Andy Crouch

Communication

Delight in Creation: The Life of a Scientist

Andy Crouch

I am married to a scientist—to be specific, an experimental physicist (which I would like to think is the very best kind). For more than fifteen years now, I have accompanied Catherine through a life in physics, a kind of *Pilgrim's Progress* that began in the Slough of Graduate School, continued through the Testing Fields of the Job Search and the harrowing of the Vale of Tenure, and is now wending its way through the Elysian Fields of Mid-Career Teaching, Research, and Administration. Along the way, just like Christian in Bunyan's classic, she has encountered plenty of both helpful and dangerous characters, some reassuringly metaphorical and others all too literal. And I, like Christian's friend Hopeful, have tried to be a faithful companion, though often I have been able to do little more than cheer or wince at the twists and turns of a life in science.

There is a serious point in my playful invocation of *Pilgrim's Progress*. Like many of the most complex human endeavors—parenting, farming, becoming a Christian—the life of a scientist is not just an "occupation," something that occupies us for a while and might then be followed by something entirely different. Being a scientist is as much about being as doing, as much about a particular way of being formed as a person as it is a set of activities or even skills. Training in science is induction not so much into a particular worldview (though it includes absorbing plenty of the kind of cognitive presuppositions that that word suggests) as it is a kind of posture or stance toward the world, toward one's work, and toward one's fellow human beings, both scientists and nonscientists. And the life of a scientist is a journey, one freighted with ultimate concerns and laden with values. It is a journey into a set of virtues, the habits and dispositions that make one a person of a particular kind of character.

When we talk about faith and science, we tend to focus on the cognitive content of both endeavors, the truth claims and worldviews that animate these two crucial dimensions of modern human life. These are important matters, and I do not at all mean to diminish them. At the same time, there are inevitable limits to what any pastor or church can do to constructively integrate the knowledge content of science—so vast and rapidly expanding that even scientists cannot pretend to be expert in anything but a tiny portion—with the content of Christian faith. But there is another way to approach faith and science which

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I believe might well be more within reach of most pastors, and more essential to their job description than being deeply literate in the latest scientific discoveries and theories—and that is simply to attend to and prayerfully support and encourage the scientific life itself as a vocation that can reflect the image of God and be a place for working out one's own salvation.

So here is what I wish our fellow Christians knew about the life of a working scientist.

Delight and Wonder

If there is one personality characteristic of the vast majority of scientists I have met, it is delight. There is something about science that attracts people who are fascinated and thrilled by the world. To be sure, any given scientist is delighted by things that you and I may find odd or indeed incomprehensible—the intricacies of protein folding, the strata of Antarctic ice cores, or the properties of Lebesgue spaces (and no, I have no idea what that last phrase really means). But the specificity of their delights is one of delight's secrets: like love, delight is always most potent when it is particular. It is certainly possible to find lawyers who are delighted by law (I have one friend who can go on at great length, with enthusiasm, about corporate bankruptcies), dairy farmers who are delighted by cows, or lumberjacks who are delighted by trees—but I dare say your chances are much better that when you meet a scientist, you will find that they are delighted with the tiny part of the world they study day to day (at least when they are not frustrated with it, which frustrations we will examine below.)

In many scientists, delight is matched by wonder—a sense of astonishment at the beautiful, ingenious complexity to be found in the world. This is not the "wonder" that comes from ignorance—"I wonder how a light bulb really works?"—but a wonder that comes from understanding. Indeed, as we have progressed further into humanity's scientific era, we have been able to disabuse ourselves of a mistaken early-modern notion: that the more the world became comprehensible, the less it would be wonderful. That turns out not to be true at all. Ask a scientist: wonder grows as understanding grows. Indeed, wonder *only* grows if understanding grows. If we replace our childhood awe of lightning with an explanation such as, "It's nothing but a transfer of voltage across a highly resistive material" (an example of what G. K. Chesterton wittily called "nothing-buttery"), perhaps the world will seem like a less wonderful place. But those who actually pursue knowledge of lightning—of electromagnetism or cloud formation or weather systems or climate—end up being even more in awe of the world than they were as children. This is surely one of the remarkable features of our cosmos: the more we understand about it, the more we are in awe of its beautiful elegance and simplicity, and at the same time, its humbling complexity.

To be sure, many, if not most, scientists do not see this wonderful world in the way that most Christians would hope. For us, wonder is a stepping-stone to worship—ascribing our awe for the world to a Creator whose worth it reveals. For many scientists, wonder is less a stepping-stone than a substitute for worship. Yet they stop and wonder all the same.

Intellectual Humility

I doubt that humility is among the first traits most people think of when they think of scientists. And indeed, some scientists (like some academics and intellectuals generally) exhibit a combination of confidence in their own intellect and limitations in their social skills that make them seem abrasive if not arrogant. A few have made a public career of intellectual overreaching, not least in matters of science and faith. But in my experience (and certainly, let me stress, in the case of my own wife!), this is much more the exception than the rule. If intellectual humility is essentially a willingness to admit what you do not and cannot know, science cultivates humility like few other pursuits can, because in few other pursuits do you so often find out that you were wrong.

Even though we tell the story of science through its high points—the discoveries and confirmed theories that won Nobel Prizes and launched new eras in technology—the actual practice of science, for nearly every working scientist, involves far more failure than success. This is especially true for experimental science, the kind that requires the most direct interaction with recalcitrant reality. On most days, in most labs, the data do not add up, Matlab has an untraceable bug, the laser is on the fritz,

and all the cultures become contaminated when the undergraduate research assistant sneezes. And while each of these everyday setbacks requires immense amounts of patience and persistence to overcome, they are only the quotidian version of the perplexity that begins early in the study of science. Every scientist, in the process of their training, has had to repeatedly discover that their intuitions about the world are simply wrong, or at least incomplete. Even great scientists have come up against the sheer oddity and unpredictability of the world. Albert Einstein, for example, never fully accepted the uncertainty at the heart of quantum mechanics, something that is now universally accepted by physicists.

This regular confrontation with the limits of one's own knowledge and skill is not to be taken for granted. The other divisions of the academy, the social sciences and the humanities, deal with matters of such variability and complexity that it is often difficult to say conclusively that anyone, or any theory, is entirely wrong. Marx's and Freud's grand theories may not seem nearly as plausible as they once were, but there are thousands of people following their lines of thought without losing the respect of their intellectual peers. But Ptolemaic cosmology or Lamarckian evolution now have, simply, no followers. They have been proven wrong beyond a reasonable doubt. Who is likely to be more intellectually humble: someone who, early in her training and daily in her work, learns that her assumptions have been wrong, or someone who can always argue his way out of any intellectual predicament? It is perhaps no accident that "grade inflation," in which undergraduates' grades ratchet ever upwards in a nod to the consumer realities of the modern university, is much less pervasive in the sciences, where you cannot cajole your way into an A. The honest and humbling truth is that there is likely more intellectual humility in the average physics laboratory than in the average theology classroom.

Frustration

To be sure, this humility is hard won. Not only is the work of science (and many technical fields) painstaking and frustrating, those pains are often taken for the sake of very small, incremental gains in knowledge. Every arena of human work involves difficulty, delay, and disappointment—"In the sweat of thy face shalt thou eat bread, till thou return unto the ground." Science, too, labors under the curse of a world that is not the way it is supposed to be. It is easy for us who are lay people regarding science to confuse science with technology. Technology is built on well-established knowledge, camouflaging tremendous amounts of human toil and sweat (not just scientific labor, of course, but also the labor of those who design and assemble our devices). Indeed, part of technology's attraction is its implicit promise to temporarily repeal the Curse, delivering an experience of godlike effortlessness to its end user. Those of us who benefit from the end product of the scientific–technological process can easily forget that at the beginning of every discovery, from the steam engine to the transistor, people were laboring at the uncharted edges of human knowledge, and that most days they left their workbench quite unsure whether they were making any progress at all. Scientists may or may not believe in the words of Genesis 3, but they know the burdens of work—even and especially delightful work—very well.

Collaboration

This may be the thing that nonscientists understand least about science. Science is done in community. Popular culture, perhaps inevitably, has a hard time portraying this accurately. Dr. Frankenstein, toiling alone in his lab long after midnight, has become our paradigm for the practice of science. Or maybe for a younger generation, it is "Doc" Emmett Brown from *Back to the Future*, tinkering with time in his garage. But Frankenstein and Doc are mad scientists, not real ones. Real—that is, sane—scientists collaborate. They work closely with one another—with peers, with advisors, with students. Nearly all scientific work today is intensely collaborative in a way that is foreign to nearly any other academic discipline, emphatically including theology. The most celebrated theologians (and pastors, too) write books with only their name on them, while the most celebrated scientists co-author papers with dozens of collaborators. It has been nineteen years since a single individual won the Nobel Prize in physics.

With the collaborative practice of science come the joys as well as the challenges of managing many people's priorities, expectations, egos, abilities, and

limitations. Perhaps that is why, in a way that also confounds popular stereotypes, I so often find that highly successful scientists have strong social skills. They are not always the smoothest guests at the dinner party, but they have something more important—genuine interest in people, reserves of patience and generosity, and the ability to build and sustain teams that can survive the frustration of day-to-day research.

Let's see: a community of people who work side by side, motivated by delight and wonder, characterized by intellectual humility and a willingness to admit that they have been wrong and change direction, who together help one another bear the frustrations of work in a fallen world—does this sound like something the church ought to celebrate? Or perhaps even emulate? And yet I have never heard the world of science, the world my wife inhabits every day, held up even as a potential metaphorical reference point for the true beloved community toward which all of us are called. Perhaps it is closer than we think.

It is not, of course, the beloved community. The world of science has its shadow side, and this too forms the life and work of my wife and her fellow scientists. Among the features of this shadow side are competition, risk, isolation, and specialization.

Competition

Just as powerful and real as the cooperation within research groups is the competition between research groups to be first past the post with new discoveries. The currency of the academic scientific world is publication, and only the first group to submit its results can publish in the field's most prestigious journal. (Patents in industry have even higher stakes.) The history of science is replete with simultaneous in- dependent discoveries (Wikipedia has a fascinating, long list including Boyle's Law, the Möbius strip, and the polio vaccine), which suggests that "discovery" is as much a result of others' prior work, and mysteriously important social conditions, as any one person's or group's pure genius. In a better world, that insight might chasten ambitions to be unique and first. But in the world we have, if anything, it aggravates the competition, since it is likely that, whatever you are working on, some other group is probably also tantalizingly close to snatching the prize.

Competition can be healthy: most of us need it to reach the highest level of performance we are capable of, and when it is healthy, it is exhilarating, even for those who do not finish first. But competition is most healthy when it occurs in an environment of abundance, where everyone knows that they stand to gain by entering the race. For example, consider the joy, satisfaction, and camaraderie at both the beginning and end of a typical triathlon. Competition becomes stressful, if not toxic, when it takes place in an environment of diminishing resources and threats to survival. Unfortunately, that is more and more often the case in the practice of science today. The twentieth century, fueled both by economic growth and by a high-level competition between the Soviet Union and the West, was a time of abundant resources for scientific work. In many fields, the twenty-first century looks to be much more constrained. As in many sectors of our global economy, first-place finishers are winning a greater share of the available resources. As the pressure ratchets up, so do the risks to the emotional and spiritual health of those practicing the science (and, very possibly, to the long-term productivity and fruitfulness of the scientific enterprise itself).

Risk

The very essence of scientific research is to probe the edges of what is known, meaning that even the most talented scientists can only guess at the chances of success at the outset of any new research venture. What is true for individual experiments is true for whole research programs and whole lives in science. Some friends of ours from Catherine's graduate school years, all of whom worked with some of the most celebrated scientific mentors in the world at MIT and Harvard, have gone on to gain tenure and major funding after a handful of years, while others with equal talent and training have lost one job after another in the restructuring of the pharmaceutical industry. To choose a career as a scientist is to embark on a journey whose end cannot even be reasonably guessed at from the beginning, no matter how great your talents or fortunate your choice of mentors and advisors.

Few scientists are exempt from the psychological stress that comes with this kind of uncertainty. The best scientists, who tend to be both risk tolerant and optimistic by nature, harness it as energy for bold choices and unconventional experimental ventures; others can end up nearly paralyzed by the fear of making a wrong decision. Either way, their lives are shadowed by a degree of uncertainty that belies their relatively high professional status.

Isolation

It might seem odd that a highly collaborative endeavor could also be isolating. Indeed, scientists generally find great camaraderie in their research groups and within their disciplines. But to practice science is also to accept a certain amount of isolation from one's fellow human beings. Sometimes the isolation is emphatically physical—long lonely observing sessions at remote telescopes, all-nighters in a lab waiting for biological processes that take their own sweet time, or, in my wife's case, needing to work in a lab in the basement (to minimize vibration) with no windows (to minimize ambient light).

But the isolation is also intellectual. The high degree of specialization that science requires means that even most members of my wife's physics department cannot easily understand her current research, nor she theirs. Even more difficult is explaining one's work to neighbors or to fellow Christians, and this isolation is all too often compounded by intimidation. In school, most lay people found science, and especially the mathematics that is necessary for the physical sciences, perplexing and confusing, and were glad to be done with it as soon as they could. They are uneasy and inexperienced in talking about scientific research, so they quickly change the subject. This can make for very short conversations after church—or more likely, it means that scientists simply never get to share the joys and challenges of their work with most of the people with whom they worship and play.

Specialization

Another kind of isolation comes from one of the great achievements of Western society: the division of knowledge into ever more specialized subfields. There is no doubt that ever-increasing specialization has unleashed discovery, creativity, and indeed much of the prosperity that we enjoy. But specialization has intellectual and personal costs for at least some scientists, such as my wife, who went into physics for the love of physics as a whole. It was the beautiful and comprehensive elegance of physics that she was most eager to study and teach—and surely one of the great gifts of every field of science is the glorious symmetries and patterns that seem written into the fabric of our universe.

But sustaining a research career in physics requires attention to what can seem to the rest of us absurdly minute sub-sub-specialties, which have only become more tightly defined over time. Some, perhaps most, scientists thrive on these tiny areas of focus. But those of us who care about the way the world holds together, and believe that all things come together in Christ who is the wisdom and power of God, must insist that too much specialization is not good for anyone's soul. The sterility that is necessary for a successful biological experiment, or the austere vacuum essential to many experiments in physics, are not viable environments for flourishing life. Nor is intellectual specialization the highest form of knowledge—it is more likely to be the kind of knowledge that merely puffs up unless, after the fruits of specialization have been harvested, they are reintegrated with the complexity of fully human lives.

Ministering to Scientists

Such is the life of a scientist, at least the scientist I have known best. Some of these formative realities have been elements of intellectual careers for centuries (wonder, frustration, competition, the demand for novelty, perhaps the intimidation of nonspecialists). Others are particularly modern and not exclusive to science (specialization and isolation affect or afflict many careers in our age). Others are very specific to the vocation of a physicist and would be less true of a biologist or an ecologist. Since many scientists are also teachers, another essay's worth of commentary could be added on the challenges of teaching faithfully and well. And I have not mentioned the many complexities that come with being a woman, and more specifically a mother, in one of the few disciplines that still sees persistent underrepresentation of women as well as ethnic minorities. But I hope that at this point you are sensing

that embracing the vocation of research puts one on a path that will ultimately require tremendous spiritual and emotional growth—or that will hinder such growth. As with so many professional callings, I have found that science makes such demands on its practitioners that those who succeed in it tend to be either strikingly mature and wise persons, or sadly foolish and stunted, with relatively few in the middle. The stakes in a scientific vocation are high.

And here is my concern: with Catherine by my side, I have sat through fifteen years' worth of sermons in churches that by and large have served our family very well with worship, teaching, fellowship, and opportunities for mission. There is much that I have been grateful for in those sermons. But I cannot help noticing that in all these years, unless I am forgetting something, I do not remember hearing one thing, in church or in a Christian Bible study or in another Christian context, that even acknowledged most of the dynamics she encounters in her vocation every day. Does the gospel really have nothing to say to our sense of wonder and delight in the world? Is it silent on how to manage competition and risk? Does it give us no guidance on the qualities that make for real, fruitful collaboration? To the contrary, all these are the soil where discipleship can grow, where grace can be discovered, and where real faith can be nourished. What other opportunities are we missing to name the ways that every vocation in our congregation points us toward, and indeed requires, the death to self and trust in God that are the essence of trust in Jesus?

Another way of putting this is that all these challenges and gifts are intensely personal. That is, they bear very directly on what kind of person Catherine is. They influence her as an embodied human being, affecting her sleep, her thoughts, her dreams, her heart rate, and her blood pressure. And they are not fundamentally about the theoretical content of physics. They are about the practice of physics. They are about the embodied patterns of life that have shaped the horizons of possibility and impossibility for Catherine and her colleagues.

None of these realities, incidentally, can be given an adequately meaningful account within the framework of science itself. Science itself cannot interpret the practice of science—not in a way that does justice to the whole experience of being a scientist, answering the questions of why it is a genuine human calling, why it is potentially full of temptation as well as potentially full of grace, why it can produce such delight and such difficulty. Those are theological questions, but more immediately they are ministry questions, requiring someone to come alongside scientists with resources from outside of science itself.

Many people who end up in academic vocations are comfortable with abstraction. There is real intellectual leverage that can be gained by abstracting away from particular persons, to talk about, for example, "personality"; to abstract away from a set of methods, practices, discoveries, and theories to talk about "science"; to abstract away from a set of beliefs and rituals to talk about "religion." Yet ministry is one human vocation that dare not be abstract. The most fruitful ministry always is engaged with very concrete communities and persons.

Indeed, when theologians and pastors neglect the personal component of science and engage it as if it did not have tremendous implications for the personal lives of scientists, the loss is asymmetric. Scientists do not do less valuable science if they set aside questions of theology. To the contrary: science is a discipline of specialized investigation. But this is precisely what theology and ministry are not. A friend of mine is fond of saying that most academic disciplines seek to know everything about something, but theology claims to know something about everything. Theologians owe the world as comprehensive an accounting as is possible given our human limits. Our theologizing, preaching, and pastoral care cannot afford to ignore whole fields of endeavor, especially ones that both deliver such salient information about the world and that impinge so directly on the lives of people who practice them.

And if there is one thing that Christians ought to insist on when we approach questions of science and religion, it seems to me that it is the primacy of persons—the persons who practice science, and the persons who are affected by its practice. Persons are, to borrow a word from nothing less than the intelligent design movement, irreducibly complex. I am not at all sure that, evolutionarily speaking, the

bacterial flagellum is irreducibly complex. But I am quite sure that my wife is irreducibly complex. I am quite sure that you are irreducibly complex. And I am furthermore sure that such irreducible complexity demands from me a certain reverence.

I am also sure that the reverence you, my wife, and I myself command in our irreducible personhood is something that science cannot, using its own methods and practices, secure. In fact, neither can theology, nor religion, considered as theories alone, secure the reverence and respect that our personhood requires. Only embodied communities can cherish these strange and wonderful beings called persons—only communities that consciously examine the practices of the society around them, and cultivate distinctive practices of their own.

The practice of science, and the practices of the world of technology that emerge from science, is one of the determinative features of our world, for better and for worse. Those practices in some ways give life to the deepest hopes we could have for human flourishing in the Christian tradition. In other ways they put most profoundly at risk true human flourishing as best we understand it based on the revelation of God in Jesus Christ. If there is a meaning to the word ministry, it must have something to do with shepherding persons into practices that lead to true life. Some of the practices of science and a technologically shaped world do exactly that; others do exactly the opposite. Those of us who teach and preach, and those of us who befriend—and even marry!—scientists, can offer them an incalculable gift if we are willing to accompany them on their journey of formation as scientists and persons. We can help them understand that the very fabric of their vocation is potentially a means of grace.

And then, like Hopeful, we may encourage their progress toward the one truly worthwhile destination, the Heavenly City, where all our days will be, like science at its very best, full of wonder and delight.

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You are invited to draft an article related to

"The Matter of Mathematics"

Russell W. Howell, Kathleen Smith Professor of Natural and Behavioral Sciences, Westmont College, Santa Barbara, CA

Russell Howell has co-authored the textbook *Complex Analysis for Mathematics and Engineering* which is in its sixth edition, and is the co-editor of the HarperOne book *Mathematics through the Eyes of Faith*. He has provided an essay, now posted on the ASA and CSCA web sites, that gives an intriguing description of the latest developments in mathematics along with possible implications raised for Christian faith.

The essay is intended as an invitation. Readers are encouraged to take up one of the insights or challenges, or maybe a related one that was not mentioned, and draft an article (typically about 5,000–8,000 words) that contributes to the conversation. These can be sent to Howell at howell@westmont.edu. He will send the best essays on to peer review, and then we will select from those for publication in a mathematics theme issue of *Perspectives on Science and Christian Faith*.

The lead editorial in the December 2013 issue of *PSCF* outlines what the journal looks for in article contributions. For full consideration for inclusion in the theme issue, manuscripts should be received electronically before May 30, 2014.

For those readers who prefer to take a literary approach in sharing their ideas, please submit essays (up to 3,000 words), poetry, fiction, or humor inspired by the invitational essay to emily@asa3.org for possible publication in *God and Nature* magazine.

Looking forward to hearing your perspectives,

James C. Peterson
Editor, *Perspectives on Science and Christian Faith*