philosophical Scottish pedagogy at Edinburgh, Cambridge was seen as a celebration of the elite. Maxwell once overworked to the point of sickness in preparing for exams (Glazebrook 29-30). Despite his struggles, Maxwell's time at Cambridge clearly set

the groundwork for his career, starting with his exhaustive and brilliant mathematics-heavy study on the nature of Saturn's rings (Goldman 109-112).

From his time at Edinburgh University, he adapted a philosophical detachment and caution to his method. The essence of this is seeing that even the most commanding of scientific theories is fragile, forging a directive to purge any model or analogy of its excess into its essence. Maxwell's imaginative and philosophical tendencies, when applied to his problem solving, enabled him to see beyond the pitfalls of his day's Common Sense Philosophy (Goldman 42-44; Hendry 15). The Scottish way at the time had reacted to Hume's skepticism to throw away the whimsy of any 'art of discovery' and create a superfluously cramped misinterpretation of Newton: abstaining from hypothesis and imagined cause or analogy to rely wholly on Induction and observance of effects. It is important to note that this view crumbled away in the century to come, succumbing to the reality that a working hypothesis is practical to get anywhere (Goldman 44). Another point of impact to Maxwell came from Sir William Hamilton, the final figure of the Common Sense philosophers. He teaches that causal and analogical thinking have to be a necessity by consequence of the limitations of the brain: all one learns of the world is gained through the senses, liable to distortion; producing knowledge that is relative rather than absolute (Hendry 27-30). The dynamical tradition in physics is propelled from that understanding. Hamilton championed technical mathematical models as a fit media between nature and the human mind. Going further, he sees the constant analogy between mind and nature as a manifestation of God. In a letter to a friend about this idea, Sir Hamilton expounds:

> "There are, or may be imagined, two dynamical sources: one subjective, *a priori*, metaphysical, deducible from meditation on our ideas of Power, Space, Time; the other Objective, *a posteori*; physical, discoverable by observation and generalization of facts or phenomena: that these two sciences are distinct in kind, but intimately and wonderfully connected, in consequence of the ultimate union of the subjective and objective in God, or to speak

> less technically and more religiously, by virtue of the manifestation which he has been pleased to make of himself in the universe to the intellect of man; so that the two sciences are never wholly separate, but may and ought to advance together, and use many common expressions, and each possess an analogy to many if not all the results and theorems of the other." (Hankins 175)

Maxwell was spiritually mission-driven, with his scientific endeavors not just in harmony with his spirituality but part of it. He was open-minded by nature of his uncompromising faith rather than despite it. Maxwell's footing in the science and spirit of things kept him well supported through turmoil regarding models of man, whether they be of natural religion or of a scientific nature (including evolutionary theory, introduced with much tremor during his career) (Hutchinson 12,14; Goldman 46,69,87-89; Lestienne 21). When writing to his father during his time with the Apostles, we see Maxwell's love of God as designer translate into his view of faith being the most sublimated platform. "Let nothing be willfully left unexamined. Nothing is to be *holy ground* consecrated to Stationary Faith, whether positive or negative. […] Christianity - that is, the religion of the Bible - is the only scheme or form of belief which disavows any possessions on such a tenure. Here alone all is free." (Campbell & Garnett 178)

What this produced in Maxwell was a talent that evaded mental locks and pioneered with minimal preconceptions. He had a uniquely-undeceived open mindedness, with clear-eyed separation between the naturally compromisable and the critically uncompromisable. His philosophical approach both to the natural and the spiritual meant he architected his mind and understanding in a way that holds water long past bouts of contemporary positioning.

Maxwell's defining characteristic lay in his purity of mind, in his adeptness at creating an architecture on an uncertain foundation into the invisible. Mirrored in his approach to Christianity and influenced by the philosophers of his fortuitously decorous environment, he was able to transcend

physical models to find what was real. The field models of physics and the statistical enlightenment of thermodynamics changed the world with pretty much unparalleled impetus. The nascent of his enlightenment wasn't arbitrary. Just as the structure of natural philosophy allowed for progress into a new spectra of enlightenment, so the settling into purity of a human psyche must be needed to advance towards the 'perfect', with the aim of that trajectory itself ever perfecting. Maxwell always fell back to that essence of what transcends any current supposition of understanding, and that spirit moved him profitably. May we all endeavor to that end.

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