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The *Journal of the Union Faculty Forum*, now in its 33rd volume, consists of scholarly articles and creative works from all areas of study. The journal is published during each fall semester. The editors invite submissions of poetry, fiction, creative nonfiction, artwork, and scholarly articles in various academic disciplines. Acceptance is determined by the quality of the work. Please submit all works through the *JUFF* website: www.uu.edu/journals/juff/.

Dedication: David S. Dockery

In the winter of 1995-96, the Union faculty gathered in Savage Memorial Chapel to hear from the newly elected president, David S. Dockery. DSD, as he would become known, had been serving at The Southern Baptist Seminary in Louisville and would soon become the 15th president of Union University. Even though his tenure would not begin officially until the summer of 1996, he had requested a meeting with the faculty of the university prior to his installation as president to share his vision for the future of the institution. It was a profound and prophetic time for Union.

During that time together, the faculty learned that this new president knew much of the rich history of Union University—a story many faculty did not know and one he believed needed to be told more broadly and effectively—and that he was firmly convinced that the university's best days were still to come. DSD had a grand vision for Union's future, a future that would be anchored in four core values: excellence-driven, Christ-centered, people-focused, and future-directed. Yet, the most memorable remarks were about the new standard this president would set for Union as an institution of Christian higher education. It was his goal for Union to be on par with Wheaton College, arguably the premier Christian college in the nation, Most, if not all, had heard of Wheaton, some probably recalling that the famous evangelist Billy Graham had graduated from there. President-elect Dockery assured the faculty that with a fervent team effort, this lofty objective could be achieved. His rallying cry was unforgettable: "Not only is it my desire that Union will be known as the 'Wheaton of the South,' but rather that Wheaton, one day soon, will become known as the 'Union of the North." Smiles and laughter followed this fantastic idea and those present began to appreciate the new leader's sense of humor. After nearly two decades of DSD's leadership, Union's success is no laughing matter.

DSD's tenure at Union has been marked by many impressive accomplishments: a future-directed campus master plan along with the construction of multiple new buildings; the reorganization of the university into the College of Arts and Sciences, College of Education and Human Studies, and Schools of Business, Pharmacy, and Theology and Missions; the recruitment and expansion of an excellent faculty; and the recognition of excellence conveyed by such premier academic rankings as Kiplingers, *U.S. News and World Report* College Rankings, The Princeton Review, and many

others. Furthermore, DSD has supported and encouraged faculty opportunities for research leaves, for teaching and learning grants, and for conference travel. He has not only supported faculty research, but also maintained an impressive scholarly agenda of his own and has often invited faculty members to participate in his many collaborative projects. The example he has set as a scholar, writer, and lecturer has encouraged many faculty members in their own scholarly pursuits.

Recently, a long-time Union colleague stated, "Union is the Shire. It's the happiest place in Christian higher education." While Union might be the "Shire" in the world of Christian higher education, working at Union is akin to serving aboard the flagship of a fleet of vessels with the finest captain at its helm. To be employed here is to be the envy of others in the Christian academy. Dr. Dockery, thank you for boldly taking Union to places she had not gone before. We salute you DSD by dedicating this year's journal to you.

Matt D. Lunsford
John Netland

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Welcome by Faculty Forum President

It is the glory of God to conceal things, but the glory of kings is to search things out. Proverbs 25:2

Welcome to Union University's *Journal of the Union Faculty Forum (JUFF)*. As Forum President, I am pleased to invite you to engage with Union University scholars in "the glory of kings"—in searching out the mystery and beauty of creation and of the human experience. Many thanks to the faculty members for their work leading us in this royal endeavor.

The purpose of the Union Faculty Forum is to advance the university's mission of Christ-centered higher education through *JUFF* and through the Forum's role in faculty governance. I invite Union faculty members to participate in both. May our intellectual worship advance Christ's kingdom as we walk in justice and mercy.

Randal S. Schwindt, Ph.D., P.E.

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Musings on the Future of Higher Education

John Netland

Cassandras¹: the future of higher education is bleak; the humanities are doomed; state and federal support for higher education is being slashed; there are no jobs for Ph.D.s; academic standards are being eviscerated; higher education costs too much; college athletics have corrupted the academic enterprise; etc. As someone who has enjoyed a satisfying, twenty-five-year career as an English professor, I hear these warnings with a skeptical ear. These jeremiads about the state of education represent something of a seasonal ritual, a recurring lament that the halcyon days of education have vanished and that civilization itself hangs in the balance as hordes of technocrats and barbarians threaten the sanctuary of academia.

What if the doomsayers are right this time? The mythical Cassandra had the misfortune to be both disbelieved and accurate, and while some of the ritual laments for higher education are overstated, something has shifted in the academic landscape, and the doomsayers are no longer so easy to dismiss. Increasingly, the critics of higher education describe an impending catastrophe not as an assault by the vulgarians against the noble aims of humane education but as an internal collapse

¹ Cassandra was the mythical daughter of Priam, King of Troy. Her tragic dilemma was to be gifted with prophecy to foretell the future with accuracy but not to be believed.

of an unsustainable system. University of Tennessee Law Professor Glenn Harlan Reynolds warns of *The Higher Education Bubble*, a metaphor evoking memories of the dramatic economic collapses our society has experienced in recent decades (e.g., the "dot-com" bubble of 1997-2000 and the real estate and stock market declines of 2007-2008). In economic terms, a bubble refers to something that has become overvalued according to traditional measures of worth but that continues to increase in price until—quite dramatically—investors recognize the danger, sell it, and set off a chain reaction that decimates the marketable value of that item. What Reynolds and others are claiming is that higher education has come to be significantly overvalued and that its bubble is likely to burst when students and their parents will no longer pay for the cost of a university education.

I agree that higher education is in a state of crisis, but I do not conclude that this crisis is a cause for despair. To be sure, higher education is in for a bumpy ride in the next decade, but despair suggests a fatalistic inability to respond constructively to challenging circumstances. As can be the case in crises, the present moment offers an opportunity for institutions like Union University to reflect carefully on our mission, to make strategic adjustments to our means of carrying out this work, and to make a compelling case that we offer a high-quality education to meet the needs of our students, the church, and the broader world.

Most critiques of higher education, it seems to me, share three basic assumptions:

1) the cost structure of higher education is unsustainable; 2) a college degree no longer represents good value; and 3) therefore colleges must reinvent themselves, an injunction that is usually accompanied by a recommendation that we turn to technology for cost-saving solutions. The first claim seems almost self-evident, the second one is debatable, depending on how we define value, and the third claim, in my judgment, deserves careful scrutiny. There is little doubt that technology will play a crucial role in the future of higher education, but we need to think strategically about how to appropriate technology to serve educational objectives rather than to force educational practices to conform to what is technologically possible. If we allow technology to shape, rather than to serve, our educational mission, we may find that it has not saved higher education but has changed education in ways that we may come to regret.

An Unsustainable Financial Model

The cost of a college education continues to rise, leading many observers to conclude that the present financial model of higher education is simply not sustainable. According to a chart compiled by economist Mark J. Perry, from 1978 to 2011, the annual increase in college tuition and fees has risen far more (7.45% per year) than the average of all goods and services (3.8% per year) and substantially more than medical care (5.8% per year) or the median price of new homes (4.3% per year).2 To put these numbers in perspective, Perry points out that just from the year 2000 to 2011, "college tuition costs have doubled while medical costs have gone up by 'only' about 52%" (Perry). It is true that many, if not most, students do not pay the full tuition rate, but even the net cost to students has risen dramatically. A 2008 article in *Money* noted that "after adjusting for financial aid, the amount families pay for college has skyrocketed 439% since 1982" (Wang). One result is that students and their parents are borrowing ever-increasing amounts to finance a college education. A March 22, 2012, article in Bloomberg News reported that "U.S. student-loan debt reached the \$1 trillion mark, as young borrowers struggle to keep up with soaring tuition costs" (Lorin). Even more worrisome is the rise in student loan defaults. According to the U.S. Department of Education, the "three-year cohort default rate rose from 13.4 percent for FY 2009 to 14.7 percent for FY 2010." The rate was highest for students in the private, for-profit segment of higher education, and somewhat counter-intuitively, the default rates were lower for students of private, non-profit institutions than for public institutions of higher education (U.S. Department of Education). What the default rates are telling us is that increasingly, many students are borrowing sums that they cannot realistically repay given their employment options following graduation. These statistics suggest that higher education is being priced beyond the reach of many prospective students, a reality that has sobering consequences for higher education. If fewer students can afford college, enrollments will decline, which in turn will put pressure on tuition rates to rise further in order to make up for declining revenues. Needless to say, this pattern cannot go on indefinitely.

² Perry's chart uses information drawn from the Bureau of Labor Statistics and from the U.S. Census. Perry synthesizes this information for the sake of the specific comparison of these three areas.

The Value of a Degree

As long as tuition costs are relatively affordable and college graduates hold a reasonable expectation of acquiring decent employment, the public may not inquire too rigorously into the quality of the education. The collegiate experience has so many rewarding and enjoyable dimensions that some students have always been content to enjoy the experience without worrying too much about the quality of education received. Rising costs, however, tend to focus people's attention on the value of what they are paying for, leading many critics to argue that the college experience does not represent good value. These criticisms tend to take two forms: a critique of college as an economic investment and a critique of the learning itself. Those who presume that the primary reason to go to college is to get a well-paying job are now questioning whether the bachelor's degree is still a wise investment. For roughly the past half-century, college graduates could expect better wages than those with only a high school diploma. Michael Barber, Katelyn Donnelly, and Saad Rizvi concur but with an important caveat: "Achieving a degree, measured in lifetime earnings, has significantly more value than completing high school, but it is not clear that this will continue for all time and all degrees" (14). Not surprisingly, job prospects and earnings potentials tend to be significantly higher for technical fields (often indicated by the acronym STEM, for science, technology, engineering, and math related fields) than for some of the non-science disciplines in the liberal arts (Barber, Donnelly, and Rizvi 15-16). As long as increased wages are a likely consequence of a college degree, students can justify taking on even substantial amounts of debt, but at some point many students will conclude that for their occupational goals, it may not make sense to go deeply into debt for the tenuous earning potential. What those students will choose to do as an alternative remains an open question, given the tepid support in the U.S. for trade schools. Traditional universities are in danger of losing these students, who seem particularly attuned to weighing cost-benefit ratios of education. They are likely to opt for less costly alternatives (public rather than private universities, two-year rather than four-year programs, and perhaps online rather than residential institutions).

There is a different concern about educational value which may be even more important for universities to attend to. Many critics question not simply the earnings potential of the degree as much as the intrinsic quality of the education itself. It

may help us to think, along with Glenn Reynolds, about the different ways in which a college education can be perceived as valuable. Reynolds focuses more narrowly than I do on an education as vocational preparation, but his analysis is worth considering. "First," he points out, an education "may actually make [students] more economically productive by teaching them skills valued in the workplace: computer programming, nursing, or engineering, say.... Second, it may provide a credential that employers want, not because it represents actual skills but because it's a weeding tool [for employers].... And third, a college degree – at least an elite one – may hook its holder up with a useful social network that can provide jobs and opportunities in the future...." (Reynolds, Bubble, Chapter I). It may be true that many employers have used the degree as a minimal qualification to weed out job applicants, but the utility of the credential for this purpose will diminish if employers do not find that the degree-holder also possesses the knowledge, character, skills, and judgment expected of a college graduate. Colleges may also serve as a social network, but this function, too, will cease to be useful in the workforce if the people being brought together by these social networks do not display those same qualities expected of a college graduate. In short, if the education itself does not lead to greater knowledge, wisdom, and judgment, it will not create value, no matter how inexpensive it might be.

To many critics, what passes for a university education on many campuses is often intellectually insubstantial or given to various forms of ideological groupthink. Allan Bloom's best-selling 1987 jeremiad, *The Closing of the American Mind*, offered a blistering, if controversial, indictment of an academic world which he believed to have abandoned aesthetic and intellectual standards for cultural relativism and to have lost sight of the self-reflective purposes of a classical liberal arts education. In the ensuing twenty-five years, similar critiques have followed. In *Excellence Without a Soul: How a Great University Forgot Education*, Former Dean of Harvard College Harry R. Lewis maintains that Harvard has lost sight of the central purpose of undergraduate education, which he defines as helping young people negotiate the journey into responsible adulthood, find out who they are, and discover "a larger purpose for their lives" (Lewis xii). Andrew Delbanco's *College: What it Was, Is, and Should Be* points to a similar loss of purpose, maintaining that a college education "should help [students] develop qualities of mind and heart requisite for reflective

citizenship" (Delbanco 3). Delbanco identifies several culprits as responsible for this loss, including a corporate administrative culture that undermines teaching and an excessive emphasis on research that comes at the expense of undergraduate teaching. These, and books like them, argue that the contemporary university has lost its way and has relinquished its traditional role in the formation of the student's mind and character, a purpose long held to be central to a liberal arts education.

This critique is important for several reasons. First, this concern points to a significant philosophical divide in our culture's attitude toward education. Those who see a college education as nothing more than career preparation may not care whether a university is concerned with personal formation, but the Christian community ought to. If universities are not committed to the development of "reflective citizenship," as Delbanco puts it, what they are tacitly conveying is an educational ethic that values knowledge solely for personal career advancement and that relegates character formation to a purely private concern. Christian universities have the opportunity to make a case for an educational mission that takes personal formation—intellectual as well as spiritual and ethical—seriously. Second, as we consider various proposals to reform education, we should be wary of reforms that focus solely on cost containment but ignore the ways in which these reforms may affect the educational purpose of the university.

A different indictment is leveled by former Harvard president Derek Bok, who amasses considerable evidence that many students are not learning even basic academic skills:

Many seniors graduate without being able to write well enough to satisfy their employers. Many cannot reason clearly or perform competently in analyzing complex, nontechnical problems, even though faculties rank critical thinking as the primary goal of a college education. Few undergraduates receiving a degree are able to speak or read a foreign language. Most have never taken a course in quantitative reasoning or acquired the knowledge needed to be a reasonably informed citizen in a democracy. And those are only some of the problems. (Bok, "Introduction")

This is a critique that presumes some practical utility to a liberal arts education. Some liberal arts professors have traditionally been reluctant to think in pragmatic terms about the job skills that the liberal arts can cultivate, but I don't think we can ignore pragmatic considerations. What the studies Bok refers to reveal is that

too many of our students are graduating from universities without the intellectual abilities and the pragmatic skills that an education is presumed to develop.

Other sources corroborate Bok's findings. A 2004 article in The New York Times cites a "study, by the National Commission on Writing, a panel established by the College Board, [which] concluded that a third of employees in the nation's bluechip companies wrote poorly and that businesses were spending as much as \$3.1 billion annually on remedial training" (Dillon). Richard Arum and Josipa Roksa characterize campus cultures through their title metaphor, Academically Adrift, as places where students are not focused on, nor adequately prepared for, academic pursuits. They point to several studies documenting that students are studying less while being rewarded with rising grades (Arum and Roksa 3-4). Maintaining these high grade point averages is attributed to "the art of college management,' in which success is achieved primarily not through hard work but through 'controlling college by shaping schedules, taming professors and limiting workload" (Arum and Roksa 4). Researchers have also noted that the college professoriate has accommodated this pattern of higher grades for less work because professional incentives have directed professors' time and attention elsewhere than to the classroom. Hence, as George Kuh has described it, many professors have resorted to an unofficial compact with their students: "'I'll leave you alone if you leave me alone.' That is, I won't make you work too hard...so that I won't have to grade as many papers or explain why you are not performing well" (quoted by Arum and Roksa 5). The College Learning Assessment (CLA) is a tool that seeks to measure how much students learn while in college. Analyzing the results of the test spanning the fall of 2005 to the spring of 2007, Arum and Roksa conclude that "with a large sample of more than 2,300 students, we observe no statistically significant gains in critical thinking, complex reasoning, and writing skills for at least 45 percent of the students in our study" (Arum and Roksa 36).

Based on these and other critiques, we need to recognize that there is more that ails higher education than sky-rocketing costs alone, and this reality is crucial to bear in mind with any plans for reform. Cost-reduction plans will not resolve the crisis in higher education if they do not also ensure the quality of the education. Moreover, neither cost-reduction nor quality enhancement projects will succeed if we do not achieve clarity about the central purposes of an education, particularly

for faith-based institutions which situate an education in the context of God's redemptive purposes.

The High-Tech Reformation of Higher Education

If the costs of higher education are unsustainable and if the value of an education might not justify the expenditure of time and money to pursue it, then universities must reform their practices. The solution most often prescribed is to follow the high-tech transformation of industry and to allow computer technology to transform higher education. Proponents of the virtual university insist that it will, as the expression goes, "bend the cost curve downward" by doing for education what the computer revolution has done for so much of industry. It's not hard to understand the logic of such a claim. After all, when one looks at how computer technology itself has developed to offer significantly improved products at substantially lower prices, one can understand the hope that similar changes might occur as a result of applying the business model of technological development to the higher education world.

While computers have been reshaping educational practice on campuses for more than 30 years, the current model of a transformative technology is online learning, whereby the instruction for courses is delivered through recorded lectures, posted readings, interactive assignments and tests, chat rooms, discussion threads, and other resources that can be hosted on an online platform. Online learning makes it possible to extend the classroom far beyond the brick and mortar campus. It offers two advantages that could affect education costs. First, by making it possible for nonresidential students to participate, it can increase enrollments and generate more revenue than is possible with the traditional, residential pool of students. Increased revenue does not always lead to cost containment for tuition-paying students, but theoretically it could. Second, the real transformation of cost structures could come if the technology of online learning makes it possible to achieve economies of scale by dramatically increasing enrollments. Rather than the typical 25-50 students in a class, might it be possible to enroll 100,000 students in a single class? Such courses, known as Massive Open Online Courses (MOOC), have been developed by startup companies Udacity, Coursera, and EdX, working in close conjunction with such elite universities as Stanford, Princeton, Duke, Harvard, and MIT. The idea behind a MOOC is to have the very best professors on campus teach a course that is professionally produced for an online format and to make it available to as many students as possible. One person delivers the course content, while students interact with the material in ways that can be assessed by the computer, thus eliminating the human labor needed for grading. Many initial MOOCs have been offered free of charge, and some have managed to enlist well over 100,000 students for non-credit-bearing courses. If this model of online education succeeds and becomes a significant part of the curricular offerings, the economies of scale represented by these courses should create a dramatic reduction in the costs of higher education, which in turn would make the education a more realistic option for many more people. So the argument goes.

However, before we conclude that online learning will replace the traditional classroom, we need ask some hard questions about the degree to which these online courses will fulfill their cost-cutting expectations. We should note, for instance, that for all of the wonderful benefits that information technology has brought to higher education, it has not reduced educational costs thus far. To the contrary, the information technology era in higher education corresponds roughly to the thirty-year period of steady price increases highlighted earlier by Mark J. Perry. This correlation does not necessarily mean causation, but it simply points out that for the past 30 years, information technology has not been able to reduce the cost of higher education. Bennett Voyles, writing in 2004, observed that

in the 1990s, information technology was often sold as a way to dramatically cut costs, yet as time went on, the proposition turned out to be difficult to prove. Sometimes the technology didn't function as promised. Other times, it did, but it required more care and feeding than anyone had initially imagined. Either way, the result was bigger payout for an uncertain—or at least not measurable—return. (Voyles)

I think it is safer to say that to this point information technology has proven not to be a cost cutter but simply a necessary part of offering an excellent education in the information age. Hence, we should examine very carefully whether the business model of the MOOC will in fact turn out to be the game-changing cost-containing development.

Those who tout MOOCs as a cost-saving solution need to recognize both the substantial upfront development costs for these courses and the reality that these are not one-time expenses but will need to be periodically renewed. At Minding the

Campus, an online magazine published by the Manhattan Institute, Rachelle DeJong notes that startup costs are quite high. Harvard and MIT each contributed \$30 million to found EdX simply to develop the technology for the course platforms. EdX then charges universities \$250,000 for the design of each new course, as well as a \$50,000 fee each time the course is run again. Udacity charges about \$200,000 for each course it designs, but DeJong notes that with a MOOC 2.0 in the planning, Udacity is expecting to double its charges to \$400,000 per course (DeJong). These costs do not even include the substantial investment that universities have already made in the professor whose expertise and experience are necessary for the production of these master classes. One professor "had spent hundreds of hours readying the material, devoting as much as two weeks each to recording and fine-tuning videotaped lectures. The preparation itself, he said, was 'a full-time job" (Kolowich). With development costs of this magnitude, universities must count on massive enrollment, as the name indicates, just to break even. It is no surprise that the universities involved in this venture at this time are all major research universities with substantial resources and endowments. They are able to subsidize the free MOOCs now being offered, but it is obvious that any long-term business model for MOOCs will have to charge tuition, quite possibly at a rate higher than we are presently led to believe will be the case.

Beyond start-up costs, these courses will need frequent revision and updating. Anyone who claims otherwise simply does not understand good teaching. Students can be justifiably brutal in ridiculing the professor who pulls out the same set of lecture notes compiled some thirty years ago, filled with the same cultural allusions that may once have been current but which now draw blank stares. Why would students be any less dismissive of slickly-produced online lectures that are ten or twenty years old? In some rapidly-changing fields, a three-year-old lecture might well get an instructor dismissed for presenting obsolete material. There are good reasons why nursing textbooks are frequently revised. Moreover, pedagogical theorists have been reminding us for well over a generation to stop thinking of education as simply the transmission of knowledge. Even before the Internet, it was perfectly possible for a bright individual to become self-educated by going to a library and acquiring firsthand the knowledge that a university education would provide. But few individuals have been successful in pursuing an education in that way. Those who think of online

courses primarily as a cost-saving form of academic automation that can endlessly disseminate information to successive iterations of students are assuming a largely discredited theory of how we learn. If online courses are going to be instituted with excellence, they will need frequent updating performed by professors who continue to study, conduct their own research, and disseminate the results of the production of new knowledge. All of these activities are costly because they are labor intensive. Any estimate of the cost-reducing possibilities of a MOOC must take into account a realistic estimate of recurring costs for keeping the course material fresh as well as the frequent costs of updating equipment that becomes obsolete every two to three years.

Even if MOOCs or other online courses eventually produce substantial cost savings, they must also deliver the quality expected of a rigorous university education. Unfortunately, early assessment data is hard to come by and what is available is not altogether encouraging. One study, produced by the Babson Survey Research Group, purports to track ten years of online education in the United States, but the assessment tool it uses is nothing more than a survey of "academic leaders," and the knowledge gained merely indicates "perceptions" of these academic leaders. The study touts an increase from 2003 to 2013 in the percentage of academic leaders rating the learning outcomes of online classes to be equal or superior to those in traditional classes. The fact that this percentage increased from 57.2 to 77.0 tells us nothing except that in some unmeasurable way, the academic leaders of campuses already invested in online education believe that it is as good as or better than traditional programs (Allen and Seaman 5).

Other evidence paints a different picture. A *New York Times* editorial reports that "student attrition rates—around 90 percent for some huge online courses—appear to be a problem even in small-scale online courses when compared with traditional face-to-face classes" ("Trouble"). An article in *Politico* confirms the high attrition rate ("completion rates of less than 10 percent") and also adds this salient detail: "a quietly released report last week [September, 2013] on a partnership between San Jose State University and major course provider Udacity found that disadvantaged kids performed particularly poorly" (Emma). In studies produced by Columbia University's Community College Research Center, "research has shown over and over again that community college students who enroll in online courses

are significantly more likely to fail or withdraw than those in traditional classes" ("Trouble"). This emerging evidence suggests that online education may not be a panacea for all students. It is much more likely to be successful for advanced students than for average or marginal students. If these trends are borne out, then it may well be that online courses are more likely to constitute a niche market that supplements, rather than replaces, the traditional on-site paradigm of higher education—at least until there is better evidence that it can meet the needs of beginning and marginal students.

Some of the more promising online programs are those involving advanced education: graduate programs in such diverse fields as theology, library science, nursing, computer science, and education. Georgia Tech University recently announced the first entirely online master's program in computer science (Lewin). Seminaries have been offering online graduate programs for several years, and Union University has six entirely online graduate degrees (in Education, Business, Christian Studies, and Nursing). These programs make sense because graduate students have already mastered the study habits needed to be successful, independent learners. Moreover, many of these programs appeal to working professionals from far-flung communities in the United States and abroad. Because of work and family obligations, these students cannot move to the campuses hosting these programs, but the online option offers them a chance to enroll in a virtual educational community. In some cases, particularly for people involved in ministry in distant locations, the online community of learners functions even as a supportive spiritual community.

Perhaps the promise of MOOCs and other online courses will not be to replace the traditional four-year degree but to supplement it with the kinds of strategic niche programming mentioned above. Other possibilities for MOOCs include the idea of having students earn certificates of accomplishment in different subject areas, rather than taking a prescribed program of study leading to a bachelor's degree. This cafeteria-style selection holds obvious appeal to those who are simply looking to enhance skills and competences in certain areas but have no wish to complete an entire liberal arts degree. This notion of "unbundling" discrete aspects of a university education that are now packaged together is advanced in Jeffrey J. Selingo's book, *College (Un)Bound: The Future of Higher Education and What it Means for Students.* The title analogy alludes to such bundled services as cable television, which

continues to be sold as a package of many different channels, despite consumers' oftstated preferences to be able to unbundle the package and order only what they want.

Perhaps this is the direction that higher education will take, but if it does, I'm not sure that we should celebrate this cafeteria-style educational choice. One of the central assumptions on which the liberal arts ideal is based is that a truly well-educated person knows many different fields beyond his or her chosen area of specialization and can thus understand inter-relationships amongst the different bodies of knowledge. This breadth and synthesis of knowledge brings with it perspective and judgment, qualities of mind and character that are indispensable to both leaders and citizens of free societies. Many observers of higher education have lamented the fragmentation of knowledge in the modern university, a concern that as disciplines become more highly specialized, well-educated people know more and more about narrower bodies of knowledge and less and less of a shared common culture. The unbundled university is likely to contribute further to this fragmentation. It will make it easier for students to pick and choose what they most desire to learn, but that will come at a cost to an ideal that many of us still find compelling: the person who understands a sufficiently wide array of knowledge to be able to make informed decisions and be able to contribute effectively to his or her profession, community, and society. Christian educators in particular believe in transmitting a common spiritual and cultural legacy that provides context for knowledge and selfunderstanding. Christian education is based on the premise that in God knowledge finds a coherent framework of meaning, and a well-designed liberal arts education should help students discover that framework.

Reforming Educational Practices Strategically

What, then, should the contemporary university do to survive the present challenges? The broad goal, I would suggest, should be to maintain and even improve the value and quality of the education offered. Cost containment strategies cannot come at the expense of educational excellence, lest we transform the pursuit of education into an acquisition of empty credentials.

The place to begin, I suggest, is not to follow trends but to reconsider the central mission of the university. An institution needs to clarify and remain committed to its core values and to allow those core values to shape its practices, lest it inadvertently

allow cutting edge practices to redefine the mission. It will not be much of a success if, in order to stay in business, a university has to compromise on its core mission.

Second, as a close corollary to defining its mission, universities need to avoid the "groupthink" that encourages one-size-fits-all solutions. Universities are under tremendous pressure to emulate what every other successful university has done, with the result that many universities are carbon copies of each other, just with different athletic mascots. It may be a correlative rather than a causal relationship, but it is striking that the past three decades of dramatic cost increases coincides with a period of tremendous growth on most college campuses. During this era, colleges and universities have sought to keep pace with each other by building spectacular facilities and amenities, such as state-of-the-art fitness facilities, specialty dining services, and technologically sophisticated classrooms that are not always fully utilized. It is the rare institution that has the courage to resist this conformity and, instead, to be strategic about maximizing its unique mission and capabilities, but I suspect that these are the institutions that will emerge from this crisis stronger than ever. These are the institutions that will adopt new technologies thoughtfully and strategically, as a way to further their institutional missions rather than out of a panic that everybody else is doing so and therefore so must they. It is worth remembering that a shared characteristic of all bubbles that eventually burst is a conventional wisdom that is absolutely certain of an indisputable truth. Thus, in the mid-1990s, nearly all savvy investors just "knew" that startup dot.com industries represented an inevitable path to prosperity; even as late as 2007, prospective home buyers and real estate speculators just "knew" that home ownership represented the safest and steadiest investment possible.

Third, colleges and universities need to figure out what they offer to students and to the broader society, develop those offerings as best they can with the resources available, and make a case to their various constituencies that what they offer is worth supporting, both in the form of tuition-paying students and supporting partners. Christian institutions in particular need to make a case to the broader church that a Christian education is not simply a private good that privileged students can afford but that it is a vital element of the church's witness to the broader world. In an essay that is filled with some sobering analysis, this point actually represents what I believe to be an encouraging opportunity for the many Christian institutions that do provide

an excellent, faith-shaped education. We have a good story to tell, and we need to document this story and have the confidence to proclaim it unapologetically.

Finally, we need to be willing to think creatively about new initiatives and more efficient ways of educating our students. Many of these new initiatives will involve creative programs that can expand the reach of our institutions. Online programming will undoubtedly continue to be a useful means of reaching carefully targeted audiences with programming suited to students' backgrounds and levels of learning, but we should also continue to reconsider some of the practices that we have become familiar with and take for granted. Are there ways in which we can achieve better efficiencies within the traditional residential campus? Might there be opportunities for better collaboration and sharing of resources amongst institutions with similar missions? In metropolitan areas with multiple smaller institutions, each of which strains to maintain adequate facilities in all areas of campus life, might it be possible to share resources and to complement institutional strengths through creative collaboration? It will not be easy to do so, and any programming that will involve such collaboration will require considerable trust and graciousness in negotiating the unique elements of campus culture, of theological commitments, and of academic distinctiveness. With trust in the God who has sustained Christian higher education in the past and with a commitment to using the resources of mind, capital, and facilities that He will continue to provide, I believe that academic institutions that seek to honor God in pursuing the academic vocation with excellence and faithfulness have an opportunity to flourish even in a time of crisis.

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Vitamin E: Daily Requirements, Dietary Sources, Symptoms of Deficiency, and Recent Use in Clinical Studies*

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ABBREVIATIONS

 $\begin{array}{ccc} \alpha T & \alpha \ tocopherol \\ \gamma T & tocopherol \\ T_3 s & tocotrienols \\ T_5 & tocopherols \end{array}$

ROS reactive oxygen species RNS reactive nitrogen species PUFA polyunsaturated fatty acids EFA essential fatty acids

ILs interleukins

αΤΤΡ tocopherol transport proteins
HDL high density lipoproteins
LDL low density lipoproteins
VLDL very low density lipoproteins
MI myocardial infraction

DM diabetes mellitus CVD cardiovascular disease EAR estimated average requirement

EAR estimated average requirement RDA recommended dietary allowance UL tolerable upper intake level AVED ataxia with vitamin E deficiency

IU international unit CF cystic fibrosis

RCT randomized clinical trials

Hp haptoglobin
Hb hemoglobin
CI confidence interval
TE tocopherol equivalents

G6PD glucose-6-phosphate dehydrogenase PIP phosphatidylinositol phosphates

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Vitamin E was discovered in 1922 by Evans and Bishop, who observed that rats could not reproduce when fed pure lard as their only source of nutrition, while rats that were fed various grains could reproduce and the infertility problem was corrected.¹ Diets with rancid fats fed to laboratory rats or chickens caused various pathological abnormalities, but diets supplemented with wheat germ oil concentrates would cure these conditions.² This unknown substance was called "the anti-sterility factor" and was later identified as tocopherol,²-⁴ from the Greek words tokos, meaning childbirth, and phero, meaning to bring forth, along with the "ol" which indicates the alcohol property of a molecule.⁵ It was more than 30 years after its original discovery before studies confirmed that humans also require vitamin E in their diets. ⁶

Sources of Vitamin E

Vitamin E, one of the essential fat-soluble vitamins, exists in nature as eight compounds that are mostly synthesized by plants. These compounds are divided into two classes: the tocopherols (Ts), which have a complex ring (chroman) and long saturated side chains in their structures, and tocotrienols (T3s), which have a chroman ring but with long unsaturated side chains. These two classes are further divided into α , β , γ , and δ isoforms. γT is the major form of dietary vitamin E, while αT is the most important form of vitamin E present in human plasma and tissue.

Synthetic αT is designated as *all-rac* α -tocopherol (all racemic), consisting of an equal mixture of the eight stereoisomers RRR, RSR, RRS, RSS, SRR, SSR, SRS, and SSS.⁸ The natural form of αT exists only in the RRR configuration.⁸ While all of the stereoisomers have equal antioxidant activities, only those that have RR-configuration have high biological activities.⁹ T3s are less widely distributed in nature, generally have lower biological activities than the Ts, and are of lesser nutritional importance than Ts.⁶

US food provides about 75% α T, 20% γ T, and 5% β T and α T3 of the total vitamin E activity, respectively. Although γ T has only one tenth of the biological activity of α T, it makes a significant contribution to total vitamin E activity in the body because of its wide distribution in foods. The ratio of α T to γ T in soybean oil is 8 mg to 70 mg/100 g, while in corn oil it is 20 mg to 70 mg/100 g. This content shows

that dietary intakes of γT are usually 10 times higher than αT , but in the plasma, γT represents only 10% to 20% of total vitamin E.¹²⁻¹³ Variations in αT and γT contents have been reported ranging from 0% to 100%, which might be due to αT decomposing faster than γT .¹⁴⁻¹⁵ Vitamin E content in green leafy vegetables and prepared foods varies due to the different seasons and conditions of the harvest, climate, ripeness, freshness, and food processing.¹⁴⁻¹⁵

The highest amount of natural vitamin E is found in oils; wheat germ oil has the highest content of 157 mg/100 g of αT equivalent. The vitamin E contents of other vegetable oils are as follows: corn 19 mg/100 g, cottonseed 43 mg/100 g, peanut 15 mg/100 g, safflower 40 mg/100 g, soybean 16 mg/100 g, and sunflower 49 mg/100 g. Besides oil, other sources rich with vitamin E include peanuts, whole wheat, mayonnaise, margarine, and several fortified foods such as breakfast cereals. ^{10-11,16}

Biochemical and Physiological Functions of Vitamin E

Vitamin E has a variety of biological roles such as scavenging reactive free radicals, stabilizing and maintaining membrane fluidity, and functioning as an immunomodulator. Oxidative stress is a term used to describe an imbalance between free radical oxidants and antioxidants, in which excess free radical oxidants cause cellular damage. The damaging effects of free radical oxidants such as reactive oxygen species (ROS) or reactive nitrogen species (RNS) on lipids, proteins, and nucleic acid have been implicated in the etiology of several human diseases.

Vitamin E is the most important chain-breaking, lipid-soluble antioxidant present in all tissue cells, and is considered the first line of defense against lipid peroxidation.¹⁹ Due to the presence of a chroman ring in its structure, vitamin E is chemically capable of scavenging ROS, RNS, and free radicals catalyzed by lipid peroxidation.²⁰ Vitamin E also functions to prevent oxidative damage to polyunsaturated fatty acids (PUFA) in the membrane.²¹⁻²² Lipid peroxidation creates a chain reaction that continues to produce new free radicals, and this reaction is propagated until the chain reaction is terminated, usually by antioxidants. Vitamin E's effect on inhibiting the initiation and chain propagation of lipid peroxidation also contributes to membrane stability and fluidity and its protective effect against oxidative stress damage.^{18, 23-24}

Vitamin E also plays an important function as an immunomodulator by causing the proliferation of lymphocytes, increasing total serum proteins, increasing the proliferation of natural killer cells and T cells, and increasing production of cytokines such as interleukins (IL 2, 6), which might be lacking in elderly patients.²⁵ This age-related decline in immune response may increase the risk of infectious disease and complications in elderly patients.²⁵ However, some studies showed significant improvement in the immune system after even short-term vitamin E supplementation.²⁶

Daily Requirement of Vitamin E

Vitamin E, just like other vitamins, has an estimated average requirement (EAR), recommended dietary allowance (RDA), and tolerable upper intake level (UL).^{9, 27} The EAR was defined based on the amount of RR-αT intake that reversed erythrocyte hemolysis in men who were vitamin E-deficient as a result of consuming a vitamin E-deficient diet for 5 years.^{9, 19} EAR can also be defined as the amount of vitamin E expected to satisfy the needs of 50% of the people in the age group based on a review from the scientific literature.²⁸ The RDAs are designed based on the daily dietary intake level of a nutrient considered sufficient by the Food and Nutrition Board to meet the requirements of 97.5% of healthy individuals in each life-stage and gender group.²⁸ RDA is calculated based on the EAR and is approximately 20% higher than the EAR.²⁹ The UL is defined as the highest level of daily consumption that current data has shown to cause no side effects in humans when used indefinitely without medical supervision.²⁹⁻³⁰

For dietary purposes, vitamin E contents in foods are expressed as αT equivalents (α -TEs). One α -TE is equal to the activity of 1 mg RRR- αT . To estimate the α -TE of a mixed diet containing different natural forms of vitamin E, the number of milligrams of βT should be multiplied by 0.5, γT by 0.1, and αT 3 by 0.3, respectively. The synthetic *all-rac* αT should be multiplied by 0.74, while one milligram of αT acetate is equivalent to 1 international unit (IU) of vitamin E.²⁸

A plasma concentration of 12 μ mol/L of α T (consumption of 12 mg/day) was chosen as the target to provide a plasma concentration equal to the EAR. ²⁰ The RDA for infants 0 to 6 months is 4 mg/day and for 7 to 12 months is 5 mg/day. ³¹⁻³² The EAR

and RDA for children 1 to 3 years, 4 to 8 years, and 9 to 13 years are 6, 7, and 11 mg of α T/day, respectively.³¹⁻³² The 2000 RDA for individuals older than 14 years is 15 mg/day as defined in the Dietary Reference Intake (DRI).⁹ The RDA guideline for 2000 is higher than the 1989 RDA recommendation, which was 8 mg for adult women and 10 mg for adult men.³³ There is no additional RDA requirement for pregnant women, but for lactating women the RDA is 19 mg/day. It is very important, however, that pregnant women should have additional vitamin supplementations to decrease possible risk of spontaneous abortion due to vitamin E deficiency.³⁴

Although the RDA for adults is set at 15 mg/day, mean dietary intake of vitamin E in the US is only about 6 mg/day. 35 It is estimated that about 96% of women and about 93% of men do not meet the current vitamin E recommendations. 36 According to the Food and Nutrition Board of the Institute of Medicine, vitamin E deficiency in healthy adults is noticeable when it is less than 12 μ mol/L of α T. However, studies of vitamin E status in diverse populations have used cutoffs ranging from 2.8 to 24 μ mol/L to define deficiency. 9,37 Serum level α T of less than 0.5 μ mol/L indicates deficiency in vitamin E. 38 Because of the linear relationship between serum vitamin E and total serum lipids, the serum vitamin E (mg) to total serum lipids (g) ratio has been used to identify conditions of hyper- or hypolipoproteinemia. For example, a ratio greater than 0.6 mg/g for a child under 12 years or greater than 0.8 mg/g for older children and adults is considered normal. 39

In the plasma of individuals not supplemented with daily vitamin E, the average αT concentration is 22 to 28 $\mu mol/L$, which is about 10 and 100 times higher than γT (2.5 $\mu mol/L$) and δT (0.3 $\mu molL$), respectively. $^{40\text{-}41}$ In tissue, the highest contents of αT are found in adipose tissue (150 $\mu g/g$ tissue) and the adrenal glands (132 $\mu g/g$ tissue). Other organs such as the kidney, heart, and liver contain between 7 to 40 $\mu g/g$ tissue. The differences in the relative amounts of different Ts suggest tissue-specific mechanisms for transport and storage of Ts. 7 In contrast to Ts, plasma T3 concentration is usually below 1 $\mu mol/L$, suggesting that T3s are rapidly metabolized by the liver and fecally eliminated. $^{42\text{-}43}$

To compare the 1989 RDA to the 2000 RDA requirement, a recent study was conducted in twelve healthy volunteers. Quantified kinetics, bioavailability, and metabolism of αT were measured. The study showed that to maintain a plasma concentration of 12 μ mol/L, an αT intake of 9.2 + 0.2 μ mol/L/day (4+0.1 μ mol/L/

day) was sufficient to produce plasma αT of 19 to 27 μ mol/L/day.⁴⁴ This study showed that the actual requirement for vitamin E is lower than the current 2000 EAR and RDA. There also had been similar studies to support that the 1989 RDA of 10 mg/day is sufficient to maintain correct plasma vitamin E.⁴⁵ More studies are needed to establish if the current 2000 EAR and RDA for vitamin E may be set at higher than necessary concentrations.

Symptoms of Deficiency in Vitamin E

Vitamin E is absorbed along with essential fatty acids (EFA), polyunsaturated fatty acids (PUFA), and triglyceride. People with intestinal disorders associated with fat malabsorption are susceptible to deficiency or low levels of EFA, plasma vitamin E, and PUFA.⁴⁶⁻⁴⁷ These people include those with a defect in lipoprotein metabolism (abetalipoproteinemia) or fat malabsorption syndrome (AVED, Crohn's disease, celiac, biliary cirrhosis, spruce, pancreatitis, cystic fibrosis), premature infants with very low birth weight, people with hematological and immunological disorders, and people who have had gastrectomies.⁴⁸⁻⁴⁹ In adults, malabsorption may take place for several years before the blood vitamin E concentration drops below 9.3 μmol/L. After 5 to 10 years of deficiency in vitamin E, people may develop neurological abnormalities.^{6,50-51}

The most severe deficiency of vitamin E was found in patients with abetalipoproteinemia. This inborn error of lipoprotein metabolism is due to a defect in the microsomal triglyceride transfer proteins which prevents the appropriate assembly of lipoproteins and apolipoprotein B.⁵²⁻⁵⁵ All patients with this condition have undetectable serum concentrations of vitamin E from birth.⁵⁶ The absence of chylomicron, which is necessary for vitamin E absorption, and the lack of low density lipoproteins (LDL) and very low density lipoproteins (VLDL) necessary for vitamin E transport in patients with abetalipoproteinemia caused retinal pigmentation and neuropathyataxiaduring these conddecade of life, which can later progress to blindness.⁵² Other neurological syndromes associated with this disease include Friedreich's ataxia, manifested as loss of reflexes, loss of balance (cerebellar ataxia), loss of position sense, loss of vibration sense, abnormal feet, curvature of the spine, generalized muscle weakness with cardiomyopathy, and impaired glucose metabolism.⁵⁷⁻⁵⁸

In a clinical study, children with abetalipoproteinemia were treated with large

doses of vitamin E, 100 mg/kg/day, from the time they were 16 months old. After the trial, these children showed a significant decrease in neurological and retinal complications in comparison to children that were given the normal requirement of a total of 10 to 30 mg/day of vitamin E.⁵⁷⁻⁵⁸ Additionally, if the children already showed some neurological dysfunction prior to the vitamin E supplementation, their symptoms were halted or reversed once the vitamin E deficiency was corrected.⁵⁷⁻⁶⁰ Vitamin E can also prevent development or halt progression of retinopathy.⁶¹

The lesser symptoms of vitamin E deficiency are found in patients with ataxia with vitamin E deficiency (AVED). This rare autosomal recessive neurodegenerative disease is due to a defect in the gene for α -tocopherol transport protein (α -TTP), an intracellular cytosolic liver protein that binds to aT with high selectivity and regulates the amount of αT secreted into plasma.⁶² Patients with AVED lacked a functional hepatic binding protein for αT for the transfer of αT to VLDL and transport to the liver. The gene for AVED was localized on chromosome 8q. More than 20 mutations in the α -TTP gene have been identified in AVED patients.^{32, 63-64} Recent studies showed that normal aTTP binds to phosphatidylinositol phosphates (PIPs), which function to promote the inter-membrane transfer of αT by α-TTP.⁶⁵ In AVED patients, there is impaired interaction of aTTP and PIPs and miscoding of arginine residue, resulting in a severe deficiency of vitamin E.⁶⁵ Although the absorption of vitamin E is normal in AVED patients, vitamin E disappears from plasma more rapidly in AVED patients than in normal individuals.⁶⁶ Patients usually have very low serum vitamin E levels with normal intestinal fat absorption.⁶⁷ Normal serum vitamin E and clinical improvement can be achieved when patients are dosed with 800 mg/day of vitamin E. This dose is smaller than the 100 mg/kg/day required for the treatment of abetalipoproteinemia.⁵²

In children born with fat malabsorption such as cystic fibrosis (CF), a vitamindeficient condition can develop rapidly with neurological consequences. Neuropathological changes in CF children include neuroaxonal dystrophy affecting the gracile nucleus and degeneration of large-caliber axons in the sensory neurons. Neuropathological changes in CF patients with vitamin E deficiency might also produce high concentrations of free radicals and ROS. Evidence of increased oxidative stress in CF patients includes elevated plasma malondialdehyde, elevated breath pentane and ethane, elevated plasma hydroperoxides, and depletion of major lipoperoxidation substrates such as linoleic and arachidonic acid.⁷³⁻⁷⁴ In clinical trials with 22 CF patients, it was shown that patients supplemented with 200 mg vitamin E/day caused an increase in plasma vitamin E that correlates with increased plasma PUFA, and this increase prevented oxidative degradation of cell membranes.⁷⁵

Patients suffering from celiac disease, an immune-mediated disorder affecting the small intestine, may have neurological disorders due to vitamin B1, B6, B12, niacin, riboflavin, and vitamin E deficiencies.⁷⁶ Vitamin E deficiencies in celiac disease patients are usually manifested as neuropathy, opthalmoplegia, cerebellar ataxia, extrapyramidal disorder, and myelopathy.⁷⁷

Patients with hematologic disorders such as thalassemia, sickle cell anemia, or defective glucose-6-phosphate dehydrogenase (G-6-PD) or who undergo kidney hemodialysis were also shown to have low plasma αT. It was assumed that chronic low red blood cells could decrease plasma Ts.⁷⁰ Supplementation of vitamin E in these patients could decrease red blood cell fragility and partially correct anemia.⁷⁸⁻⁸⁰

After gastrectomy, fat absorption is usually impaired and bile secretion becomes abnormal.80-81 The abnormalities of fat malabsorption are more prominent in patients with total gastrectomy or R-Y construction than in patients with subtotal or partial gastrectomy. 80, 82 In patients who have had gastrectomies, transported foods are usually not following the normal physiological route. Food passes along a shorter pathway to the upper part of the small intestine in the duodenum, which causes obstruction of lipid absorption and impairment of bile secretion.83 Patients with total gastrectomies usually manifest neurological symptoms worse than patients with partial gastrectomies.84-86 The neurological symptoms for vitamin E deficiency include cerebellar ataxia, peripheral neuropathy, and myopathy. The neuronal damage is believed to occur due to accelerated hyperoxidative reactions of unsaturated fatty acids of the phospholipid membrane.⁸⁷ In recent years, vitamin E was also reported to regulate genes involving scavenger receptors, α-TTP, α-tropomyosin, matrix metalloproteinase, and collagenase.88-90 Plasma vitamin E can be kept within a normal range for up to about 50 months after gastrectomy; however, after 50 months, vitamin E serum levels may become very low, causing neurological disorders.⁸³ More than 300 mg/day of oral intake of vitamin E is necessary to normalize vitamin E concentrations in gastrectomized patients.91

Signs and Symptoms of Toxicity

The UL for vitamin E is 1000 mg/day, which is equivalent to 1100 IU of synthetic or 1500 IU of natural vitamin E. The UL was based on an increased bleeding tendency observed in rat studies because sufficient and appropriate quantitative data assessing long-term adverse effects of high-dosage vitamin E supplementation in humans was not available.^{32, 91} Recent meta-analyses showed a slight increase in all-cause mortality with high doses of vitamin E supplementation. However, according to The Food and Nutrition Board of the Institute of Medicine, there is little evidence for adverse effects when vitamin E is taken below the UL.^{42, 92-94} Moreover, in a recent follow-up study of the α -tocopherol, β -carotene cancer prevention study (ATBS study), which surveyed 20,092 Finnish male smokers, higher baseline serum vitamin E was reported to associate with lowered total and specific mortality in male smokers.^{42, 95}

However, habitual intake of high vitamin E may antagonize endogenous vitamin K. Adults tolerate relatively high doses of vitamin E without significant toxicity. Signs and symptoms of vitamin E toxicity such as muscle weakness, fatigue, double vision, emotional disturbance, breast soreness, thrombophlebitis, nausea, diarrhea, and flatulence have been reported with intakes of 1600 to 3000 mg/day. 96-98

Vitamin E and Diabetes—Recent Research

Diabetes mellitus (DM), a lifelong progressive disease, is characterized by sustained high blood glucose and is the result of the body's inability either to produce insulin or to use insulin properly. 99-100 Sustained hyperglycemia can cause microand macro-vascular complications throughout the body, including neuropathy, retinopathy, kidney disease, and cardiovascular disease (CVD) complications. DM is classified into type I and type II. People with type I DM do not produce insulin, while people with type II DM produce limited insulin or have insulin resistance. Insulin resistance, defined as a body's inadequate response to a given amount of insulin, has been known to be exacerbated by environmental factors such as obesity, oxidative stress, aging, and sustained hyperglycemia. 99-102 Moreover, people with hyperglycemia are more susceptible to hypertension, myocardial infraction (MI), stroke, atherosclerosis, and other CVD complications which may lead to increased morbidity and mortality. 103 Intervention to control CVD risks by lifestyle modification

and pharmacotherapies using anti-diabetics, statins and angiotensin-converting enzyme inhibitors have been well studied. However, there are still some groups of people who are not able to afford or access these drugs, especially in poor developing countries; therefore, the approach of using supplementations that are cost-effective, safe, and carry desirable outcomes is important to consider.¹⁰⁴

There is a new approach to investigating the relationship between vitamin E and haptoglobin (Hp) in diabetic patients. 105-106 Hp is a plasma glycoprotein synthesized by hepatocytes which functions to bind free hemoglobin (Hb). Free Hb is released from red blood cells with high affinity to cause formation of an Hp-Hb complex. 106-107 Free Hb can cause oxidative tissue damage due to the fact that Hb contains heme iron in its structure. 105 The complex of Hp-Hb serves to inhibit the oxidative property of free Hb by preventing the release of heme iron from Hb. 108-110 The normal ratio of Hp to Hb in the blood is usually 10 μM to 25 nM (Hp is 400 times in excess of free Hb); therefore, Hp is capable of binding all the free Hb released during red blood cell turnover. 105, 111-112 Once Hb is bound to Hp, it is rapidly cleared from the bloodstream via the CD 163 scavenger receptor which is located on monocytes and macrophages. 105, 113 Down regulation of CD 163 in people with Hp 2-2, a homozygous Hp genotype found in 36% of the population, causes the clearance of Hp-Hb complexes in these patients to be less efficient than in people with Hp 1-1 (16% of the population) or Hp 2-1 (48% of the population).^{107, 111, 114} People with or without DM can have Hp 1-1, Hp 1-2, or Hp 2-2 genotypes. Additionally, diabetics with the Hp 2-2 genotype have a deficiency in their high density lipoproteins (HDL) which impairs the body's ability to stimulate the reverse transfer of cholesterol from macrophages.¹¹⁵ Hp is also known to have antioxidant properties with variable efficacy to reduce oxidative stress and ROS and RNS formations. People with Hp 1-1 or Hp 1-2 have superiority over those with Hp 2-2 in blocking the production of ROS- or RNS-mediated free Hb. 108, 110

Three randomized controlled trials (RCTs) were conducted in 1829 diabetics with the Hp 2-2 genotype and 3135 diabetics with Hp 1-1 or Hp 2-1 genotypes to observe the role of vitamin E in reducing cardiovascular risk in these patients. These 3 trials are the Women's Health Study (WHS), the Heart Outcomes Prevention Evaluation (HOPE), and the ICARE study, which was a subset of other RCT studies. ¹¹⁶⁻¹¹⁹ In these three RCTs, blood samples for Hp polymorphism were analyzed. The studies showed that people with Hp 2-2 had a significantly higher incidence of experiencing

non-fatal MI, stroke, or cardiovascular death than non-Hp 2-2 individuals. The odds ratio (OR) is 2.03 (95% confident interval (CI), 1.46 to 2.81), which signifies a harmful effect from the Hp 2-2 genotype. The results from HOPE and ICARE also showed that vitamin E supplementation at 400 IU daily for about 4.5 years (HOPE) or about 1.5 years (ICARE) significantly reduced composite CVD outcomes (total mortality, CVD mortality, non-fatal MI, and stroke) in Hp 2-2 diabetics (95% CI, 0.4 to 0.86), but vitamin E had no effect in Hp 1-1 or Hp 1-2 diabetics. In the WHS study, vitamin E supplementation at 600 IU daily caused a 15% reduction in composite CVD outcomes in Hp 2-2 diabetics, while it caused a 20-25% increase in composite CVD outcomes in non-Hp 2-2 diabetics. Vitamin E appears to provide substantial cardiovascular benefits in Hp 2-2 diabetics, while it appears to promote CVD events in Hp 2-1 diabetics.

A simulation study was conducted by the Kaiser Permanente Northwest Region Health System using data from 8632 members age 55 and older with type II DM. Special software was used to predict the clinical events of these patients over a period of 50 years.¹²⁰ This simulated model showed Hp 2-2 non-diabetics that were given vitamin E supplementation would add 1.09 life-years/person and 0.89 qualityadjusted life-years/person as compared to 3.94 life-years/person and 2.49 qualityadjusted life-years/person for diabetics with Hp 2-2. 120 Per 1000 Hp 2-2 individuals, treatment with vitamin E supplementation for over 50 years would theoretically prevent 75 MI events, 31 cardiac surgery procedures, and 19 percutaneous cardiac interventions. 120 Although this simulated pharmacogenomics study used computerized data, this study provides strong evidence that vitamin E provides significant clinical benefits for Hp 2-2 diabetics. At this time, an Hp kit is not commercially available for pharmacogenomic typing; however, this simple and inexpensive method might be a useful tool in the near future to detect different genotypes and identify how different treatments affect the outcomes of diseases. About 36% of the Hp 2-2 genotype population might benefit from vitamin E supplementation.120

Conclusion

Vitamin E is a lipid-soluble antioxidant that was first discovered in 1922. There is still much information that we do not know that needs further investigation. In

the 90 years since its discovery, research has focused on understanding the different properties of this vitamin as an antioxidant and scavenger of harmful free radicals, and in signal transduction and gene expression. We now know more about vitamin E and its role in neurological diseases such as AVED, abetalipoproteinemia, celiac and other malabsorptive diseases. We also understand how impairment in liver transfer genes affects how vitamin E is absorbed, transported and metabolized. Additionally, although the 2000 RDA and EAR for infants, children, adults, and pregnant and lactating women have been established, some studies showed that lower RDA requirements might be sufficient for maintaining health. Therefore, further study is needed to answer this inconsistency.

Results from some clinical trials have proven to be both disappointing and promising. It is speculated that different people might utilize vitamin E differently depending on age, sex, populations, race, and disease states. However, vitamin E supplementation provides significant clinical benefits in Hp 2-2 diabetics.

Additionally, further research is needed to find biochemical and genetic markers for vitamin E to determine what subsets of the population will benefit from taking this inexpensive and safe supplementation.

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Does Modern Science Communicate Purpose?

Jimmy H. Davis

I his paper is an amplification of presentations given at the 2012 Christianity in the Academy meeting and the 2012 American Scientific Affiliation meeting. For the last decade and a half, I have had the blessing of being able to work with Hal Poe, Colson Professor of Faith and Culture at Union. Our collaboration on questions at the interface of science and faith has resulted in the production of four books, one of which has been translated into Romanian. This paper is an elaboration on ideas presented in our latest book *God and the Cosmos* published by InterVarsity Press.¹

The interface between science and faith is an interesting place. Francis Bacon (1561–1626), the English philosopher and pioneer in the scientific revolution, urged study and proficiency in "the two books of God," "the book of God's word, or in the book of God's works; divinity or philosophy: …let men endeavour an endless progress or proficience in both...." During the Patristic Period, Augustine of Hippo (354–430) expressed the view that all truth is God's truth when he stated, "…let every good and true Christian understand that wherever truth may be found, it belongs to his Master...." Purpose is a topic in both the book of God's word and the book of God's work. Yet, there seems to be, in some areas, more dissonance than consonance between the "truth" of science and the "truth" of faith.

Purpose is one of those areas where Christian faith and modern science seem to have no common ground. On the one hand, Biblical writers and orthodox theologians through the ages would agree with the theologian Millard Erickson (1932–) when he states the following:

...there is the Christian doctrine of the divine plan, which affirms that an all-wise, all-powerful, good God has from all eternity planned what is to occur and that history is carrying out his intention. There is a definite goal toward which history is progressing. History, then, is not moved by chance happenings, impersonal atoms, or blind fate.⁴

On the other hand, *purpose*, *plan*, and *direction* are words that seem to appear in modern science only when we are being told that *purpose*, *plan*, and *direction* do not exist in modern science, whether the natural or biological sciences. Is there any way to reconcile the two books of God in regard to purpose?

This paper applies the philosopher William Hasker's faith-discipline integration model to investigate whether modern science allows room for purpose.⁵ Hasker presents his model of faith-discipline integration as follows:

[a] systematic mapping...of the general ways in which the world-view issues connect with the particular concerns of various disciplines....Integration is concerned with integral relationships between faith and knowledge, the relationships which inherently exist between the content of the faith and the subject-matter of this or that discipline, such connections do not have to be invented or manufactured.⁶

Hasker's model employs four major dimensions of integration:

- [1] World-view Foundations;
- [2] Disciplinary Foundations;
- [3] Disciplinary Practice;
- [4] World-View Contribution.

In my application of Hasker's model, all four points will be considered, but the major focus of this paper will be on the third point, Disciplinary Practice.

1. World-view Foundations: What Christian world-view insights are relevant to the discipline? In our current discussion of purpose, some key points from the Christian world-view would be the doctrines of creation, providence, and eschatology. From the creeds and from systematic theology, one has the metanarrative of God as Creator who prepared and sustains this world for

humans. The history of this world will end in the triumphant return of Christ as King of Kings and Lord of Lords.

2. Disciplinary Foundations: What are the foundational assumptions—methodological, epistemological, and ontological—of the discipline, and are any of these assumptions problematic from the standpoint of the Christian faith? Scientific assumptions in regard to purpose include that the universe is orderly and understandable; that modern science assumes that all physical events have physical causes. In order to find these causes, modern science breaks the event down into parts and looks for some mechanism (pattern of connections) that gives rise to the event being studied. Modern science explains natural phenomena in terms of natural causes and does not invoke supernatural intervention. This approach to understanding nature is called methodological naturalism.

This emphasis on the common course of nature and on the regularity of the laws of nature put Western scientific thought on a path that led some thinkers to position God as an absentee first cause (deism), to have no need for God in the explanation (methodological naturalism), or to conclude that there is no God (ontological naturalism). The emphasis on contingency and necessity (laws) in relating the parts of the metanarratives results in scientific views that range from no evidence of purpose in nature to no purpose at all.

3. Disciplinary Practice: What scientific issues or statements cause concern to Christians? And how do the scientific answers to questions at the interface of science and faith square with the Christian faith?

Applying methodological naturalism to the history of the universe results in the following metanarrative: about 13.7 billion years ago, there was the simultaneous appearance of space and time—an infinitely small and infinitely hot universe—commonly called the Big Bang. As the universe expanded and cooled, the following stages of matter occurred: quarks and leptons, protons and neutrons, nuclei, atoms, first-generation stars, galaxies, second-generation stars, planets, and life. Beginning about 10 billion years after the Big Bang, the metanarrative of life includes cells, multicellular organisms, fish, plants, reptiles, dinosaurs, birds, mammals, and humans.

What is the scientific metanarrative saying to theologians? In this paper, I will use the term *consonance* to signal areas of accord or harmony between

the scientific understanding of nature and the theological understanding of God's creation. There is consonance between the beginning of the universe and the doctrine of creation.⁷ There also appears to be a consonance between the scientific metanarrative ending with humans and the Christian doctrine of humans made in the image of God.

There is also dissonance between the origin metanarratives. As discussed in the Disciplinary Foundations section, the scientific emphasis on contingency and necessity has caused some leading scientists to conclude that there is no purpose. Is there any opening for common ground?

A brief examination of some of the views of well-known scientists from the physical sciences documents this dissonance. In 1979, the American theoretical physicist Steven Weinberg (1933–) won the Nobel Prize in Physics for his work on the unification of the weak force and the electromagnetic force. In his 1977 book, *The First Three Minutes: A Modern View of the Origin of the Universe*, he presents the metanarrative from the Big Bang to three minutes after the Big Bang. In his conclusion to the book, Weinberg states:

It is almost irresistible for humans to believe that we have some special relationship to the universe, that human life is not just a more-or-less farcical outcome of a chain of accidents reaching back to the first three minutes, but that we were somehow built in from the beginning....It is very hard to realize that this all [the beautiful Earth] is just a tiny part of an overwhelmingly hostile universe. It is even harder to realize that this present universe has evolved from an unspeakably unfamiliar early condition, and faces a future extinction of endless cold or intolerable heat. The more the universe seems comprehensible, the more it seems pointless.⁸

In their book, *Origins: The Lives and Worlds of Modern Cosmologists* (1990), Alan Lightnam and Roberta Brawer interviewed twenty-seven leading astronomers; among their questions they asked if the astronomer agreed with the Weinberg conclusion that the universe is completely pointless. A typical answer is that of the astronomer Sandra Faber (1944–) when she replied:

Why is the earth the way it is? I don't believe the earth was created for people. It was a planet created by natural processes, and, as part of the further continuation of those natural processes, life and intelligent life appeared. In exactly the same way, I think the universe was created out of some natural process, and our appearance in it was a totally

natural result of physical laws in our particular portion of it — or what we call our universe....is there some motive power that has a purpose beyond human existence? I don't believe in that. So I guess ultimately, I agree with Weinberg that it's completely pointless from a human perspective.⁹

Although physicists such as Weinberg and Faber conclude that there is no evidence of purpose, certain apparent fine-tunings in astronomological constants imply purpose to others. The British cosomologist, astrophysicist, and Astronomer Royal Martin Rees, Baron Rees of Ludlow, (1942–) has proposed that there are only six fine-tuned numbers: 10

- N = ratio of the strengths of electromagnetic force to that of gravity;
- Epsilon (ε) = strength of the force binding nucleons into nuclei;
- Omega (ω) = relative importance of gravity and expansion energy in the Universe;
- Lambda (λ) = cosmological constant;
- Q = ratio of the gravitational energy required to pull a large galaxy apart to the energy equivalent of its mass;
- D = number of spatial dimensions in spacetime.

These observations arise out of a purely methodological naturalistic approach to the Big Bang model and not from a God-of-the-gaps argument. It appears that, if several astronomological constants are not fine-tuned, then the life span of the universe would not be long enough for life to appear (10 billion years). Furthermore, without this fine-tuning, the right ingredients for life to appear would not be present in the universe; these ingredients are thought to be the twenty-five elements found in humans.¹¹ As English physicist, cosmologist, and astrobiologist Paul Davies (1946–) states:

Scientists are slowly waking up to an inconvenient truth—the universe looks suspiciously like a fix. The issue concerns the very laws of nature themselves. For 40 years, physicists and cosmologists have been quietly collecting examples of all too convenient "coincidences" and special features in the underlying laws of the universe that seem to be necessary in order for life, and hence conscious beings, to exist. Change any one of them and the consequences would be lethal. Fred Hoyle, the distinguished cosmologist, once said it was as if "a super-intellect has monkeyed with physics." To see the problem, imagine playing God with the cosmos. Before you is a designer machine that lets you tinker with the basics of physics. Twiddle this knob and you make all electrons

a bit lighter, twiddle that one and you make gravity a bit stronger, and so on. It happens that you need to set thirty something knobs to fully describe the world about us. The crucial point is that some of those metaphorical knobs must be tuned very precisely, or the universe would be sterile.^{12,13}

As Davies states, "Like Baby Bear's porridge in the story of Goldilocks, the universe seems to be just right for life. So what's going on?" ¹⁴

To be fair to Davies, Hoyle, and Rees, they all propose physical solutions for the fine-tuning. The focus of this paper is not to discuss the merits of their arguments, but rather to determine if the findings of the modern physical sciences leave room for discussion of purpose. To me and others, this fine-tuning does provide a common ground for a discussion between science and theology of purpose in nature.

Although the physical sciences provide a common ground with theology in regard to purpose through fine-tuning arguments, evolutionary biology seems to throw cold water on this common ground by denying purpose in the story of life. A brief examination of some views from well-known scientists from the biological sciences reveals dissonance between the scientific and religious metanarratives. The American scientist George Gayland Simpson (1902–1984) was one of the most influential paleontologists of the twentieth century and a major participant in the modern evolutionary synthesis. In his book, *The Meaning of Evolution:* A Study of the History of Life and of Its Significance for Man (1949), he states:

Man is the result of a purposeless and materialistic process that did not have him in mind. He was not planned. He is a state of matter, a form of life, a sort of animal, and a species of the Order Primates, akin nearly or remotely to all of life and indeed to all that is material. ¹⁵

The British evolutionary biologist Richard Dawkins (1941–) served from 1995 to 2008 as Oxford University's Professor for Public Understanding of Science. What kind of "public understanding" did Dawkins promote? A book published at the beginning of his professorship was *River Out of Eden: A Darwinian View of Life* (1996) where he states, "The universe we observe has precisely the properties we should expect if there is, at bottom, no design, no purpose, no evil and no good, nothing but blind, pitiless indifference." ¹⁶

The American paleontologist Stephen Jay Gould (1941-2002) was one of the most widely read popularizers of modern science through his *Natural History*

articles and books. In *Wonderful Life* (1989) he used the Cambrian Burgess Shale fossils to popularize the idea that the story of life had no purpose because of contingency in the evolutionary processes. The Burgess Shale contains fossil remains of what is called the Cambrian explosion, the relatively rapid appearance of most major phyla (body types) around 540 million years ago. The modern understanding of these fossils comes from work in the later part of the twentieth century by the British geologist Harry Whittington (1916–2010) along with graduate students Derek Briggs and Simon Conway Morris. Gould relied on and acknowledged the British team's work. Gould's theme was as follows:

If we could perform the great undoable thought experiment of 'rewinding the tape of life' back to the Cambrian and 'distributing the lottery tickets' at random a second time, the history of animals would follow an entirely different but equally 'sensible' course that would almost surely not generate a humanoid creature with self-conscious intelligence.¹⁷

But further study of the fossil record, again using a methodological naturalistic approach, now questions Gould's conclusions. As the British paleontologist Conway Morris (1951—) continued to study the Burgess Shale fossils as well as similar fossils found in Greenland and China, he changed his interpretation of the implications of these fossils in regard to purpose or direction in evolution, which he expressed in his book *The Crucible of Creation: The Burgess Shale and the Rise of Animals* (1998). This work was followed by *Life's Solution: Inevitable Humans in a Lonely Universe* (2003) and *The Deep Structure of Biology: Is Convergence Sufficiently Ubiquitous to Give a Directional Signal?* (edited 2008). In all these works, he has challenged Gould's idea that contingency played such an important role in evolution.

Convergence is the biological concept that Conway Morris proposes as evidence of a constraint on the unfolding of evolution—"replaying the tape" would result in similar lineages and properties evolving again. Convergence in evolution refers to organisms acquiring similar biological traits (wings, consciousness) in unrelated lineages. Convergent traits are called analogous structures in contrast to homologous structures, which have a common origin. Bat, bird, and pterosaur wings are considered analogous structures (convergence) while the wing of the bat, the leg of the horse, and the hand of man are considered homologous structures. Conway Morris states:

Similar environmental selection pressures, acting on differing anatomies, can create convergent or parallel adaptations....Given certain environmental forces, life will shape itself to adapt. History is constrained, and not all things are possible....perhaps there is a course and a direction to evolution that would be achieved despite diverse anatomical starting points.¹⁸

Other scientists are exploring whether there are laws or tendencies in evolution that give it a predictive power. In 2010, the NASA Astrobiology Institute hosted the workshop, "Molecular Paleontology and Resurrection: Rewinding the Tape of Life," which addressed this question.

The American evolutionary biologist Lynn J. Rothschild (1957–) of NASA Ames Research Center and Stanford University proposed that there are likely universal biological patterns based on the following observations:

- The likelihood of life being based on organic carbon because of the prevalence of organic carbon in comets, meteorites, and interstellar medium;
- The likelihood of water as a solvent because of widespread occurrence and chemical properties of water;
- The universality of the laws of chemistry and physics;
- The universality of the principle of natural selection;
- The selective tyranny of the environment;
- The likelihood of the availability of solar radiation as a source of energy;
- The observations of convergence at both molecular and organism level.¹⁹

Using these principles and a methodological naturalistic approach, Rothschild demonstrated why she thinks that photosynthesis is a predictive property in the history of life. In another presentation, the evolutionary biologist Stephen J. Freeland of the NASA Astrobiology Institute at the University of Hawaii presented evidence that the 20 amino acids found in living systems are the result of chemical and physical constraints rather than random chance.²⁰

The overall theme of the workshop was, as Rothschild concludes, "This amalgam creates a surprising amount of predictive power in the broad outline.... there are certain tendencies, if not 'laws', that provide the predictive power."²¹ Does everyone agree that evolution is predictable based on physical, chemical, and biological principles rather than being contingent or a product of the quirks

of history? As Rothschild stated in her presentation, "Some yes, some no."

Have these thoughts on convergence returned purpose to biology? The American theologian John F. Haught states, "...I proposed that any process that is bringing into actuality what is undeniably valuable is purposeful."²² By this definition, one could argue that Conway Morris has indeed returned purpose to biology. Similar to the work with fine-tuning, the latest biological research has revealed a common ground on which to discuss purpose.

4. World-view Contribution: "What specific contribution does the discipline make to the Christian vision of reality?...In short, what difference does the discipline make for Christians who are not its students and practitioners?... This last dimension, world-view contribution, is the one which has been least emphasized in the literature on faith-learning integration...." In considering the contribution that science might make to the Christian vision of reality, one has to be careful not to base one's theology on the latest science but rather to base one's theology on the book of the word. For example, the Galileo events reveal how damaging accepting prevailing views of science as proof of one's theology can be. A better path is considering areas of consonance and dissonance between science and theology.

From all the previous discussions, some contributions that science can make to the Christian vision of reality include:

- The universe had a beginning. Here there is consonance between the latest theory of science and the doctrines of the church. However, one should never forget that before 1927, the accepted scientific theory, for millennia, was that the universe was static and eternal. ²⁴ Also, one needs to keep in mind that there is dissonance between the Big Bang model's heat death of the universe and Christian eschatology.
- The unfolding of physical and biological entities. There is consonance between this idea and the statements in Genesis about the Earth bringing forth living creatures.²⁵
- Purpose and direction are reflected in methodological naturalistic findings. To me this is a very exciting area of science. A common ground seems to have opened for dialogue between scientists and theologians about purpose whether in the physical or biological realm.

The article by Hasker provided a productive model for organizing my thoughts in regard to the faith-disciple integration issue of purpose. His four areas (World-view Foundations, Disciplinary Foundations, Disciplinary Practice, and World-view Contribution) have allowed me to conclude that purpose is not excluded by modern science. Hasker's model has also allowed me to focus on the primary issues of science and faith, and not get sidetracked by secondary and tertiary issues. Regarding primary theological issues—purpose in history—it is refreshing to discover that there is consonance between science and faith. Finally, we probably need humility more than technical expertise as we continue to explore this important issue.

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Excerpts from "Art and Faith"

Lee Benson

On my Back Porch

Yesterday while I was studying, my wife brought me a beautiful pink rose from our garden. She had placed it in a simple, hand-made clay cup that had been wood-fired. This morning while studying, I happened to glance at the rose, and its beauty captivated me completely. I examined it as a young lover would examine the body of his beloved. At that moment, a twinge of despair blew gently against my heart, and I knew with full reality that neither I nor any human could ever truly create a work of art. In a small rosebud is the declaration of the cosmos that real art is the realm of the Divine, that God will allow no man to venture there.

I just saw a rose of Sharon bloom fall to the ground. I wonder if in the reality of God, heaven, and the angels, a great tragedy has occurred much like a tourist breaking the finger off an old Greek statue, but more sincere.

From the Smoky Mountains

Nature brings humans to God. It seems to have this mystical, transporting quality that enables passage from the cerebral to the Transcendent, from the earthly to the Divine. Maybe that was the purpose of Eden: a continual conduit to God, a natural bridge for flesh to stroll hand in hand with Divinity. It is not such a great stretch to believe that if man were capable of communing with God, then an appropriate environment would have to be created where both parties could peacefully coexist.

There is great meaning in the existence of surprise lilies and even more in their fragrance—an aroma that rivals even Chanel's *CoCo Mademoiselle*. However, the startling comes when one sits quietly and considers who could have, even in 4.2 billion years, thought up this minor speck of the universe.

It is always the conceiving of art that is the most challenging.

The Stability of the Solar System

Bill Nettles

Canaveral, FL (NASA, 2013). When the final rocket of the launch assembly finished firing, the satellite had a launch speed greater than any other man-launched spacecraft. About one year later, in February 2007, it passed by the largest planet in our solar system, Jupiter, a distance of about 5 Astronomical Units (AU) from the Sun. Its destination is Pluto, the former ninth planet, now classified as a dwarf planet. It is expected to arrive in July 2015, nine and a half years after its launch, at a distance of more than 39 AU from the Sun. In the fall of 2011, it passed the orbit of Uranus. At that position it took about 3 hours for a control signal from Earth to reach *New Horizons*. When it reaches Pluto, it will take about 5 hours for that signal to make the trip. For a variety of reasons, some of which I hope to address, *New Horizons* will only have one fly-by of Pluto and its moons, rather than going into orbit.

This situation raises a few questions that play off of each other. First, how can we be so confident that the satellite will reach its destination and will get there when we expect it to (and why does it take so long to get there)? Second, if we know enough to be confident, why can't we orbit Pluto? The simple answer to each is the same: gravity. The longer answers are a fascinating, centuries-long story.

Observing the Heavens

People have gazed at the sky ever since humanity was created (Hayden & Villeneuve, 2011). The changing regularity of the motion of the Sun, the Moon, and the patterns of stars has fascinated mankind for centuries. When something such as a comet dared to upset the regular patterns, doom and disaster were expected. Even as late as the twentieth century, some people ascribed doomsday predictions to comets and eclipses (Flaste, Noble, Sullivan, & Wilford, 1985). These seeming interjections, however, are explained by the same rules that govern the regular motions of the sky.

In watching the sky, early mankind soon discovered that, while the Sun makes a routine appearance and warms the land, the location of the Sun and its duration in the sky changes a little bit every day. The people who studied the skies also discovered a lightly changing background of stars each night. After watching these patterns, they found the appearance cycle of the Sun and the stars began to repeat. They noticed that the time from sunrise until the Sun was at its highest point varied from long (in the warm season) to short (in the cool season), but the time from noon to noon changed very little, if at all.

Soon, monuments such as Stonehenge in England (Hawkins, 1965) were built which would mark the days that had the longest daylight (and highest elevation noontime Sun), shortest daylight (and lowest elevation noontime Sun), and equal daylight and nighttime (equinoxes). The longest and shortest daylight days were called solstices because that was when the noon Sun (Sol) "stopped" getting higher or lower in its cycle. Observers noticed that the patterns of stars that appeared at night repeated their cycle based on these solstices and equinoxes with a period of about 360 days. We call this cycle a "year."

The other obvious pattern-maker in the sky, the Moon, did not follow the equinox/solstice pattern, but performed its own regular dance across the sky, changing shape each night. It rose at a different time compared to the Sun every day` but would repeat its pattern of rising (and setting) every 29 to 30 days. The Moon's shape progressed from a mere sliver close to the Sun, but rose (and set) later than the Sun each day. It grew to a full circle of light on the opposite side of the sky from the Sun and then began shrinking. It would begin rising so late that the Sun began to rise before the Moon set. Eventually, the Moon fell back into the Sun; then a "new" Moon would appear to repeat the pattern. Because of the mismatch of the Sun's and

Moon's cycles, sometimes there would be 12 full moons in a year. Other times 13 would occur.

As the regularity of the Sun and the Moon were determined and coordinated with warm and cold seasons, crop planting, and harvesting times, societies developed calendars to remind themselves of upcoming weather patterns and the proper actions which were needed to stay alive. Some chose to gauge the calendars by the Sun's cycle through the stars (also called the "Zodiac") and others, the Moon. Some civilizations created mixed calendars (called solunar calendars) that accounted for the patterns of both but adjusted to synchronize them every few years (Jobes & Jobes, 1964).

Adding to this pattern of patterns were five stars that wandered around among the fixed stars along the Zodiacal path. The Greeks called these *planētēs astēr*, or wandering stars, and today we call them planets. These had their own motions, unrelated to the cycles of each other, the fixed stars, the Moon, and the Sun. On the other hand, they did have regular patterns and behaviors of their own. We now call these planets by the names Mercury, Venus, Mars, Jupiter, and Saturn. The planets are named after mythological deities because many civilizations believed that astronomical objects were either the actual embodiment of a god or the direct representative of a god (Jobes & Jobes, 1964). The discoveries and observations of these planets are fascinating stories in themselves but are not pertinent to answering our questions.

From the point of view of a person standing on Earth and watching the sky, it makes sense that all these objects are moving around the Earth. More curious people asked, "Can we predict their movements?" Others, especially those who knew the patterns, asked the question, "Why do these things move as they do?" As mentioned before, clever monuments like Stonehenge and the Pyramids of Giza mark out the positions of the Sun at the equinoxes and solstices. Stonehenge is also said to have been used to calculate eclipse dates, which indicates an advanced understanding of the motions of the Sun and Moon. It also indicates that the builders of Stonehenge understood that eclipses were a part of the regularity of the solar system, not interjections by a displeased demi-god (Hawkins, 1965).

Modeling the Heavens

One of the strongest influences in Western culture regarding the order of things on Earth and in the sky was the philosopher Aristotle (384-322 BC). Aristotle believed that objects were composed of four primary elements: earth, water, air (or wind), and fire. Earth was the heaviest of the four, and fire was the lightest. In Aristotle's cosmology (structure of the universe), everything had its own place. Objects rose and fell because they were moving to their place. Heavier objects moved toward the center of the universe, and lighter objects away. Because objects fell "down," that direction was the center of the universe, so Earth just happened to be at the center (Danielson, 2001). The Sun, a fire, was naturally in the sky away from the center, as were stars. Water fell from the air yet remained above the Earth, and fires lit on Earth rose upwards through the air. Through this reasoning, most of the world was convinced that the Earth resided at the center of the universe, giving us the term "geocentric."

Aristotle and his followers held that mathematics was useful only as a descriptive tool after one reasoned the proper structure of things philosophically (Layzer, 1984). They scorned the concept that mathematics could provide any insight into structure or could provide any new information beyond the observations which had already been made.

Another group of Greek philosophers, led by Pythagoras (570-495 BC), held the opposite view regarding the usefulness of mathematics. They believed that mathematics, especially the study of harmonic relationships, could provide "deep insight" into the structure of the world. Pythagoras had already demonstrated the power of his method by analyzing the harmonic relationship between the lengths of strings and the pleasant sound of musical intervals played on the strings. Our musical scales in Western music find their basis in the work of Pythagoras (Layzer, 1984).

Coming out of this Pythagorean mathematical background, the Greek philosopher Aristarchus of Samos (310-230 BC) proposed that the Sun was at the center of the universe (no one at that time had any knowledge of such things as galaxies). He also proposed a system that placed the planets around the Sun in the correct order based on distance. Aristarchus also used some clever observational measurements to propose correctly that the Sun was much farther from Earth than was the Moon. Aristotle mentioned the work of Aristarchus to King Gelon when summarizing the

state of "science." Unfortunately, Aristarchus didn't have the influence that Aristotle had gained, and the appearance of the motions of heavenly bodies observed by the common man didn't agree with his assertion (Layzer, 1984).

Ptolemy

Several hundred years later, Claudius Ptolemy (90-168 AD), a Roman-Egyptian mathematician, astronomer, and philosopher, developed a calculational model for predicting the motions of the planets through the skies based on a geocentric universe (Longair, 2003). In developing this model, he utilized the work of both Babylonian and Greek astronomers, and his calculations were remarkably accurate for his time. The appearance of his model, however, was accepted along with Aristotelian thinking; this merely describes what we "know" to be true. There was no insight or reasoning to be gained from the mathematics.

With geocentrism firmly defended philosophically, observationally, and mathematically, the "can we predict" question and the actual structure seemed settled. Even the "why" question had an answer, although it was purely philosophical. Ptolemy's system used circular motion, and circular motion (along with straight-line motion) was considered a "natural" motion; i.e., it needed no cause or influence. Oddly, Ptolemy found it necessary to use circular orbits that rotated on other circles, and these larger ones had their centers offset from the Earth's center. The model wasn't "pure" from a philosophical viewpoint, but that aspect was ignored for the most part.

As Christianity spread, the Catholic Church began to take official positions on this question of cosmology and adopted the Aristotelian-Ptolemaic model. This seemed to have happened mainly by cultural absorption and because there was little, if any, contradiction with the Holy Scriptures. In the Bible, no passage definitively places the Earth physically at the center of the universe. The Catholic Church would eventually find isolated verses which could be quoted to support their stance should the need arise (Longair, 2003).

For almost fourteen hundred years, as far as we can tell historically, no one challenged the geocentric viewpoint. Ptolemy's model didn't make much difference in the lives of most people, but it worked for those interested in astronomy by predicting the seasons for farmers, helping to predict tides for sea merchants and

navies (based on the movement of the moon), and feeding the money bags of the astrologers.

Copernicus

Nicolaus Copernicus (1473-1543 AD) was a Polish mathematician, astronomer, and lawyer. He attended the University of Krakow where he studied, among other things, the writings of Pythagoras, Plato, and Aristotle and became intimately acquainted with Ptolemy's cosmology. He eventually became dissatisfied with the geocentric model and developed a Sun-centered model after the fashion of Aristarchus. It began as a private venture for him; he wanted to see if astronomical phenomena could be described with the heliocentric perspective of Aristarchus, starting with a rotating Earth orbiting the Sun, the other planets orbiting the Sun, and the Moon orbiting the Earth. He also believed, like the Pythagoreans, that mathematics was a tool that could provide insight into the harmony of the natural order (Longair, 2003).

He wanted his work to remain private, not wishing to be scorned by the public and the church (both Catholic and Protestant) for proposing such a radical cosmology. In 1536, however, Pope Clement II requested the publication of Copernicus's work as an alternative method for calculating the heavens (Longair, 2003). It was written in Latin, the academic language of the time, and published under the title *De revolutionibus orbium coelestium* (*On the Revolutions of the Celestial Spheres*) in 1543, the same year he died.

The model did not receive widespread acceptance for several reasons. First, it was just as cumbersome to use, and it provided no more accuracy than Ptolemy's model. More significantly, it didn't match everyday experience, and it conflicted with the official position of Christendom, which had been adapted from Aristotle (Danielson, 2001).

The Copernican model had some interesting features. All the planets still moved on natural, circular paths, but their speeds were considered to change as they moved around the Sun. The circular paths had their centers offset from the Sun. Copernicus gave no reason for their changing speeds. The Earth moved on a circular path at a constant speed.

Many people mistakenly state that Copernicus proved or discovered that the Sun was the center of the universe. Nothing could be further from the truth; he neither

discovered nor proved anything (Danielson, 2001). What Copernicus presented was a model of the known astronomical universe which has the Earth, planets, and stars moving around the Sun and the Moon moving around the Earth.

While not accepted, the Copernican model did start a movement among mathematicians, astronomers, and other scientists that emphasized collecting and analyzing data to build models (Layzer, 1984). Because of the work of Copernicus, basic philosophy took a back seat to investigation and mathematical analysis in describing the behavior of the physical world. Thus began the age of modern scientific investigation.

Don't get the impression that there were no experimentalists before the time of Copernicus. Archimedes (287-212 BC) was an avid experimentalist and gave us several principles of motion, fluid behavior, and engineering which are still used today. In fact, Archimedes gave inspiration to Galileo, who in turn influenced Newton.

Tycho Brahe and Kepler

For several decades, those who believed that the Copernican model provided a more accurate description of the universe remained silent. In the late sixteenth century, Danish astronomer Tycho Brahe (1546-1601 AD) proposed a modified geocentric model in which the Sun revolved around the earth and all other planets revolved around the Sun. (Longair, 2003).

Tycho, a firm believer in observational astronomy, petitioned the King of Denmark to develop the best astronomical observatory in Europe with Tycho himself as the chief astronomer. The King, wanting the best, agreed. Although this was before the time of astronomical telescopes, Tycho bought, built, and invented an impressive collection of observational instruments. With these he set about collecting years' worth of observational data on the planets and over one hundred stars. More to his credit than his exhaustive work ethic was his insistence on and talent for documenting the uncertainties of his measurements. As a result, the data he gathered charted the positions of the planets with an uncertainty ten times smaller than any previous observations (Longair, 2003). With this data, he hoped to prove his Tychonian model superior to either Ptolemy's or Copernicus's models in its ability to calculate the motions of heavenly objects.

Tycho made other ground breaking observations. He observed an exploding star—a supernova—and determined by parallax measurements that it was well beyond the orbital distance of any planet. This disturbed the Aristotelian and Platonic notion that the heavens were static and perfect. He also observed comets and demonstrated that they were positioned well beyond the atmosphere, also in contradiction to Aristotelian thought.

Tycho recognized that his talent was with instrumentation and observation, not calculation. Needing a mathematician to analyze and systematize his data, he hired the best mathematician he could find, a young Copernican by the name of Johannes Kepler (1571-1630).

Kepler, like the Pythagorean philosophers, had been enamored with the idea of harmonies in mathematics and envisioned the spacing of the planets to reflect a harmonic structure around the Sun. He had developed a system in which the planetary orbits were nested at distances described by the Platonic solids. This model had been published throughout Europe in a book, The Cosmographic Mystery. It was this book that motivated Tycho to seek out Kepler.

Given the chance to test his own theories of the planets with the excellent data provided by Tycho, Kepler took the job. His first task was to analyze the positional data of Mars and present it as a defense of the Tychonian model. The Mars data was chosen because it was universally recognized by astronomers that the Ptolemaic and Copernican models were both notoriously wrong in describing the motion of Mars, and more providentially, the Mars data was what Tycho's assistant was working on when Kepler joined the team. Had Kepler begun with data from Jupiter or Venus, he might not have been directed to the discoveries he made (Longair, 2003).

Kepler was tenacious in his work and honest in reporting his results. When he first compared the Mars data with both of the prevailing models and demonstrated that neither was satisfactory, he showed that he was not afraid to report results that proved his initial assumptions incorrect. Shortly after Kepler began working with the Tychonian model, Tycho passed away. Before these events, Tycho had moved his observatory from Denmark to Prague (now in the Czech Republic). Upon Tycho's death, the Emperor Rudolph II commissioned Kepler to become his official astrologer, advising the Emperor and his court in their decisions. The adult Kepler did not believe in the influence of planets and stars in the affairs of men but did

recognize the value of a job, so he accepted the position. This opportunity also gave him time to work on Tycho's data. When Kepler couldn't match the data to the Tychonian model, he returned quickly to the Copernican model with one immediate modification: he shifted the centers of the orbits of Earth and Mars to the center of the Sun, not to an offset point. While this modification improved the agreement of the model to the data, it was still not accurate.

Kepler quickly realized that circular orbits for the Earth and Mars could not be consistent with Tycho's data. Because circular motion had been the assumption for millennia, Kepler had no historical precedent for other paths. He was reduced to making educated guesses about the possible shape of an orbit around the Sun and about the location of the Sun inside that orbit.

Kepler Works Out the Details

Kepler's scientific attitudes were rooted in Pythagorean ideas and Platonic philosophy and geometry. While working in the midst of Roman Catholics, Kepler mixed his Protestant Christianity with Pythagorean science. He was convinced that the universe was created by God—specifically Yahweh of the Bible—that it was maintained by Him, and that, as King David wrote in Psalm 19:1, "The heavens declare the glory of God" (ESV). Kepler believed that God created the universe with harmonic relationships, an overlay of his Pythagorean thinking onto his faith in Biblical revelation. Kepler often wrote of theology, and he wanted to become a seminary theologian but eventually realized that would not happen. Much to his credit, he realized that honoring God was not dependent upon becoming a professional theologian. He wrote to one of his early teachers, Michael Maestlin, "For a long time I was restless. Now, however, behold how through my effort God is being celebrated in astronomy" (Kepler, *Johannes Kepler Gesammelte Werke*, 1596). Kepler ultimately wanted, as Max Casper puts it, "to think the thoughts of God over again" (Casper, 1959).

It turned out that Tycho's data did not support Kepler's original harmonic, Platonic-solid model, and he was greatly disappointed. However, he did not abandon the ideas of mathematical harmony and physical causation. Kepler was convinced that the Sun and the planets interacted in a regular, predictable, and discoverable way; he simply did not know how to mathematically describe the interaction. He was

also wise enough to realize that he needed to abandon his original perspectives and to investigate other possible harmonies.

One of the harmonies of uniform circular motion which could be preserved with non-circular paths was the idea of constant areal velocity. To understand this, consider first uniform circular motion: a circular path at constant speed. If one draws a line from the geometrical center of the circle to the object, that line will "sweep" a certain area in a fixed amount of time. No matter where the object is on the path, the same amount of area will be swept in that same amount of time. Next, consider how one could have constant areal velocity in a circular path if the line is drawn from a hypothetical point not in the center, called the "nexus". The speed of the object would have to be faster when closer to the nexus and slower when farther from the nexus. Kepler knew from his data that Mars moved faster when closer to the Sun and slower when farther away. While a circular orbit might be possible, having the Sun at its center was not. One could imagine other non-circular paths with a differing nexus while attempting to conserve areal velocity. Kepler chose to use constant areal velocity as his guiding principle without any precedent for doing so, and he would use this flash of genius to "think God's thoughts after Him" (Longair, 2003).

Because he did not have a mathematical description of the interaction of a planet with the Sun (although he believed this was the main interaction that produced the orbit), Kepler was left with choosing various orbital shapes and Sun locations inside these orbits and attempting to fit the Mars data to these choices. Kepler made several other crucial choices: (1) the Sun is at the nexus of the orbit for each planet, (2) each planet's orbit describes a plane, (3) these orbital planes can be different, and (4) the areal velocities of each planet can be different from each other. Making assumptions like these was essential because mathematically matching the Mars data taken by Tycho not only depended on Mars's motion, but Earth's motion.

The details of Kepler's analyses and attempts are beyond the scope of our story, but they can provide some fascinating insight into the genius and persistence of this devout man. Let me encourage you to read more about him.

Kepler repeatedly developed and analyzed the data until he realized his choice was either wrong or promising. He was very systematic in his approach, not wanting to miss the answer due to neglect on his part. After almost two decades of analyses, he began using an elliptical orbit with the Sun at its geometrical center. This orbit quickly failed because it presented two far points (aphelion) and near points (perihelion) per orbit, and the data was dramatically misfit. The next logical Sun location was the geometrical focus of the ellipse.

An ellipse, by definition, has two points—focuses—that are symmetrically offcenter. The sum of the lengths of lines drawn from a point on the ellipse to each focus is constant no matter where on the ellipse that point lies. This sum is also equal to the major length of the ellipse; therefore, the focus is as geometrically important as the symmetry center. Kepler, as a Pythagorean, strongly appreciated this.

When Kepler placed the Sun at the focus of the elliptical paths for both Earth and Mars, the Mars data matched the ellipse with remarkable precision. Kepler successfully applied his new model to the data for other planets. His willingness to assume constant areal velocity had been vindicated. The result of his work on the Mars orbit was published in a book: *Astronomia Nova (New Astronomy)*. Curiously, his initial assumption is often referred to as Kepler's Second Law; a better name would be the Law of Areas. For some reason, the Law of Ellipses is numbered as his First Law, although it was the penultimate conclusion of the assumption of the Law of Areas. Kepler related the orbital periods of the planets to the sizes of the orbits and discovered his harmonic lagniappe: "The squares of the orbital periods are proportional to the cubes of the orbital semidiameters [semi-major axes]." This, appropriately, is called Kepler's Harmonic Law or Kepler's Third Law and is the gold medal of his quest for cosmic harmony.

In this work, Kepler developed a superior model of the observable physical universe, and it was Copernican in philosophy, if not mathematics. While one might wish to argue that the Earth was the center of the universe, the simplicity, harmony, and symmetry of the motions of the planets in Kepler's description provided overwhelming evidence that the Earth was not the center of the physical universe. Whether the Earth was the center spiritually or metaphysically was a different question. Some viewed the Earth's newly discovered position as being "exalted" while others viewed it as being a "demotion." In the physical world, nothing had changed (Danielson, 2001).

Galileo and Kepler

About the same time that Kepler was working out the planetary orbits, an Italian scientist, Galileo Galilei (1564-1642), was taking the Dutch-invented telescope and turning it toward the stars. Galileo was a proponent of Archimedean science insofar as he believed that mathematical laws could be developed to describe physical behavior (in particular, motion) and that observation should be used to test the validity of the mathematical laws. It was this principle of observation that motivated him to look upward. What he saw shocked him and the world: the planet Venus exhibiting phases and also objects moving around Jupiter, not the Earth (or the Sun) (Longair, 2003).

Galileo was probably Copernican before he ever looked at the skies, but his Archimedean leaning initially held him back from stating it publicly. When he saw the phases of Venus and their progression, he realized that these observations were impossible if the Sun and Venus moved around the Earth but were entirely possible if Venus and Earth moved around the Sun. In addition, the orbit of Venus had to be interior to Earth's orbit just as Copernicus proposed (and Kepler would confirm).

In observing the planet Jupiter, Galileo eventually saw four tiny points of light, like a string of pearls, changing position hourly in a plane near Jupiter. Careful observation brought him to the conclusion that these specks were moons which orbited Jupiter. This was the first observation of a heavenly body that did not appear to move around the Earth. His observations were so shocking that he was accused of placing fake images inside his telescope so that anyone looking through it would see the "lies" that Galileo was telling.

The information about these moons was communicated to Kepler, who undertook his own study of them. He built his own telescope, making several improvements to Galileo's design to improve the magnification and resolution of the device, and collected his own data on the movements of these lights. His analysis confirmed that their motion was consistent with his laws, especially the Law of Ellipses and the Harmonic Law, except that Jupiter was at the focus of their elliptical orbits. Whatever action produced the planetary orbits around the Sun was of the same nature as that which caused the orbits of Jupiter's moons.

Kepler was willing to speculate about the purpose of Jupiter's moons. In a response to Galileo's *Starry Messenger*, which first reported the moons to the world,

Kepler wrote: "The conclusion is quite clear. Our moon exists for us on Earth, not for the other globes. Those four little moons exist for Jupiter, not for us. Each planet in turn, together with its occupants, is served by its own satellites. From this line of reasoning we deduce with the highest degree of probability that Jupiter is inhabited" (Kepler, *Conversation with Galileo's Sidereal Messenger*, translated 1965). We have yet to confirm Kepler's conclusion. As of 2013, Earth is the only planet confirmed to have life.

Kepler's wild imagination, while producing some questionable ideas, was necessary for his success. We often underestimate the difficulties of the work he accomplished and rarely hear about his additional efforts in the field of optics.

His interaction with Galileo was not entirely congenial (although not combative). Galileo, while an avid experimentalist, was puzzled by Kepler's ellipses, and said so in his *Dialogues Concerning the Two Chief Systems of the World*: "It seems to me that one can reasonably conclude that for the maintenance of perfect order among the parts of the Universe, it is necessary to say that moveable bodies are moveable only circularly" (Galilei, 1632, translated 1953). It seems that even the great Galileo, champion of modern experimentation, had his own biases, for he had no evidence to support such a statement. In fact, Kepler's work shows it to be wrong.

Newton Completes the Picture

The next step in the journey to Pluto takes place in the English countryside during the days of the Black Plague. Isaac Newton, a well-respected philosopher of nature, had left the city to avoid exposure to the plague. Newton had already formulated his ideas that objects would move on straight paths unless some outside influence caused them to change direction, move faster, or move slower. He had also reasoned that circular motion required an influence (action) of some type. Today, we refer to this influence as a "force."

While on the family farm, quite possibly while sitting under a fruit tree (although it is not confirmed), Newton speculated that the force holding the moon to the Earth, causing it to move around the Earth rather than in a straight line, should be the same force which caused apples to fall to the ground. This imaginative thought caused him to spend a great deal of time doing mathematical calculations on the shapes of paths that different mathematical descriptions of forces would produce. In the course of

doing this work, he developed what we know as calculus to help him manufacture his product: orbits.

It was in this work that he discovered that only an "inverse square" force would produce a repeating orbit, although he didn't publish the results at the time. He required prodding from a friend, Edmund Halley (Longair, 2003; Westfall, 1983). Halley was a recognized scientist who was interested in astronomy and comets. Knowing Newton's mathematical genius, Halley asked whether there was some action which could produce the elliptical orbits that Kepler had calculated. Newton replied positively, naming the "inverse square" force. Halley was astonished that he had never heard of this result, and over a series of years, persuaded Newton to publish his work on motion and gravity, *Philosophiae Naturalis Principia Mathematica* often simply referred to as Newton's *Principia*.

In the *Principia*, Newton gives mathematical basis to the reason why the orbits of planets and moons are elliptical. He also showed that this "inverse square" force would produce the behaviors described by Kepler's Law of Areas and Harmonic Law.

While Kepler's work showed how planets move around the Sun and how moons move around their planets, it could not predict how the planets would affect each other or how they affected comets. With Newton's marvelously simple force and his calculus (another form of calculus was developed simultaneously by Leibniz on the continent), everyone had the tools to calculate the gravitational influence of any object.

Making New Horizons Work

Now we can fast forward a few hundred years, for it's not until the twentieth century that we have been able to generate the large forces needed to push objects away from the gravity of Earth. Since Newton's day, we have had the knowledge to calculate how much force and energy is needed for this push. We have also been able to calculate which direction we needed to push objects in order for them to meet at a later time. The problems in actually making it happen were finding the proper fuels and being able to rapidly calculate the results of small changes. Improved chemistry, engineering, and the advent of electronic computers have solved these roadblocks.

In order to launch a payload to Pluto, a tremendous amount of energy is needed, even for a small satellite. In fact, we cannot presently (2013) give the satellite enough

energy during launch with the fuel systems we have; Jupiter is about as far as we can go without some other help. One might think "just build a larger rocket," but when you do that, you need more fuel to lift the fuel that you will burn later. There is a "break-even" point in the satellite-rocket fuel-distance calculation that determines how far you can go. To go past Jupiter, we need some help.

That help comes from "stealing" some energy from a planet by having the satellite fly past a planet when the planet is travelling in its orbit in the same direction that we wish the satellite to go. The gravitational pull of the planet gives a boost to the satellite, which provides the extra energy needed for its journey. We have also learned to use the gravity of a planet to reduce the energy of the satellite if it needs to be slowed down. We did this with a satellite called Messenger, which recently entered a semi-stable orbit around Mercury. However, the Sun's gravitational pull will eventually pull Messenger away from Mercury. While all these gravity games follow Newton's gravitational "inverse square" law, the rules require that we know with high precision the mass of a planet.

We can't take a planet and put it on a butcher's scale, but we can send a satellite up to orbit a planet. We can measure the period of motion and the elliptical parameters of the orbit and, from Kepler's and Newton's laws, calculate a precise mass. Of course, we need an estimate of the mass to get the satellite to begin to orbit, and we get this by estimating the volume and density of the planet. The lack of a precision mass measurement explains why we have sent several satellites to each of the nearby planets and the moon; we needed to measure the actual orbits of satellites before we could send something which would be able to land on a planet, execute a stable and predictable orbit, or receive a controlled gravity boost from a planet.

Now we are ready to answer the questions posed in the second paragraph of this article. Because of the work of the Pythagoreans, Tycho, Kepler, Galileo, and Newton, we know with great precision where Pluto (and all of the planets) will be in relation to the Sun and Earth many years from now (and where it was many years ago). We know this because we know how gravity affects the planets. We also believe, quite reasonably, that gravity will behave in a stable, predictable manner.

New Horizons will be the first satellite to have a close encounter with Pluto, so we don't have a good precision value for the mass of Pluto, but we do know that it is small (less than the mass of Mercury). Because the amount of energy needed to reach

Pluto is so large and Pluto's mass is so small, there is not enough gravitational force to slow New Horizons enough to allow it to orbit Pluto. We could have placed the satellite in an orbit to catch Pluto with a slower speed, but then it would have been several decades before it reached its destination. The close proximity fly-by of Pluto will give us pictures and planetary mass information that could be useful in future missions (NASA, 2013).

Einstein and the New Gravity

Understanding Newtonian gravity has allowed us to explore our nearby planets. In the early twentieth century, Albert Einstein reasoned and calculated that gravity had some finer aspects that Newton had not considered. Einstein's development of gravity showed that masses not only affected the paths of other masses, but also the measure of time near those masses. Einstein predicted mass could cause light to change direction, but the effect was so small that this could only be seen with current technology near large masses like stars and galaxies. He also predicted that the measurement of time would change as the strength of a gravitational field changed; this effect is an important part of the calculations used in the global positioning system (GPS). Without understanding this effect, GPS would not work.

Both Newtonian and Einsteinian calculations regarding gravity are used daily around the world to predict motions of satellites, planets, and galaxies with a precision and reliability that almost no other scientific theory has duplicated. We would be remiss, however, to assume that these are the final answers to predicting the future of the Universe. Their reliability depends on the One who created and sustains them. From a scientific viewpoint, we trust these calculations and use them as if they won't change. From a faith viewpoint, we understand that God will do what He determines, and we trust that He is good.

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A Collection of Poems

David Malone

My Clothes Wear Me

Only hours after I put them on, they begin to lose their structure, woof relaxing, warp growing loose. They shamble: even the heaviest starch can't restore their sharp creases. Soon, the constant friction renders them thin at the thighs; buttons drop off, roll unnoticed beneath beds or cars and lay hidden under dust mice or thick, iridescent oil. The ends of collars wear away, as do the edges of cuffs: when did we become so shabby? my clothes wonder. They find themselves, again and again, in arguments so familiar that even their most righteous words nauseate them; they stop in the middle of every other sentence, filled with longing, awaiting the arrival of a thought that will be perfect, clean and new.

Love Don't Waste No Time

a blues villanelle

Love don't waste no time on me my heart's as scalding as a napalm blast; I'm a bone-dry desert, I'm a raging sea.

The only wealth that I've amassed is in the women I've left and the cars I've crashed—love don't waste no time on me.

I'll answer all the questions that you didn't ask, blame you for all the pain I suffered in my past— I'm a poison desert, I'm a roiling sea.

I'll recuse myself from you like the west from the east; You think I'll bloom a prince but I'll remain a beast— Love don't waste no time on me.

My desire for you ain't built to last; I'll devour other women like I've ended a fast— I'm a burning desert, I'm a lightless sea.

You dream you'll smash the mold from which I'm cast, But your flesh on my flesh scrapes like a rasp— Love don't waste your time on me; I'm a corpse in the desert, I'm a fetid sea.

Why Couldn't Eleven?

The day after her eleventh birthday, your youngest daughter refuses to wake up. She hides beneath her covers, moaning. "I wish every day could be my birthday," she says. "My birthday is the only day when everybody treats me like I'm special."

That afternoon, your oldest daughter looks through the photo albums for pictures taken when she was eleven. "Eleven is the first time I remember feeling self-conscious about my body," she says. "I wore a skirt to school and spent the whole day pulling it down because I wanted to cover up my legs."

You remember your sixth grade classroom, gray December light rolling through the wall of windows, six or more classmates surrounding you, pointing out what was inadequate about your pants and shoes, your hair, the way you laughed. You spent years baffled, feeling as though you'd missed class the day the teachers spelled out how to talk and act and dress. How empty they must have felt, you try to think. Why couldn't eleven be communal and aloof, pure and prime, cool to the touch, silvery, disinterested, a number that stands beside itself yet is irreducible, with a scent like a ripe autumn fruit, filling the room as soon as the knife slides through its rind with freshness and light and the clean smell of wind? Instead, what lingers in the room is the smell of something once alive and small that crawled deep beneath an appliance and died, its liquefying flesh and loosening skin staining the room, the air and your nostrils dyed with its seeping, mammalian scent.

My Circle

Matt D. Lunsford

Knowledge. Shape.

O! To symmetry, geometry!

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Now I draw a shape,
beautiful—
my circle,
round, yet
ratio
diameter
perimeter
measure
numerical—
not at all rational!
True.

Circle is, circle does.
Can the infinite too, be bounded?
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2013 Winner of the Annual Pi Poetry Contest sponsored by the Society of Physics Students. Note: A Pi poem is a poem that is constructed of words of length equal to the digits of Pi. That is, the first word in the poem is 3 letters long, the second is one letter, the third is 4 letters, etc. The sound "O" as in "O, my love!" is the digit zero.

Expanse

Patricia L. Hamilton

Keep me as the pupil of the eye; hide me in the shadow of Thy wings. Psalm 17:8

1

66 Oh, the Valley," people used to say, eyebrows raised in a we-know-all-aboutthat arch. "Drink lots of caffeine and keep the radio cranked up."

True, the heat and unbroken miles of dashed white lines flying by could produce a hypnotic effect. But in my early days of teaching, I looked forward to leaving high-density Southern California behind after a taxing school year and crossing the Tehachapis into the San Joaquin Valley. As soon as I coasted down the last thousand feet of the Grapevine, my soul would relax, as if it had slipped out of a tightly laced corset and plopped down in a comfortable, old easy chair.

What the Central Valley provided was expanse. I could rocket through open space under a limitless blue sky. To the east the frozen peaks of the Sierras formed ragged scallops shaped like the imprint of a giant's bite. As I traveled north, a universe of pastureland gave way to vast tracts of cotton and alfalfa, then to a checkerboard of orchards and fields—almonds and kiwis, tomatoes and onions, corn and walnuts, nectarines and plums. Interspersed among them were lush vineyards, each one its own expanse.

For the last ninety miles to my parents' house, the blaze of light in the western hills would dream itself golden, the occasional stand of fragrant eucalyptus casting shadows across the highway. Dead-tired from long exertion, my soul gradually settled into a rhythm of deep, even, calming breaths.

All these years later, if I close my eyes, I can still summon up the landscape and the repose it offered.

2

In the expanse of sky, majestic, silver-edged clouds only Baroque painters would have the effrontery to imagine radiate an allegory of *shekinah* glory. As I amble along, I expect to be slain by such heavenly splendor. But the earth, solid and substantial, bears me up. The vineyard on my left—vines stretched out in a chorus line, arms entwined—is doubly rooted to the dark soil by trunks and stakes. The peach orchard on my right—dense and shady, aflutter with a battalion of fidgety birds—exhales a moist breath as I pass, the ripening fruit exuding a velvety perfume.

All around I see extension. The rutted and cracked road I walk is a silver ribbon flung toward that painterly sky. Up ahead, the sharp, straight furrows of newly plowed fields elongate in the rich bronze light. My shadow is twenty feet tall.

Quiet surrounds me as well. But the absence of any particular defining sound—the clink of playground swings or bat-cracks from a softball game—is not mere emptiness. The silence is an organism made up of a myriad of cells: a furtive rustle of leaves, the distant rasp of a dog's bark, the fleeting whine of a far-off truck. As I listen, this living quietness becomes its own expanse, like a silky coverlet spread over the waning day. Evening will soon tuck it in and smooth its surface across the reclining form of the drowsy world.

3

Some people see expanse in terms of human conquest: far-flung empires rise, only to fall to their successors' ambitions. From this standpoint, mastery of impossible distances—say, from here to the South Pole, or to the moon—connotes power. Others see humans as dwarfed by any great expanse, dwindled down to a puddle of meaning against the backdrop of a Karakoram glacier or the Kazakh Steppe.

In the field beside me, spindly wild oats form a fragile lacework of paleness in the ebbing light. As shadows deepen, every stalk grows distinct, luminous. Up close, each one is unique.

I look around—my eye snagged by a fat blackbird landing on a wire, my ear buzzed by a single-engine plane nosing its way east—and wonder if expanse doesn't confer significance on the individual. Why shouldn't God look down and spy me meandering, antlike, along this road? Who else is there to catch his eye?

As my soul takes its ease propped against plump cushions of expanse piled upon expanse, I ponder the vast intricacy of the world and recall what I've nearly forgotten in the press of ordinary life: I am the pupil of my Father's eye.

The Relationship Between Spiritual Well-being and Years of Practice in Nurses Delivering End-of-Life Care

Carol K. Nethery and Cynthia F. Powers

The purpose of this study was to examine the relationship of spiritual well-being and years of practice in nurses delivering end-of-life (EOL) care. The Spiritual Health and Life-Orientation Measure (SHALOM), developed by Dr. John Fisher (2010), was used to evaluate the relationship between years of nursing practice delivering end-of-life care and spiritual well-being in four domains identified as personal, communal, environmental, and transcendental. Fisher (2010) designed the SHALOM questionnaire to reflect spiritual dissonance between what an individual believes is ideal for spiritual well-being and his or her own lived experience. According to Fisher (2010), the individual's personal, lived experience has been shown to have a significant impact on his or her ability to help others develop spiritual health. Confirmatory factor analyses on SHALOM using data from a study involving 4,462 people, including nurses and caregivers, showed good reliability as well as validity (Fisher & Brumley, 2008).

Fawcett and Noble (2003) stated that it often appears that nurses must rely on their own integrity, beliefs, and value systems to minister to their patients. As O'Brien (2008) noted, "In ministering to a dying person, the caregiver must understand not

only the patient's beliefs...but his or her own as well" (p. 122). Shelly and Miller (2006) believe that regardless of what our culture tells us about keeping religion to ourselves, nurses cannot separate their professional roles from their faith.

For this study, the operational definition for end-of-life care is the care provided to an individual in the last stages of life, estimated to be the final six months or less (O'Brien, 2008). Longley (2003) explains that palliative care, which focuses on keeping the patient comfortable by treating the symptoms of a disease, is offered mainly by hospice but may include other settings where end-of-life care is delivered. End-of-life care based on the hospice philosophy focuses on providing comfort and support to the terminally ill and their loved ones. Hospice care takes a holistic approach rather than a curative approach and is not limited to a service or setting. It emphasizes dealing with the emotional and spiritual impact of the illness from the patient's perspective and as it relates to his circle of support (Martens, 2009).

Clark, as cited by O'Brien (2008), defined spiritual well-being (SWB) as "an integrating aspect of human wholeness, characterized by meaning and hope" (p. 61). Whether referring to a patient or a caregiver, "an individual's perception of the spiritual meaning of an event or illness is influenced by personal, spiritual, and religious attitudes and behaviors" (O'Brien, 2004, p. 40).

The theoretical model and conceptual framework for this project was based on Jean Watson's Theory of Human Caring (Watson, 1997). This theory focuses on the interactions between the nurse and patient, with the nurse deliberately emphasizing the caring relationship and the potential for healing in the three areas of mind, body, and spirit (Pipe et al., 2008). Watson's theory is applicable to this project because it "supports the exploration of hope, spiritual well-being, and quality of life as dimensions that are highly relevant for nursing care" (Pipe et al., p. 1).

O'Brien (2008) states, "In ministering to a dying person, the caregiver must understand not only the patient's beliefs and feelings about death, but his or her own as well" (p. 122). Traditionally, nursing has focused on meeting the spiritual needs and concerns of the patient. The personal and spiritual well-being of the nurse was secondary to meeting the spiritual needs of the sick. O'Brien (2008) describes one nurse's perspective on the importance of prayer and Scripture reading as a way of providing support for his or her practice. Specifically, O'Brien reflects on the thoughts of a pediatric oncology nurse and the significant role this nurse's spirituality has had

in strengthening her professional practice as well as her personal well-being. As this nurse cares for terminally ill children, she states:

I truly do believe it's my faith in God, in the Lord Jesus, that holds me up. I try to pray every morning when I'm getting ready for work and when I can steal a few minutes I read some Scripture. My church is a big support. It is the spiritual that keeps me in oncology nursing. (O'Brien, 2008, p. 98)

Research specific to investigating a nurse's own spiritual well-being and the impact this might have on the delivery of holistic nursing care is limited. Hospice nurses distinguish themselves from their peers in other specialty practice areas by their continual focus on end-of-life care (Lea, 2005). Fisher (2010) states that "people's spiritual health depends on their world-view and beliefs as well as lived experience" (p. 106). Shelly & Miller (2006) noted, "Nurses who see death daily find themselves becoming gradually drained of life and hope" (p. 222). This study explores whether dealing with the process of death every day affects the spiritual well-being of a hospice nurse as well as any nurse working in end-of-life care by examining if a relationship exists between a nurse's spiritual well-being and years of practice delivering end-of-life care.

Method

This descriptive, quantitative, correlational study explored the relationship between the years a nurse has worked in end-of-life care and sense of spiritual well-being as measured by the SHALOM questionnaire, used with permission of Dr. John W. Fisher. The study was approved by Union University's institutional review board and by the Chief Nursing Officer (CNO) of Jackson Madison County General Hospital. An online survey program was utilized to ensure anonymity.

The study population (30 female, 3 male) consisted of 32 RNs and one LPN who had at least one year experience in hospice or other end-of-life care. No students were included in the study. The mean age of participants was 43.03 years. Participants worked in hospice (n=11), on the oncology floor (n=4), and in other EOL care settings (n=18). Twenty-seven participants worked more than 36 hours per week, while six participants worked 16–32 hours per week. Table 1 compares years in nursing and years in EOL care. Participants indicated their religious affiliation, and the results were grouped into five categories: Baptist (n=8); Catholic/Anglican

(n=4); Methodist/Presbyterian (n=6); Non-Denominational (included Church of Christ, Pentecostal, and Christian, n=14); none (n=1).

Dr. Fisher's SHALOM questionnaire provides a model whereby "spiritual wellbeing is reflected in the quality of relationships that people have in one or more of the four domains of spiritual health" (Fisher & Brumley, 2008, p. 50). The acronym SHALOM measures two elements—the spiritual health measure and life-orientation measure. The spiritual health measure allows an individual to introspectively examine his or her own personal experience. The life-orientation measure focuses on the perception individuals have for spiritual well-being in the four domains of personal, communal, environmental, and transcendental. The 20 item SHALOM questionnaire consists of four domains with five items in each domain. The personal domain examines self-awareness, self-worth, and life's value and purpose, while the communal domain deals with culture, religion, and values, expressed as "love, forgiveness, trust, hope and faith in humanity" (Fisher, 2010, p. 107). Awareness of one's spiritual well-being is important because "spiritual care is delivered as much by who one is as by what one says" (Brittain, as cited by Taylor, 2002, p. 60). Specific to the communal aspect of spiritual well-being, Shelly (2008) emphasizes the importance of Christian community for spiritual health and growth. Worshipping with a body of believers, participating in fellowship groups, and having Christian mentors and friends helps provide the foundational support that allows for focus and direction in a nurse's daily practice. The environmental and transcendental domains go beyond "care and nurture...to relationship of self with some-thing or some-One beyond the human level" (Fisher, p. 107). The focus of the questions in each of these domains is listed in Table 2.

Results

The study results were analyzed using SPSS19. Based on the mean value for each of the four domains (personal, communal, environmental, and transcendental) and a summative mean, there was no significant difference in spiritual well-being and number of years a nurse had practiced in end-of-life care (Table 3). The mean of each domain and summative mean were analyzed based on each of the demographic variables. The study results showed no significant difference in

spiritual well-being between the practice settings of hospice, oncology units, or other end-of-life care settings.

Discussion

One limitation of the study was the small sample size. Further research on this topic with more participants might result in more data to support a correlation between a nurse's spiritual well-being and years of practice in end-of-life care. Data suggests that the SHALOM scores might be an effective assessment of a nurse's spiritual well-being that can be used to determine span of clinical practice as a nurse in EOL care. A future study using years of end-of-life care as the dependent variable rather than spiritual well-being is recommended.

Secondary information from this study revealed an interesting relationship between spiritual well-being and religious affiliation (Figure 1). Although the highest number of participants indicated affiliation with no particular denomination (n=14), the aggregate SWB score for this group was the lowest overall.

Conclusion

The purpose of this study was to evaluate if there is a relationship between spiritual well-being and years of nursing practice in end-of-life care. The data indicates there is no significant difference in spiritual well-being and the number of years a nurse has practiced in end-of-life care. When looking at work settings, communal spiritual well-being differed significantly from the other domains overall (personal, environmental, and transcendental) but not between the three work settings (hospice, oncology floor, other end-of-life care settings). Specific to hours worked (no participants worked less than 16 hours per week), there was no significant difference in spiritual well-being. There was no statistically significant difference in SWB scores in any of the domains between female and male participants.

Although this study did not identify correlation between years of practice in providing end-of-life care and the spiritual well-being of the participating nurses, Shelly (2008) emphasizes the importance of maintaining spiritual health in nursing practice. She addresses the importance of nurses meeting their own spiritual needs, emphasizing how they often focus first on serving others, "family, home, church, and

community" (Shelly, p. 1167). In doing so, nurses often disregard their own needs. Caring for one's self starts with loving God. A biblical reference to support this fact is found in Matthew 22:37 (Holman Christian Standard Bible) where Jesus commands us to "Love the Lord your God with all your heart, with all your soul, and with all your mind." Worshipping God and spending time nurturing one's spiritual needs provides a healthy way to back away from the constant demand to serve others and allows the nurse to personally receive God's love. Matthew 22:38 (Holman Christian Standard Bible) states, "Love your neighbor as yourself." It is important to realize that Jesus is telling us to "love others as ourselves, not instead of ourselves" (Shelly, 2008, p. 1167). The profession of nursing is about serving others. To avoid burnout, Shelly stresses nurses must allow themselves to receive love and support from friends and family. If this does not occur, nurses will have little to pass on to those for whom they care. Furthermore, by seeking God to meet their spiritual needs, nurses "will find new energy and direction in meeting the needs of those in their care" (Shelly, 2008, p. 1168).

Lea (2005) also states that "healthcare policy-makers and administrators have a responsibility to consider all dimensions of care when designing and implementing health care guidelines and systems" (p. 1). This includes the spiritual component of holistic care as well as the spiritual health and well-being of the nurse. It is hoped that through dissemination of these survey results and with future study, health care organizations, locally and nationally, will take measures to positively impact any patterns, trends, and areas of concern or significance.

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Appendix

Table 1

Years in nursing compared to years nursing in EOL care

	Years in Nursing					
Years nursing	Less than	1 - 5 years	6 - 10	11 - 20	Over 20	
in EOL Care	1 year		years	years	years	
Less than 1						
year	2	3	1	0	0	
1 - 5 years	0	6	0	2	3	
6 - 10 years	0	0	3	2	3	
11 - 20 years	0	0	0	5	2	
Over 20 years	0	0	0	0	7	
Total	2	9	4	9	15	

Note: Nurses that worked less than 1 year in EOL care (n = 6) were excluded from the study.

Table 2

Items comprising four domains of spiritual well-being in SHALOM

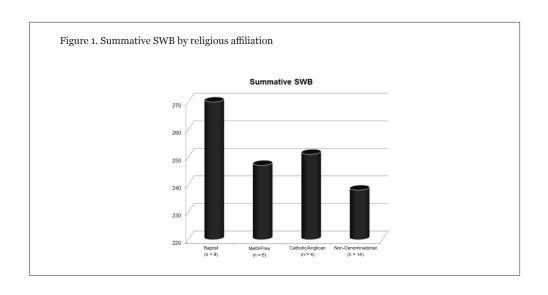
Personal	Communal		
sense of identity	love of other people		
self-awareness	forgiveness toward others		
joy in life	trust between individuals		
inner peace	respect for others		
meaning in life	kindness toward other people		
Environmental	Transcendental		
connection with nature	personal relationship with the Divine/God		
awe at a breathtaking view	worship of the Creator		
oneness with nature	oneness with God		
harmony with the environment	peace with God		
sense of 'magic' in the environment	prayer life		

Note. Reprinted with permission from "Development and Application of a Spiritual Well-Being Questionnaire Called SHALOM" by John Fisher, 2010, *Religions*, 1, p. 109.

Table 3
Years in EOL nursing and SWB scores

Years Nursing in EOL Care	Personal SWB items 5, 9, 14, 16, 18	Communal SWB Items 1, 3, 8, 17,19	Environmental SWB Items 4,7,10, 12,20	Trancendental SWB Items 2, 6, 11.13, 15	Summation of Four Domains
Less than 1	66	67	47	59	239
1 to 5	67	66	49	68	251
6 - 10 yrs	64	64	51	66	245
11 - 20 yrs	62	63	51	63	241
Over 20 yrs	70	68	57	69	264

Note. Fisher explains that SHALOM questionnaire reflects the quality of relationships of each person with themselves, with others, and with God. The questionnaire consists of 5 questions, as identified in this table, in each domain of "Personal, Communal, Environmental and Transcendental spiritual well-being" (Fisher, 2010, p. 105).



Sovereignty

Micah Watson

Books reviewed:

Giorgio Agamben, *Homo Sacer: Sovereign Power and Bare Life* (Stanford: Stanford University Press, 1998).

Jean Elshtain, Sovereignty: God, State, and Self (New York: Basic Books, 2008).

Sovereignty is a perennial concept in political philosophy that continues to attract political theorists and practitioners of all persuasions. It is also a subject, like natural law or justice, which elicits controversy even in the attempt to define it. Nevertheless, it is safe to say that sovereignty, and political sovereignty in particular, has to do with the nature of who or what is in charge and how power is exercised. Controversy ensues as soon as one takes the additional step of inquiring whether a given sovereign should be in charge or insists that there is a normative element as to whether a sovereign's authority is warranted. The subject of sovereignty also reveals a great deal about the approach taken by those who wrestle with it.

We see this illustrated in two relatively recent books addressing sovereignty and its importance for our politics and our understanding of the human condition. Jean Bethke Elshtain's *Sovereignty: God, State, and Self* and Giorgio Agamben's *Homo Sacer: Sovereign Power and Bare Life* each purport to find in the notion of sovereignty a key to the history of political philosophy in the West. In many ways

the books, and their authors, could not be more different. And yet they each address what appears to be the same political phenomenon.

Jean Bethke Elshtain is a political philosopher with appointments in Georgetown's Department of Government as well as the University of Chicago's School of Divinity. *Sovereignty: God, State, and Self* traces how debates about God's sovereignty influenced understandings of the sovereignty of nation-states and finally morphed into conceptions of human beings as individual sovereign selves. Elshtain writes self-consciously within what might be called the "central tradition" of the West and acknowledges her debt to the Greeks, Augustine, Thomas Aquinas, Pope John Paul II, Benedict XIV, and Albert Camus, among others.

Elshtain describes sovereignty as the "sine qua non of political life" as it is more often than not an unexamined starting point in political science rather than a concept to be investigated (xiii-ix). Those states are sovereign that hold ultimate power within definable boundaries. Elshtain's project in this book is to peel back that basic assumption and reintroduce a normative quality to the mere fact of governments exercising power (43). She thus aligns herself with Plato, Aristotle, and their followers. To hold that sovereignty is essentially an amoral concept, recognizable only by observing who wields power rather than by who wields power appropriately, is to restate the essential definition of justice given by Thrasymachus and challenged by Plato's Socrates in the *Republic*. Elshtain's project is Aristotelian in that her position holds that a proper conception of sovereignty cannot sever the concept of power from the appropriateness of the *ends* to which that power is directed.

Elshtain's book is ambitious. Her aim is nothing less than to retell the story of Western philosophy by tracing the various debates about sovereignty. Her book can be divided into three sections apropos to the title: the first addresses sovereignty and God, the second sovereignty and the state, and the third sovereignty and the individual.

The debates over sovereignty begin with arguments about the nature of God's power and its relation to God's goodness. This relation is seen in a paraphrase of Socrates' question to Euthyphro in the dialogue named after him: is the "good" good because God says so, or does God say so because it is good? One answer emphasizes God's power and will. God is not bounded by anything, including his previous promises or actions. Sovereignty here is bound up in the ability to transcend limits,

even self-imposed limits. The "good" we mortals think we apprehend may very well be mistaken should a sovereign God change his mind.

Elshtain identifies with the other side, which emphasizes God's goodness, reason, and trustworthy character. Following Thomas Aquinas, she argues that God has guaranteed, to some degree, the intelligibility of the world and our access to it. It is not like him, as she puts it, to pull the rug out from under us (30). Yet this understanding is tempered by an Augustinian emphasis on our creaturely nature and the difficulties we have with language (4-6). Elshtain steers a middle course here between an untrammeled ode to human reason and a despairing pessimism. We see through a glass darkly, but we still see.

The thread which begins in her theological section and continues throughout the work is an ongoing contest between a monistic depiction of power and a pluralistic conception. The monistic picture of God is as a deity who is remote, unbound, and arbitrary. Elshtain defends the pluralistic conception of God in part by exegeting Augustine's treatise on the Trinity and endorsing his emphasis on God's relational nature. Moving to the political realm, the monistic picture of sovereignty in the state is one of ultimate and unbridled power. We think of Louis XIV's remarkable claim, "I am the state." In contrast, the pluralistic picture follows the model of Jesus' statement that there are things of Caesar and things of God; neither church nor state should see itself as the ultimate earthly authority. One of the most valuable contributions of Elshtain's book is her debunking of the Enlightenment stereotype that described the medieval political model as one of unchecked power guaranteed by God's decree. On the contrary, as Elshtain demonstrates, the West did not know true absolutism until modernity identified sovereignty, and justice, with the mere command of the sovereign (107).

Elshtain concludes her book with a discussion of how the notion of sovereignty has migrated not only from God to political states but also from politics to individuals. This section features Elshtain at her most prescriptive and critical. Her previous ruminations on how several seminal thinkers have treated sovereignty in both God and state are invaluable, yet naturally historical and as such somewhat distant. The same cannot be said for Elshtain's concerns about how sovereignty as autonomous self-empowerment has manifested itself in contemporary culture. Here her critiques hit closer to home. What does it mean to understand

oneself as an autonomous will unbound by anything outside of one's own desires and decisions? What happens when one rejects a recognition of and respect for human finitude and instead experiments with improving our very natures through bioeugenics? What do the practices of abortion and euthanasia tell us about how our society draws the circle of who merits concern and protection and who does not? With characteristic skill, Elshtain weaves these themes together with reflective mediations on original sin, hubris, and the fundamental dangers that accompany humanity's flirtation with redefining what it means to be human.

* * *

Giorgio Agamben is an Italian philosopher whose academic interests include public law, ancient grammarians, political and postmodern philosophy, and the philosophy of language. His 1995 book, *Homo Sacer: Sovereign Power and Bare Life*, appeared in English in 1998. It was followed by a short sequel, *State of Exception*, published in English in 2005. *Homo Sacer* is, to put it mildly, a difficult and intimidating book. Unlike Elshtain, Agamben assumes his audience's familiarity with his dialogue partners, namely Michel Foucault, Carl Schmitt, Walter Benjamin, Hannah Arendt, Heidegger, and Nietzsche. The writing can fairly be described as dense and indeed at some points almost incomprehensible. It is not a book to be taken up lightly, and one would do well to have alongside *Homo Sacer* the works of Foucault and Schmitt. Perhaps most indispensable is Agamben's sequel, *State of Exception*, as it seems to be written with a larger audience in mind. Despite the steep learning curve with Agamben, he has become a *cause célèbre* in postmodern circles and among elements of the political Left which were particularly critical of the Bush administration. Why is this the case?

Just as Elshtain's book is a retelling of the history of Western philosophy, so is Agamben's book an ambitious project. Agamben claims to have found *the* key to understanding politics. Much of *Homo Sacer* and *State of Exception* is an extended interaction with Nazi philosopher of law Carl Schmitt. Schmitt defined the sovereign as that entity which could declare a state of exception. The state of exception's closest English rendering is the imposition of martial law; in theory it is the notion that a

¹ In this regard, Agamben offers a welcome respite from most postmodern theory in that he has the boldness to claim he's found something true across time and culture. There is a whiff of metanarrative that permeates his work.

sovereign government can set aside the constitutional order for the sake of saving that same constitutional order. The same idea is seen in the phrase often heard from defenders of extraordinary measures purportedly needed for national security: "The Constitution is not a suicide pact."

This rough idea is that the letter of the law can be disregarded for a greater necessity, and we find this notion throughout antiquity. Agamben devotes a chapter of *State of Exception* to the Roman *Iustitium* whereby law could be suspended to deal with a catastrophic emergency. We can also see a glimpse of this principle in Mark 2, where the Pharisees complain to Jesus about his disciples breaking the Sabbath. Jesus' reply, that King David himself broke temple law to eat bread when he was hungry, illustrates his larger point that the law (Sabbath) was made for man and not man for the law.

Agamben focuses on an obscure figure in Roman law, the *homo sacer*, a man who has been designated as a criminal but who cannot be sacrificed by the state. At the same time, the protection of the law is lifted from the *homo sacer*, and he may be killed with impunity. While Agamben delves into much detail as to how this figure was understood by the ancient Romans, for his purposes the most salient point is that the *homo sacer* cannot be sacrificed but can be killed. For the *homo sacer* to be sacrificed, his humanity would have to be recognized. He represents the danger that accompanies a sovereign that takes upon itself the power to declare some of those residing within its sphere as expendable.

But how does the fate of one unfortunate figure in ancient Rome relate to Agamben's concerns with the modern state? Simply put, Agamben believes that the state of exception rationale now defines the entirety of Western governments rather than being an occasional resort to extraordinary measures. The paradigmatic example of this rationale is found in Auschwitz. The National Socialist regime based its claims to extraordinary powers on an unending series of national emergencies. The Nazis' coinciding decision to define Jews and other groups as inhuman took the principle of *homo sacer* and expanded it to include millions of people no longer related to the legal realm except insofar as that very same legal realm had designated them as such. While this dynamic raises several conceptual puzzles, the important point is the sovereign stepped out of the legal bounds that supposedly gave it its shape and subsequently engineered an unimaginable genocide.

This explanation, however, does not stop with the Third Reich. What makes *Homo Sacer* a controversial book is Agamben's claim that this paradigm of the "camps" describes Western governments as such. What makes *Homo Sacer* prophetic, in the eyes of some, is the convergence of Agamben's theories with the Bush administration's treatment of non-combatants following the events of September 11th. Agamben, and other academics such as Judith Butler, sees the designation of Guantanamo Bay prisoners as only the most obvious example of how modern democracies manifest the *homo sacer* logic of the concentration camps by designating some people as existing in a legal limbo and thus ultimately expendable.

Yet it is important for Agamben's purposes to emphasize that Guantanamo is not an oddity but the exemplar of modern democratic society. Agamben goes so far as to claim a link between the totalitarian regimes of the 20th century and modern-day democracies (10) and spends the last third of *Homo Sacer* trying to reconcile this claim with the accomplishments and human rights declarations of the same democracies that opposed Nazism, Fascism, and Communism in the last century. It is only a matter of time before the decadence of consumerist democracies bent only on the bare necessities of life degenerates into the totalitarian regimes they had once rivaled. According to Agamben, this descent has already happened (174). Any time the state declares a class of people capable of being killed—outside the protection of the law—it displays the logic of the camps as the essence of modern politics.

It is difficult to know how to respond to such a claim. We might expect Agamben to provide some sort of tangible evidence beyond the extreme examples. Agamben rejects this expectation. In the introduction to *Homo Sacer* he asserts the existence of a secret link between democracy and totalitarianism, but does not claim this in any "historiographical" way. Rather, Agamben works on a "historic-philosophical level, since it will allow us to orient ourselves in relation to the new realities and unforeseen convergences of the end of the millennium." (10). In a 2004 interview with the *German Law Journal*, the interviewer queries Agamben about how he can so easily link the United States with Nazi Germany. Agamben's response is telling:

But I am not an historian. I work with paradigms. A paradigm is something like an example, an exemplar, a historically singular phenomenon... I use this paradigm to construct a large group of phenomena and in order to understand an historical structure.... But this kind of analysis should not be confused with a sociological investigation. ²

In other words, Agamben is more or less making it up—or so it seems to this reviewer—who has been trained in political theory within the larger discipline of political science, a discipline that places at least some value on connecting political ideas with observable, concrete political reality. To equate the everyday politics of contemporary Western democracies with the unspeakable evil of Nazi Germany's concentration camps grossly mischaracterizes current governments while at the same time it universalizes the very particular horror found in Dachau and Auschwitz. It is an error of empirical description exceeded only by a risible moral equivalence implied by the comparison. There is a reason the very words "Dachau" and "Auschwitz" elicit from us a different reaction than "Washington", "Paris", and "London."

To be sure, Agamben's particular examples are real historical phenomena, and Agamben has found an interesting puzzle for philosophers of law in his description of the state of emergency.3 How does the law legally allow for its own suspension? Moreover, his real examples—the Nazi death camps, the shameful internment of Japanese Americans, even Guantanamo, for the sake of argument—all illustrate the extremes to which government can go in putting aside constitutional constraints because of an overriding emergency. We would do well to heed his warning regardless of whether we find his explanatory rubric persuasive.

But notice that the political lesson we draw from this valuable reminder is, in an intellectual sense, rather trivial. Democracies can do bad things. Even the most just political societies degenerate. Plato's Republic covered this theme rather well. One wonders what comparative standard Agamben has in mind or what historical era witnessed governments that did not commit atrocities or designate classes of people as expendable.

But there is a more fundamental question that must be put to Agamben. What resources does his approach to philosophy offer such that we can appropriately

² Ulrich Raulff, "An Interview with Giorgio Agamben," *German Law Journal*, Vol. 5, No. 5, 2004, 609-614. Omitted in the ellipses are references to Foucault.

³ Agamben introduces the puzzle in *Homo Sacer* but explains it more thoroughly in *State of Exception*. Basically, when a government claims a state of exception, it creates a conceptual space that is both apart from the legal realm and yet created by it. As Agamben puts it, the state of exception is an exclusion that is included in that the legal realm creates it. At the same time this "it", this state of exception, is by definition independent of the law which authorized its creation. This aporia is what defines the modern exception of soverging the state of exception. ssence of sovereignty.

describe the injustice we might find in Guantanamo, or the depth of depravity we did find in the concentration camps? We ought not to forget that Agamben operates in the disenchanted world this side of Nietzsche's shadow. Once one has jettisoned the existence of a good to be discovered and not merely created, does not one also lose the capacity to speak convincingly about evil? Perhaps this is why Agamben describes Nazi atrocities as "disturbing" and "disquieting" but never evil or diabolical. Perhaps this is why he can equate modern governments with the Holocaust, but cannot appreciate the modest but tangible benefits such societies have provided to actual citizens living real lives within them. We might wonder if the problem of evil cuts both ways. Undoubtedly, those who have found Agamben compelling would claim that this reviewer has failed to understand him, and it is certainly true that his book contains more than can be justly considered in this review. Readers will have to determine for themselves where the fault lies and in what measure.

* * *

Reading Elshtain and Agamben provides the reader with an education not only in the concept of sovereignty but in what political theory and philosophical inquiry should be. Elshtain assumes the essentially Aristotelian and Christian framework which holds that there is a discoverable human nature and purpose and that there are genuine moral goods and virtues which constitute a morally worthwhile life. While always mindful of the limitations incumbent on fallible creatures, Elshtain's teachings on sovereignty call us back to the possibility that there are truths to be found and even revealed truths to be accepted.

In contrast, Agamben follows in Nietzsche's wake. He is one of many philosophers, existentialists, genealogists, and aestheticians who have continued Nietzsche's work of unmasking a disenchanted world, attempting to create their own values and sifting through—or deconstructing—the scattered fragments of thought from those who do not yet know that God is dead. While Agamben cites Foucault, Benjamin, and Schmitt most frequently, it is the towering figure of Nietzsche who stands behind them. This is the real reason why Agamben works in paradigms that do not lend themselves well to critical evaluation.

The attempt to craft a framework within which these two approaches to political ideas and phenomena can be adjudicated is a quixotic enterprise. To evoke Alasdair

MacIntyre, we are confronted with rival and entirely incommensurable traditions of thought. As evidenced in this review, neutrality is not an option, even granting the genuine insights we can glean from the "other side." With that in mind, we would do well to heed the warning Agamben offers about the dangers of governments abusing their sovereignty even if we might prefer Elshtain's tradition to explain why such abuse deserves our condemnation.

Response Times and Sleepiness Among Fatigued CRNAs

April Yearwood and Brad Harrell

Building a Safer Health System, 44,000 to 98,000 patients die in hospitals every year because of medical errors in the United States. Higher error rates are more common in intensive care units, operating rooms (OR), and emergency rooms. In fact, 82% of preventable errors caused by human error occurred during anesthesia administration. There are multiple physiologic and psychological factors that place these providers at a higher risk for medical errors. Increased workload, fatigue, mental overload, ineffective communication, and faulty information processing are associated with higher risk. With anesthesia being a dynamic, complex, task-driven, stressful decision making environment, human error and impaired performance are common. Young et al. define fatigue as "a state of increased discomfort and decreased efficiency resulting from prolonged exertion; a generalized feeling of tiredness or exhaustion; loss of power or capacity to respond to stimulation." The effects of fatigue may be an important determinant of the ability to clinically manage an event in the OR with an appropriate reaction time.

Well known catastrophes have occurred due to sleep deprived and fatigued individuals, including the Exxon Valdez oil spill and the Chernobyl nuclear disaster.³ Fatalities from fatigued truck drivers are another concern. The National Transportation Safety Board (NTSB) data from 1998 showed 31% to 58% of truck driver fatalities are fatigue-related due to sleep deficiency. The federal government issued laws due to public safety concerns from fatigue for commercial motor-vehicle drivers. If the restrictions imposed for sleep or off-duty time are not abided by, those drivers are more likely to be involved in a fatal accident.³ Furthermore, Biddle and Aker stated that the number of close calls or "near-accidents" from commercial truck drivers due to fatigue is unknown but can be compared to the unknown number of "close calls" or "critical incidents" in anesthesia.³ The number is "unknown" because of providers underreporting mistakes.

Studies have shown that a single night without sleep can significantly decrease performance, especially on skilled cognitive tasks, beginning as soon as 18 hours after awakening. Dawson and Reid correlated performance impairment from fatigue with alcohol intoxication and found that "moderate levels of fatigue produce higher levels of impairment than the proscribed level of alcohol intoxication". Their results (in percentages) after being awake ten hours revealed mean relative performance on the tracking task (a computer-administered psychomotor vigilance test of hand-eye coordination) decreased by 0.74% per hour up to twenty six hours of being awake (P < 0.05). For subjects with a blood alcohol concentration of 0.10%, using the same tracking task, the mean relative performance decreased, on average, by 11.6% (P = < 0.05). When they equated the two percentages at which performance declined, they found that the performance decrement between 10 and 26 hours of wakefulness was equivalent to the performance decrement observed with a 0.004% rise in blood alcohol concentration (See Figure 1).

Another similar study indicated that cognitive psychomotor impairment after being awake for 24 hours equals that produced by a blood alcohol level of 0.10% on a hand-eye coordination task.⁶ This level of intoxication is higher than 0.08%, which is considered drunk by motor vehicle laws. Fatigued individuals can continue to function physically and mentally. However, the quality of their work is likely to suffer, which is especially problematic when human lives are at stake. Furthermore, fatigued individuals are more likely to select risky alternative behaviors when

performing a task.^{1,7} If CRNAs came into work drunk they would likely be fired and possibly face criminal charges if they administered an anesthetic due to possible harm to the patient.

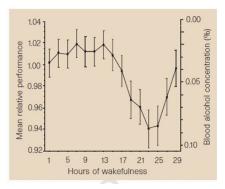


Figure 1. The effects of sleep deprivation on psychomotor performance are shown as equivalent to the effects of acute alcohol intoxication between 10 and 26 hours without sleep. Used with permission from Drew Dawson, (1997) Nature 388: 235.5

Safely providing care for patients with vigilance is an ethical responsibility of anesthesia personnel. ^{8,9} Vigilance is referred to by Weinger as "a state of readiness to detect and respond to certain specified small changes occurring at random intervals in the environment". ⁴ In 2003, work-hour rules were put in place for anesthesia residents while in training; however, after the training period, no mandate defines the amount of work hours. ³ The intent of these regulations, made by The Accreditation Council on Graduate Medical Education, was to provide better working conditions that would, in turn, provide better patient care. ^{8,10,11} The regulations came into being after the investigation of the death of 18-year-old Libby Zion, a patient who most likely died from fatigue-related causes from healthcare providers. ^{10,11} Two resident emergency room physicians had been on the job for 36 hours with an excessive patient load and inadequate staffing. This quickly became a high profile legal battle in which both were charged with 38 counts of gross negligence. ¹² Zion's tragic case helped set the stage for the medical-error movement in the 1990s.

The IOM recommended minimizing the use of 12-hour shifts and limiting work hours for nurses to no more than 12 consecutive hours within a 24-hour time frame. ¹³ The fact that so many other industries/professions have regulations set in place should encourage the creation of such regulations for health care providers. Of note, the AANA recently revised the *Advisory Opinion 5.1: Patient Safety: Fatigue, Stress, and Work Schedule Effects* and updated it with the *Position Statement 2.17: Patient Safety: Fatigue, Sleep, and Work Schedule Effects*. ¹⁴ One of the recommendations

includes that "CRNAs should not provide anesthesia patient care for more than 12 to 16 consecutive work hours within a 24-hour work period (i.e., scheduled on-duty or on call) which must include adequate breaks for meals and respite to maintain appropriate physiologic function". One study done on intensive care nurses showed the risk for making an error almost doubled when they worked longer than 12.5 hours consecutively (odds ratio 1.94, P=.03). Rogers et al. conducted a study in 2004 on 393 nurses working 5,317 shifts. Forty percent of those shifts logged were longer than 12 hours, and most nurses worked over 40 hours per week. They report 199 errors were made and 213 near-errors with over half involving medication administration. In this study, errors were three times higher when working over 12.5 hours (odds ratio=3.29, P=.001), and increased risk of errors was highly significant when working over 40 to 50 hours per week (odds ratio=1.92, P=.0001).

With vital issues of fatigue on the forefront of healthcare, this study sought to determine a significant relationship between length of time without sleep, a subjective report of sleepiness, and response times using a standardized psychomotor test. The computer-administered psychomotor vigilance test (PVT) of hand-eye coordination referenced above was chosen and used as the main outcome measure for sleep deprivation. The PVT has become arguably the most widely used measure of behavioral alertness due to its combination of high sensitivity to sleep deprivation and psychometric advantages over other cognitive tests. Lapses in attention, as measured by the PVT, can occur when fatigue is caused by sleep loss or time spent on a task. These factors make up virtually all theoretical models of fatigue in real- world performance.

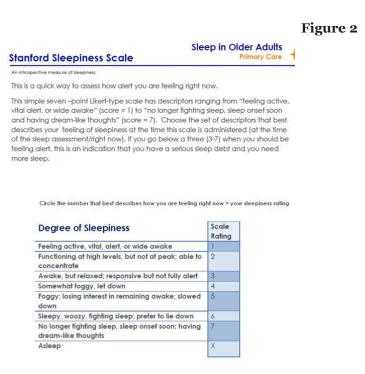
Materials and Methods

Internal review boards through both the university and clinical site approved the descriptive, correlational study. Inclusion criteria for participants in the study included full-time practicing male or female CRNAs in the operating room who take call on a regular call rotation at the hospital. No age limitations were considered. Ethnicity and health status were also not considered, and there were not any physical, mental, cognitive or emotional limitations. There were no vulnerable subjects that required special consideration such as pregnant subjects, prisoners, or students.

A final sample size of 16 full-time CRNAs agreed to participate after invitation

via letter, email, or personal conversation. Each participant signed informed consent after the components of the study were thoroughly explained (including how to operate the computerized handheld device used for data collection). Participants' names were not recorded on the instruments and an identification number was assigned to each person and to each set of survey responses. Before the first surgical case and after the last surgical case within the 24-hour study period, the CRNAs were asked to complete an online demographic survey and a Stanford Sleepiness Scale (SSS). The SSS is a seven- point ordinal scale of self-perceived subjective sleepiness which has been well validated in clinical sleep medicine and sleep research. ¹⁸ CRNAs were not actively engaged in providing care at any point during the short time that was dedicated to completing the questionnaire and testing portion of this study so as not to distract from any patient care responsibilities (See Figure 2, SSS).

After completing the survey, the CRNAs were then asked to complete a three-



minute computerized test on a Psychomotor Vigilance Task (PVT-192) handheld device (Ambulatory Monitoring Inc., Ardsley, NY). This test assesses the subject's ability to perceive instructions and perform motor responses, and measures the speed of reaction. It is a well-validated 3, 5, or 10-minute test of simple reaction time (RT). RT is considered the time from observing a visual stimulus to pressing a corresponding button and has been used extensively to evaluate sustained attention. It is known to be sensitive to sleep deprivation and has become the most widely used measure of behavioral alertness. This is 250 ms, and an RT of greater than 500 ms is scored as a "lapse". A typical RT is 250 ms, and an RT of greater than 500 ms

The 10-minute PVT is often considered impractical for the clinical setting due to time constraints; therefore, the 3-minute PVT-B (brief) was used. Compared to the 10-minute test, the 3-minute test has been validated (retains sensitivity and specificity to sleep loss) by decreasing the standard lapse time of 500 ms to \geq 355 ms. ²⁰ Upon the initial set up and use of the PVT-192, the principal investigator changed the lapse time to the appropriate settings to maintain this validity as follows: decreased the standard visual lapse criterion from 500 ms to 355 ms; decreased trial length to 180 seconds (3-minute test); and set minimum visual inter-stimulus interval (ISI) to 2 seconds and maximum visual ISI to 4 seconds (per the recommended settings of Basner and Dinges). ²⁰ All CRNAs completed testing at the beginning of their on-call shift and then again at the end of the on-call shift.

Results

To help understand the results, a few definitions are necessary for the reader to apprehend the data.

Of the 16 CRNAs included in the sample, when age and the number of lapses at

STWM	Shift time worked in minutes		
SSS at the end of shift	Stanford Sleepiness Scale recorded at the end of shift		

Lapses at the end of shift Number of reaction times exceeding 355 ms at the end of a shift. "Lapsing, or failing to respond in a timely fashion to a presented stimulus, is a hallmark of the sleep-deprived state". 16 The greater the number of lapses correlates with slower response times and is one of the two primary outcome metrics Basner and Dinges proved to have superior statistical properties.¹⁷ Four behavioral changes that occur due to sleep deprivation (which leads to fatigue) are as follows: sleep deprivation (SD) causes slower reaction times; SD results in increased error of omission and commission; SD enhances the time-on-task effect; and lastly, tests of vigilant attention during periods of SD are sensitive to both circadian and homeostatic drives. These four changes make up what is called 'the state-instability theory' that describes performance after SD. So for this definition of "lapses at the end of a shift", when the participants have more lapses, it equals great state-instability.¹⁶ Mean Reciprocal Reaction Mean Reciprocal Reaction Time (1/RT) Time at the end of shift at the end of a shift is figured by taking the individual's raw reaction times over the 3-minute test period from the PVT device and calculating 1000/RT. These response speeds are then averaged.¹⁷ This data is configured automatically by using software that comes with the device. The lower the MRRT number, the slower the psychomotor speed of test taker.¹⁶ The MRRT at the end of a shift is the second of the two primary outcome metrics in this

Table 1. Definitions and explanations of dependent variables and primary outcome metrics used in PVT-B

properties.

study proved to have superior statistical

the end of shift were compared, a moderately strong correlation existed (R = .101, Eta = .793). As age increased, so did the number of lapses at the end of the shift. When the CRNAs had fewer hours of sleep the night before being on call, the number of lapses at the end of their shifts increased, and therefore, had a weak negative correlation (P =.129, R =-.396). When the number of hours without sleep during the actual call shift was compared to mean reciprocal reaction time at the end of shift, it showed a moderate correlation (P = .024, R = -.561); therefore, the CRNAs with a greater number of hours without sleep had a lower mean reciprocal reaction time which indicates slower psychomotor (or response) speed. There was a very strong relationship between the CRNAs' Subjective Sleepiness Scale rating at the end of shift and their hours without sleep during call shift (P =.000, R =.856). All CRNAs that worked long hours without sleep rated themselves as a 6, which equates to "sleepy, woozy, fighting sleep; prefer to lie down" on the Stanford Sleepiness Scale (see Figure 2). Using a paired t-test for mean reciprocal reaction time measured at the beginning of the shift and at the end of the shift showed a high significance of P =0.00, which would be expected due to their response time being quicker at the beginning of shift versus the end of shift. When caffeine intake and mean reciprocal reaction time at the end of the shift were compared, there was a weak moderate correlation (P=.074 and Eta=.459).

A Wilcoxin correlation matrix was performed and showed a significant relationship (P =.000, R =-.909) between the number of lapses at the end of shift and the reaction time, indicating that a greater number of lapses occurred at the end of the shift. Referring to the definition of "lapses" above, "Lapsing, or failing to respond in a timely fashion to a presented stimulus, is a hallmark of the sleep-deprived state".¹⁴ When the number of lapses at the end of shift was high, the mean reciprocal reaction time at the end of shift was low, so the lower the mean reciprocal reaction time (MRRT) end of shift number, the slower the psychomotor speed of the test taker.¹⁶ This highly significant finding using these two variables is further validated by Dinges & Basner.¹⁷ They state that both mean reciprocal reaction times and the number of lapses should be used as the Psychomotor Vigilance Task's primary outcomes due to their high effect sizes. Furthermore, the authors state that "using these two PVT performance metrics increases the likelihood of finding differences between sleep deprived and alert states with smaller sample sizes".¹⁷ Another highly

significant finding was found between the CRNAs' shift time worked in minutes and the Stanford Sleepiness Scale rating at the end of the shift (P =.001, R =.759). In essence, the longer CRNAs worked, the higher their score on the Stanford Sleepiness Scale. There was moderate significance (P =.026, R =.553) for longer shift times worked in minutes and the number of lapses at the end of shift being greater. For lower mean reciprocal reaction times and higher ratings on the Stanford Sleepiness Scale at end of shift, a moderate significance was also shown (P =.013, R = -.606). Overall, this small study concluded that CRNA reaction times significantly decreased when working for up to 24 hours without rest.

	STWM	SSS end of shift	MRRT	Lapses at end of shift
Shift time worked in minutes (STWM)				
Pearson Correlation	1	.759	·553	518
Sig. (2-tailed)		.001	.026	.019
N	16	16	16	16
SSS end of shift				
Pearson Correlation	.759	1	.509	606
Sig. (2-tailed)	.001		.044	.013
N	16	16	16	16
Lapses at end of shift				
Pearson Correlation	.553	.509	1	909
Sig. (2-tailed)	.026	.044		.000
N	16	16	16	16
Mean reciprocal response time at end of shift (MRRT)				
Pearson Correlation	580	606	909	1
Sig. (2-tailed)	.019	.013	.000	
N	16	16	16	16

Table 2. Correlation table of categorical variables

No significant findings or associations were found when comparing gender, degree, and hours slept per night on average to shift time worked in minutes, Stanford Sleepiness Scale, lapses, and mean reciprocal reaction time at the end of shift.

Discussion

The mean age was 45.4 years (SD 10.9, range 29 to 64) with a mean of 11.5 years of experience (SD 13.2, range 1 to 40). The mean hours of sleep per night ranged from 5 to 8 with a mean of 6.7. Call hours worked per week over the normal 40-hour week ranged from 4 to 25 with a mean of 12.5 (SD 5.51). Limitations of this study included the limited generalizability due to such a small sample size. Another limitation is that only four of the CRNAs actually worked over 12 hours.

The range for the shift time worked in minutes was between 218 minutes to 1272 minutes with the average time worked on the call shift being 626 minutes. Work hours ranged from 886 to 1272 minutes without rest, which is more than the AANA's recommendation to not provide anesthesia for more than 12 to 16 consecutive work hours. They also recommend to include breaks in order "to maintain appropriate psychological function".¹⁴

There are volumes of data on sleep deprivation and fatigue that make the connection to safety risks. If sleep periods arranged around workloads are not given priority, fatigue will continue to be an issue with human performance. "Neither individual patients nor society as a whole would tolerate providers coming to work impaired because of alcohol or drugs. Similar levels of impairment are found in individuals deprived of sleep, yet this is tolerated". The IOM *To Err is Human* report concluded that the know-how already exists to prevent many of these mistakes. Anesthesia departments should have strategies in place for balancing workload to decrease fatigue and improve patient safety. Furthermore, we should act to prevent possible mishaps now rather than waiting until they have occurred.

This study hopefully will heighten our awareness of fatigue and the need for creating a safer work environment related to fatigue and impaired reaction times. It should petition us to look at workload hours more intentionally so that we can help to reduce errors in healthcare related to fatigue. There is great opportunity here to further study and manage the issue of workplace fatigue for anesthesia providers; however, there is an even greater responsibility to our patients to continue our long standing history of safe practice in anesthesia.

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Eyes to See: Christian Aesthetics and Perfectionist Seeing

Taylor Worley

T n *Pictures & Tears*, a fascinating history of emotional encounters before works of ▲ art, James Elkins (2001) gives careful consideration to the vast range of emotional reactions and life-changing experiences people have had throughout art history when they find themselves in front of great works of art. Again and again, he finds that many of these viewers lack the very language to describe what has happened to them or how they have been confronted by something inexplicably profound in or through the work of art. On the other hand, Elkins also looked into the lives of those who claim to understand quite well what was happening, but he reported effects that many today would find hard to believe. One such account is the story of St. Catherine of Siena's experience of the early Renaissance master Giotto's "Navicella" mosaic in 1380. (To learn more about or view portions of Giotto's mosaic, visit the first web address in the Appendix at the end of this article). Giotto's huge mosaic presents the biblical scene of Matthew 12:22-32 and Mark 6:45-52 in which Jesus comes walking across the water to meet a boat full of his disciples, buffeted by the wind and the waves on the Sea of Galilee. Standing in an outdoor courtyard of the old St. Peter's church in Rome, she pondered the scene—the uncertain passengers, the faltering Peter, and the resolute Christ, and after some time, perhaps under the weight of all

that was conveyed by the picture, St. Catherine collapsed. She was paralyzed from the waist down for the rest of her life.

Like Elkins, I wonder if this kind of seeing is possible anymore. For him, seeing in this way is unavailable because authentic belief in the divine has receded, but for the purposes of this essay, another reason will be offered. Perhaps the scarcity of these experiences results not from a lack of visual encounter but a destructive overstimulation. As Richard Winter (2005, 17-18) describes in his book *Perfecting* Ourselves to Death, popular culture's pre-occupation with image—the "perfect look" or the "perfect body"—conditions many of us with a tragically flawed kind of seeing. This seeing trains us to implicitly evaluate ourselves and each other in terms of unrealistic or impossible standards, measuring ourselves against the fantastic bodies that adorn the covers of so many magazines and that dominate the television screen and internet banner ads. These habits of visual perception reinforce the assumptions of an unhealthy perfectionist view of the body by perpetuating a mythical selfimage that cannot actually be attained. The examples of this image idolatry are so widespread and ubiquitous that they do not bear recounting. The habits of this kind of seeing and perceiving, however, require our careful consideration. This posture of image idolatry constitutes what Richard Winters (2005) calls a conditioned "response to the values of our culture" (124). Such idolatry surely accounts for a profound number of issues facing Christian psychologists and counsellors.

As Christian counsellors work with their clients to promote a holistic kind of personal health, integrating their approaches to the spiritual, mental, emotional, and bodily aspects of the person, reflection must be given to the myriad ways in which contemporary visual cultures of the "perfect body" can manipulate and distort a person's healthy self-image. This manipulation occurs when a person's self-image comes to be defined by contrast to the "perfect" bodies of celebrities, super models, and other media amalgamations of the currently popular human forms or body shapes. Whereas a person's self-image is composed of "the self-description of mental images we have of ourselves," as Gary Collins (2007, 439) makes clear, this self-image bears upon the larger category of a person's self-esteem. For preventing or repairing unhealthy self-image as a result of perfectionist seeing, Christian psychologists have several strategies that can be employed. Principally, patients require a theological account of the human person that situates every human body within the framework

of God's creation, redemption, and restoration. They would also benefit from a historical perspective on how standards of human beauty have changed over time and remain in large part relative to one's culture and social location—a fact illustrated by the history of art and visual culture. In addition to these, counsellors can also draw upon the efforts of scholars engaging the emerging field of visual culture and visual critical studies to specifically reset assumptions produced by the manipulative tactics of contemporary media and advertising cultures. The most influential and significant contributions to the field of visual critical studies include the work of John Berger (1973), W.J.T. Mitchell (1994), Griselda Pollock (1988) and Slavoj Zizek (1991). More specifically, the work of David Morgan (2005), Sally Promey (2001), and S. Brent Plate (2002) engages the field of religious visual cultures.

While that fascinating conversation will not constitute the subject of this essay, I wish instead to address the contemporary issue of perfectionist seeing through engagement with Christian traditions in art history, for Christian psychology can learn a great deal about healthy perceptions of the human body from the ways of seeing required by the best examples of historic Christian visual art. In this essay, therefore, I would like to dismantle the internal logic of perfectionist seeing and suggest several ways in which Christian aesthetics—theological vision and perception, offers us a better way of seeing ourselves and the world. Before engaging specific works from art history, I would like to address the complexities that confuse our contemporary sensibilities with respect to vision and perception.

The Problematics of Perception

Not only has the media culture of our time offered us images of fantasy and unreality, but that kind of looking is training us in lies about perception itself. Essentially voyeuristic in their approach, media outlets and advertising cultures intentionally doctor or edit their visual imagery to give the illusion of an unmediated perception of beauty—the "perfect look" or the "perfect body." In this way, the magazine photo spread or the reality TV show attempts to give its audience an immediate sense of beauty, an actual or complete apprehension of the lovely and attractive person they want or want to be. Their approach deceives because it relies on our common but false assumptions about the nature of representation. Since the advent of photography a century and a half ago, we have unfortunately lost a

healthy appreciation for the distance between our seeing and our perception. In the evolution of media forms that increasingly rely on photography, such as newspapers, magazines, television, and webpages, photographic evidence has become the unquestioned arbiter of what is real and true. As Jean Baudrillard (1999) has argued, the media image or simulacrum actually maintains a greater significance than the actual person, place, or event.

Because of photography's seemingly unmediated representation of things, we do not question to the same degree whether we saw what we think we saw, but this uncritical reliance upon photographic media must be challenged. Photography, like all other forms of visual representation—painting, sculpture, drawing, or thermal imaging—remains a medium and hence offers a mediated viewership that cannot ultimately replace or substitute for human seeing and perception. The dilemmas surrounding perception are numerous and daunting, but Ludwig Wittgenstein (2003) offers an illuminating word to dispel this sort of confusion. In his *Philosophical Investigations*, he explains:

The aspects of things that are most important for us are hidden because of their simplicity and familiarity. (One is unable to notice something — because it is always before one's eyes.) The real foundations of his enquiry do not strike a man at all. Unless that fact has at some time struck him. — And this means: we fail to be struck by what, once seen, is most striking and most powerful. (43)

In other words, the project of seeing and perceiving well can be immensely complex. Paralleling Wittgenstein's reflections, Myers and Jeeves (2003) reveal this complex of factors by concluding that perceptions "depend on where our *attention* is drawn, on our prior *experience*, and on our *expectations*" (61).²

While living with the uncertainty that occupies the distance between seeing and perceiving is an inescapable part of what it means to be human, Christian aesthetics models a way of looking through the familiar to find that which is hidden. In this way, a Christian aesthetics maintains quite different assumptions about how we see and perceive ourselves and the world. A Christian anthropology admits that seeing, like all other human activities, remains subject to all the limits of our finite, creaturely existence and the profound and deep effects of a sinful nature. Therefore, any discussion of a Christian aesthetics must be situated within the larger frame of God's salvation-historical mission to redeem, restore, and renew his people and all of

creation. Thus, it is not surprising to find a wholly different understanding of human seeing and perception included amid St. John's description of the eschatological consummation of God's mission—a celebratory procession of the redeemed led into the New Jerusalem. Consider his description of that moment in Revelation 22:1-5:

Then the angel showed me the river of the water of life, bright as crystal, flowing from the throne of God and of the Lamb through the middle of the street of the city; also, on either side of the river, the tree of life with its twelve kinds of fruit, yielding its fruit each month. The leaves of the tree were for the healing of the nations. No longer will there be anything accursed, but the throne of God and of the Lamb will be in it, and his servants will worship him. They will see his face, and his name will be on their foreheads. And night will be no more. They will need no light of lamp or sun, for the Lord God will be their light, and they will reign forever and ever. (ESV)

Through this vision given to St. John, we receive the promise that at the consummation of God's purposes in salvation history, the redeemed will not only be ushered into the presence God—the hope of all covenant history—but they will also finally and fully apprehend the face of God. Throughout all of biblical history, the face of God has remained a symbol of immense terror and fear—to see God meant one's life. But on account of their union with God in Christ, the redeemed will come to see God under no threat of lethal perception (e.g. Exodus 3:18-23). This apprehension of the face of God has been described by the great doctors of the Church as the "Beatific Vision," what M. J. Redle (2003) defines as the "direct, intuitive, intellectual vision of God, with the perfection of charity necessarily accompanying it ... the consummation of the divine indwelling in the sanctified spirit or soul, for by this vision the blessed are brought to fruition in such a union with God in knowledge and love that they share forever in God's own happiness" (168). Rather than a unique privilege of those citizens of Christ's kingdom, the perfect seeing and perfect perceiving that St. John describes here merely reflects the comprehensive nature of God's restoration and renewal of humanity—the New Creation. Both the limits of our capacity to see and perceive and the effects of sin to distort what we actually can see and perceive will be lifted in that moment of ultimate restoration and renewal. Until that glorious occasion, however, we will not experience perfection in our seeing and perception.

On this side of the *eschaton*, we must maintain a healthy suspicion of how we see things and rely on the truth, beauty, and goodness of God to understand and

evaluate what we have seen. Awaiting that final restoration of our senses, minds, and hearts, the people of God must rely on the Spirit of God to provide the discernment we need to understand ourselves and our circumstances rightly and also the grace to cover over all our misperceptions. Fortunately, God remains faithful to cultivate in us a true apprehension of things and a wisdom that increasingly sees others and the world through the lens of God's promises and the hope of the New Creation. Two particular instances in the New Testament commend themselves for understanding this difficult dynamic, one of which is conceptual and the other practical.

First, St. Paul refers to the nature of our limited vision and mediated perception of things when he writes in 1 Corinthians 13:12: "For now we see in a mirror dimly, but then face to face. Now I know in part; then I shall know fully, even as I have been fully known." In the context of a call to greater love and charity within a factious church, St. Paul reminds the Corinthian believers that we do not have perfect vision or perfect perception and must rely upon the ways of our Lord in dealing with one another. Theologically, St. Paul's articulation of human finitude here matches up quite well with his point in chapter 15 of the same letter, namely the sense of dramatic and comprehensive transformation awaiting the human person at the Resurrection. At that point, he explains in 1 Cor. 15:42-44: "What is sown is perishable; what is raised is imperishable. It is sown in dishonor; it is raised in glory. It is sown in weakness; it is raised in power. It is sown a natural body; it is raised a spiritual body."

Secondly, St. Matthew records Jesus' harsh warning about the Day of Judgment in chapter 25:34-40. At the separating of the sheep and the goats, Jesus will confront those who did not recognize him in the world and congratulate those who did:

Then the King will say to those on his right, "Come, you who are blessed by my Father, inherit the kingdom prepared for you from the foundation of the world. For I was hungry and you gave me food, I was thirsty and you gave me drink, I was a stranger and you welcomed me, I was naked and you clothed me, I was sick and you visited me, I was in prison and you came to me." Then the righteous will answer him, saying, "Lord, when did we see you hungry and feed you, or thirsty and give you drink? And when did we see you a stranger and welcome you, or naked and clothe you? And when did we see you sick or in prison and visit you?" And the King will answer them, "Truly, I say to you, as you did it to one of the least of these my brothers, you did it to me."

From Jesus' description, it stands to reason that both those considered sheep and those considered goats actually saw the same phenomena—the poor and destitute brothers and sisters of the world, but the sheep perceived the kingdom of Christ there and the goats did not. Jesus' judgment here centers on the success or failure of perception. At the very least, this portion of Scripture reminds us that accurate seeing does not necessarily guarantee accurate perceiving.

For the Christian, understanding of the world relies not only on careful and attentive seeing, but perhaps more importantly on the lens of the gospel to perceive what one sees rightly and in light of the grand reality of God's mission. As difficult as it may seem, Christians are called to see and perceive life differently than those with merely natural eyes. Thankfully, we find that we are by no means alone in this project of faithful seeing and perceiving. In his immense mercy and kindness, God has preserved his revelation for us in the words of Holy Scripture and entrusted it to the Church. Along with the great traditions of Christian faith that have gone on before us, we submit one to another in local communities of faith so that God might restore our sight even now, or as St. Paul describes in Romans 12:2, so that we might undergo "the renewing of our minds" by which our faculties—seeing and perceiving along with so many others—are redeemed. It is, after all, within these communities of faith that God is at work to redefine our notions of what is beautiful and worthy of attention (i.e. a life transformed by the good news of Jesus Christ), and in this place, members of the community hopefully come to trust one another and value each others' affirmation and encouragement beyond all other forms. Perhaps, it is not too much to hope that in these communities the level of positive affirmations extended to others might come to repair or develop the notions of self-image carried by each member. In other words, everything necessary to restore healthy self-image, practically speaking, is already present in the Church's fabric of community and the gospel's hope for a final and comprehensive restoration of all things (Rev. 21:5).

The Image Looks Back

In the project of acquiring a healthy self-image, we are helped immensely by the rich traditions of theologically informed art and visual culture from the history of the Church. Despite the immense diversity and variety of works in these traditions, a common thread can be identified in that all these forms of imagery understand that embodying theological truth through an aesthetic medium requires a carefullynuanced and subtle appreciation for mediated types of seeing. In other words, theological viewing requires participation in the life of the image as you experience it. Let me illustrate what I mean.

The nature of theological viewing is probably nowhere better illustrated than in the life of icons in the Orthodox tradition. For instance, an icon like Andrei Rublev's Trinity Icon from the 15th century initiates a wholly different sort of viewing. (To view and learn more about Rubley's Trinity icon, visit the second web address in the Appendix at the end of this article). The subtle wonder of an image like this disrupts and confounds our media-saturated viewership. The angelic figures, balanced composition, and delicate inter-play of colour suggests to our eyes a mysterious depth of meaning that is not immediately found on the surface of this image. Perhaps, one of the essential reasons that generation after generation of Christians find themselves looking into this image is that this image gazes back. The returning gaze of this image, however, utilizes a power completely unknown to the siren calls of our contemporary media culture. The gaze of Rublev's icon, at once, displays not only the strength but also the receptiveness of its unified figures. Representative of the divine Trinity, the three seated figures demonstrate the mutuality and tranquillity of their community and at the same time invite the viewer to take a place at the table of their fellowship. This dual reaching-out and reaching-in illumines to us more of the mystery of the Trinity, but in order to see and understand that dynamic within the image we must, in the classic words of C.S. Lewis (1992), resist the urge to "use the picture" for our own ends and allow it to work on us. Or, in his axiomatic expression: "The distinction can hardly be better expressed than by saying that the many use art and the few receive it" (Lewis, 19). Lewis instructs:

We must use our eyes. We must look, and go on looking till we have certainly seen exactly what is there. We sit down before the pictures in order to have something done to us, not that we may do things with it. The first demand any work of any art makes upon us is surrender. Look. Listen. Receive. Get yourself out of the way. (There is no good asking first whether the work before you deserves such a surrender, for until you have surrendered you cannot possibly find out. (19)

By means of further illustrating this type of theological viewing, let us now consider one dominant trajectory in the history of Christian art and visual culture. Because of their similarly mediated meanings, the following works can also help produce in us better modes of seeing and perceiving.

Perfectly Beautiful and Perfectly Bloody: The Renaissance Crucifixion

Even a brief survey of Renaissance art will show a clear divide between how the body of Jesus Christ on the cross was represented in the Italian High Renaissance, native to artistic centers like Florence, Rome, and Venice, versus the Northern Renaissance outside of Italy in the regions of Germany, France, England, and the Netherlands. Throughout Italy, artists were primarily concerned with depicting the beautiful body of Christ as serene, composed—almost angelic. The Northern Renaissance, however, gave vivid detail to bodily afflictions Christ suffered in his death. The history of Christian visual culture actually attests to the significance of both of these perspectives and, more often than not, we find in the historical record an essentially composed but tragically bleeding Christ. It stands to reason that the heightened attention to the details of Christ's body seen in the Renaissance serves to indicate more than artistic flourish. In pursuing this comparison, I will build upon David Brown's (2009) study of Christian views of the body in the Renaissance period as displayed in the High Italian and Northern Gothic traditions. These developments, in fact, bear a profound theological significance.

In the tradition of painting a perfectly beautiful Christ, Pietro Perugino and his more famous pupil Raphael stand out as prime examples of this approach. By no means the first, the last, or even the most successful at painting a perfectly beautiful Christ on the cross, Perugino and Raphael represent a unique moment in this broader historical development of Christian imagery. Both artists were immensely successful and internationally recognized for their public commissions and the often dramatic improvements they made to the development of Western painting. Two important ecclesiastical commissions commend themselves for consideration.

Consider first Perugino's *Crucifixion* from the early 1480's that resides in the National Gallery in Washington, DC (see the third item in Appendix). Also known as "the Galitzin Triptych," this three-panel altarpiece was commissioned as a gift for the church of San Domenico near Siena and depicts the Virgin Mary, the Apostle John, Saint Jerome, and Saint Mary Magdalene as witnesses to the Crucifixion. Considered

the master of the "Umbrian school" of painting, Perugino unites in this piece a deft and graceful treatment of Christ on the cross and attendant saints with an exquisite Umbrian landscape that carefully frames the composition.

Just a couple of decades after the completion of Perugino's work, his star pupil produced a quite similarly constructed Crucifixion scene for a side chapel in the same church dedicated to Saint Jerome. Raphael's work is called The Mond Crucifixion and hangs in the British National Gallery in London (see the fourth item in Appendix). Though more compact in its composition, Raphael has surpassed his mentor in delicately presenting the perfectly beautiful body of Christ. Adorned with angels on either side collecting the softly flowing blood of the Lord, Raphael's Crucifixion is perhaps the most beautiful representation of Christ on the cross in all of Western art history. For example, successive attempts in Western painting to rival Raphael's achievements actually represent dramatic stylistic departures like that of El Greco's Mannerist visions or the Baroque austerity and mysticism of Francisco de Zurbarán. Initially, these works communicate a profound sense of Christ's perfection manifested in his body on the cross. The nature of his perfect beauty, however, seems quite out of place as displayed on the cross. Was not this the very site of his utter humiliation, suffering, and ultimate abandonment by his father? Is not the cross the last venue appropriate for depicting his perfection? Well, some might see things that way, but perhaps there seems to be more at stake here than an unchecked humanist infatuation with the ideal human form. I want to echo theologian and aesthetician David Brown (2009) who has suggested that Perugino and Raphael are representing here a "realized eschatology" of Christ's body. Just as the artists have included Saint Jerome-who would not be born for more than three centuries after Christ—Perugino and Raphael after him present a meditation on the body of Christ, not as it would have appeared in the moment of his disgrace, but at the moment of final restoration and victory. Contrary to dominant assumptions that classical Greek ideals of perfect bodily forms produced this emphasis on a beautiful Christ, Brown suggests a more subtle reading of this artistic strategy. He explains that "Greek ideals of male beauty were undoubtedly applied to Christ, but in order to deliver an essentially Christian message that was continuous with earlier, first-millennium ways of thinking. Beauty of body, even on the Cross, was being used symbolically to demonstrate the powerlessness of evil against the forces of good" (Saunders, Maude,

& Macnaughton, 2009, 31). In this way, Perugino and Raphael have united the comprehensive arch of Christ's life in one moment, and we have here both Crucifixion *and* Resurrection.

While some may reject this subtle layering of theological themes with the representation of Christ, we do not, I think, need to go as far as some have gone in claiming that this perfectly beautiful Christ signals a God/man who shares so little of our human experience that he is completely out of reach, unavailable, and unrelatable to the viewer. An unhealthy form of perfectionism with respect to the spiritual life might see this perfectly beautiful Christ, consider a similarly complete perfecting an unattainable reality, and thus abandon efforts at sanctification in the Christian life.

There is, however, good reason for maintaining that Christ has not in fact been completely divinized here. Met by the sheer glory and splendour of Christ's form, our eyes eventually descend and focus on the other figures populating the scene. Juxtaposed with this perfectly beautiful Christ, we find the less than perfect, alltoo-human saints. Both Raphael and Perugino, in their own ways, prominently display these saints as emblems of discipleship. Raphael foregrounds Jerome and Mary Magdalene and places them closer to the viewer than the traditionally more revered figures of the Virgin Mary and the Apostle John. More significantly, if much more subtly, Perugino depicts Jerome and Mary Magdalene in a much more humble fashion and actually places them within the architectural frame of the painting's composition. Mary Magdalene and Jerome actually seem to stand at the edge of a pathway cutting through the mountains that frame the scene. Curiously, these pathways do not lead away from the foreground of the scene as much as they lead up to the top of the composition. In this way, Perugino's composition seems to suggest that the saintly paths of Jerome and Mary Magdalene-unsurpassed emblems in Christendom of the penitential life—might in fact lead to the heavenly glory that Christ displays in his beautiful body on the cross. Thus, discipleship is actually affirmed by these works rather than negated, and more importantly, a proper or biblical view of bodily perfection is transmitted. As Stephanie Brown and William Miller (2005) point out, contemporary understandings of perfection relate the sense of "an immaculate and error-free state," but the origins of perfection in the accounts of Scripture imply completion, maturation and reaching a final telos (172-173).

In this way, the beautiful body of Christ pictures a final perfection that awaits the faithful disciple.

Whereas the High Renaissance style of Perugino and Raphael seems to commend discipleship through picturing its results, the Northern Renaissance demonstrates a different approach. The opposite trajectory in Renaissance depictions of the Crucifixion initiates a wholly different experience of theological viewing. Iconic in its depiction of the Northern Renaissance's grotesque cross, Matthias Grünewald's Crucifixion from the Isenheim Altarpiece of 1515 represents a stark contrast to the delicate beauty of Perugino and Raphael's work (see the fifth item in Appendix). Often described as the most significant art work of the German Renaissance, this altar piece with its immense outer panel (9 ft. by 16 ft.) depicting this most intense Crucifixion scene has left a permanent impression on the visual imagination of Western culture. As the Oxford's *Dictionary of Christian Art* describes it, "No other Crucified Christ in all Western art exceeds this one as an expression of the full ghastly horror of Christ's terrible death" (Murray & Murray, 2004, 239). Whereas the High Renaissance tradition in Italy had included the blood of Christ in the composition as just another specific detail from the biblical narrative, Northern Renaissance artists such as Grünewald make Christ's blood the focus of the picture, as seen in the inclusion of the symbolic lamb bleeding into a chalice beneath John the Baptist. Illuminating comparisons of this emphasis can be found in the work of other seminal Northern Renaissance figures like Albrecht Dürer, Lucas Cranach the Elder, and Lucas Cranach the Younger. Informed by the emerging currents of thought in a pre-Reformation environment and signified by the clear delineation of the Baptist's extended pointer finger, this artist aims to draw attention to and create a particular reverence for the sufferings of Christ. Beaten, bruised, and bleeding, the Christ of Grünewald's *Crucifixion* could not appear a more pitiable or reviled figure.

In the face of this emaciated, writhing figure stretched across a wooden cross, we encounter the inverse of the perfectly beautiful Christ of the High Renaissance—the pre-eminent sufferer, the ultimate victim, a perfectly bloody Christ. Whereas Raphael's Christ seems completely free of any stain from the world, Grünewald's Christ has lost all of his divine esteem. If Perugino and Raphael's vision tempts us to despair that we might never attain the perfect purity of Christ, Grünewald's Christ questions whether we have really suffered anything at all. Do our trials and hardships

amount to much in light of this degree of pain and suffering? Why endure anything if our suffering will never come close to the cross of Christ?

Again, our initial reading of this image belies the complex meaning it holds. The particular context of this work bears a unique significance that explains in large part the extreme nature of Christ's bodily suffering here. Commissioned for the chapel of the monastery of St. Anthony in Isenheim, Grünewald's altarpiece was intended for a congregation well-acquainted with intense physical afflictions, for this chapel was located in a lazar-house—a hospital for those afflicted with skin and nervous diseases, also known as a leper colony. In this way, the inmates of the hospital saw before them a saviour who has suffered in the same way as they now do—a Christ with whom they could identify and in whom they might find solidarity. Solidarity, however, was not the artist's only concern, for Grünewald's Crucifixion is after all only the front panel of a multi-panel altarpiece. Behind this grotesque scene of Christ's suffering, worshippers would find a similarly astounding vision of Christ's Resurrection glory (see the sixth item in Appendix). Within the altarpiece, Grünewald placed one of the most remarkable visions of Christ's resurrected form found in all of Western art history. Whereas at his death, Grünewald's Christ suffered over every inch of his body, so at the moment of his return to life, the same afflicted figure has been transformed completely into a radiant, beaming son of man. Thus, Grünewald balances the intensity of Christ's sufferings with the eternality of his glory. In this way, viewers of this piece might be reminded of the momentary nature of this life's trials in light of eternal glory with Christ, not as a mode of flippant escapism but as a reliable means of facing the challenges and difficulties that presently beset us. Or, as St. Paul eloquently reminds us in Romans 8:18, "For I consider that the sufferings of this present time are not worth comparing with the glory that is to be revealed to us."

Conclusion

It seems that in very different ways, both the perfectly beautiful Christ of the High Renaissance and the perfectly bloody Christ of Isenheim draw their viewers into a space of contemplation and discovery only to return them to reality with a renewed imagination. These moments of visual exploration and perceptual deliberation, often provided to us through the arts, represent a healthy alternative to the incessant conditioning of our media culture. By contrast, these moments of discovery stretch

us and grow us. Training our vision in this way helps us to resist the habits of a negative, unhealthy perfectionism that accounts only for the surface appearance of our bodies and misses the hidden significance of embodiment.

As these paintings suggest, in their unique but contrasting fashions, human embodiment has and always will have special worth in God's eyes. As both creator and redeemer of embodied persons, God clearly delights in human bodies and values them enough to initiate a process of perfecting these embodied creatures, perfecting them, that is, according to a divine standard—the image of Jesus Christ (Rom. 8:29, 1 Cor. 15:49, 2 Cor. 2:13). Indeed, by the Incarnation, Crucifixion, and Resurrection of Christ, diversely represented in the paintings discussed above, God has also shown the depths of divine love for the redemption of the human person—soul *and* body. These pictures of discipleship train us to see ourselves as more than merely souls awaiting release from the body or bodies burdened by the demands of the soul. They redefine our shallow notions of perfection and enrich our hope for the complete deliverance that God has promised in Christ—the sort of deliverance through struggle made known in the haunting words given to the prophet Jeremiah: "I will give you your life as a prize of war" (Jeremiah 21:9, 38:2, 39:18 and 45:5).

To escape this life of struggle with our whole selves (soul and body) is an astounding grace of God, and the more we reflect on this promise, the better we will resist the increasingly banal and vain temptations that foster an unhealthy perfectionist seeing. Whether meditating on the body's deliverance through Scripture or contemplating profound examples of the Christian artistic tradition, moments spent considering the disciple's journey will mature us and begin to shape in us a more careful seeing and perceiving enriched by the theological wisdom we find in the journey—in short, we will undergo the preparation of the redeemed to behold the face of God.

Notes

1 According to the APA *Dictionary of Psychology*, perfectionism manifests "the tendency to demand of others or of oneself a higher level of performance than is required by the situation" VandenBos (2007, p. 685). In the context of an unhealthy perfectionist self-image, the demand to perform a better look or maintain one's body in strict conformity to perceived cultural standards of human beauty can lead to dysfunctional behaviors that include the loss of relationships, depression, eating disorders, and other forms of self-abuse.

2 For another helpful discussion of perception, see Ronald Philipchalk (1987) tackle the difficult topics associated with seeing in his chapter on sensation and perception (pp. 45-60).

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Appendix

- 1. Giotto's "Navicella" Mosaic:
- http://saintpetersbasilica.org/Interior/Navicella/Navicella.htm
- 2. Andrei Rublev's Trinity Icon:
- http://tars.rollins.edu/Foreign Lang/Russian/trinity.html
- 3. Perugino's Galitzin Triptych:
- http://www.nga.gov/collection/gallery/gg20/gg20-35.o.html
- 4. Raphael's The Mond Crucifixion:
- http://www.nationalgallery.org.uk/paintings/raphael-the-mond-crucifixion
- 5. Grünewald's Isenheim altarpiece:
- http://www.aug.edu/augusta/iconography/iconographySupplementalImages/crucifixion/grunewald1515.html
- 6. Grünewald's Resurrection panel from the Isenheim altarpiece:
- http://www.ibiblio.org/eldritch/jkh/gr7.html

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David Malone

Dr. Malone has taught English at Union since 1999. He specializes in Creative Writing and American Literature. He's earned degrees from Wheaton College, the State University of New York at Binghamton, and Northern Illinois University. Twenty-five years ago, he made the smart move of asking a sharp, funny woman he met at Wal-Mart to marry him. Among the books by the side of his bed are *The Pale King* by David Foster Wallace, *Home* by Marilynne Robinson, and *Planetary Volume 4* by Warren Ellis and John Cassaday. He's said to make a mean lasagna.

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Dr. Bill Nettles is a native of Brandon, Mississippi, and has taught undergraduate physics for over 30 years. He came to Union in 2006. He has taught courses in almost every major physics topic, along with several engineering and mathematics courses. His hobbies include wearing bow ties, working on cars (including renewing a 1969 Mustang), playing electric bass, and riding motorcycles. He loves physics, his family, and Jesus.

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Dr. Worley recently completed his doctorate in theology through the Institute for Theology, Imagination, and the Arts at the University of St. Andrews in Scotland. While his doctoral research examined how dialogue between theology and contemporary art might be restored through an engagement with the reappearance of Christian art traditions and imagery in modern visual art, his research interests continue to explore the intersection of theology and contemporary art, critical theory, aesthetics, and the philosophy of film. He serves as Associate Dean for Spiritual Life and Assistant Professor of Christian Thought and Tradition at Union University in Jackson, Tennessee. He co-founded the Society for Critical Imagination, an arts and culture initiative, with Jonathan Paul Gillette.

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