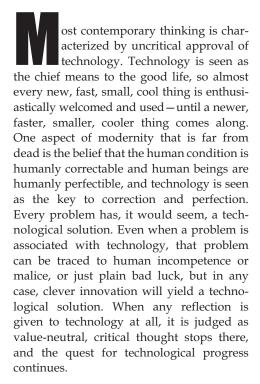# Thinking Critically and Christianly About Technology

Ken Funk

To think critically and Christianly about technology is to engage in a process of careful judgment and evaluation of it using Christian principles. The principles proposed here are that technology ought to facilitate (1) communion with God, (2) preservation of human life and improvement of human welfare, and (3) preservation and protection of the natural world. Application of these principles easily yields obvious approbation and disapprobation for technology. Closer examination, however, reveals that technology is ambivalent, it promotes subsidiary goods to primary importance, it contributes to the illusion of human sovereignty, and it is a source of moral distraction. From these and other considerations, it may be concluded that while technology may be intrinsically value-neutral, instrumentally speaking it tends toward evil in the hands of fallible humans. Christians therefore ought to be more prudent in the development, choice, and use of technology.

Ken Funk

Most contemporary thinking is characterized by uncritical approval of technology. Technology is seen as the chief means to the good life, so almost every new, fast, small, cool thing is enthusiastically welcomed and used—until a newer, faster, smaller, cooler thing comes along. One aspect of modernity that is far from dead is the belief that the human condition is humanly correctable and human beings are humanly perfectible, and technology is seen as the key to correction and perfection. Every problem has, it would seem, a technological solution. Even when a problem is associated with technology, that problem can be traced to human incompetence or malice, or just plain bad luck, but in any case, clever innovation will yield a technological solution. When any reflection is given to technology at all, it is judged as value-neutral, critical thought stops there, and the quest for technological progress continues.

Judging by outward behavior, Christian thinking about technology is in complete agreement. In terms of the technologies that Christians choose and use and the patterns of use that they manifest, the daily lives of Christians are largely indistinguishable from those of non-Christians. Even Christian worship is permeated by technology. Although distinct in its substance, the form of contemporary worship, owing to the technologies

used and the ways they are used, closely approximates those of secular business, education, and entertainment.

This ought to trouble us, for Paul the Apostle wrote to the new Roman Christians, "… do not be conformed to this world, but be transformed by the renewing of your mind, that you may *prove* what the will of God is, that which is good and acceptable and perfect"[1] He wrote to the church at Thessalonica, "… *examine* everything carefully, hold onto that which is good; abstain from every form of evil."[2] The key verbs in those passages, *prove* and *examine*, are from the Greek *dokimazein*, which means to prove, test, or examine; to hold as good or pure after trial;[3] to accredit,[4] which means to certify as meeting a prescribed standard. In short, it means to be critical. If Christians are to be responsive to Paul's admonitions, they must learn to think critically and Christianly about everything, and not least about technology.

The purpose of this article is to explain what thinking critically and Christianly

In terms of the technologies that Christians choose and use and the patterns of use that they manifest, the daily lives of Christians are largely indistinguishable from those of non-Christians.

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Thinking critically and Christianly about technology means careful evaluation and judgment of technology with respect to Christian principles. It means making value judgments about technology from a Christian worldview, and it yields a Christian critique of technology.

about technology would mean, to suggest how it might be done, and to provide some examples of doing it.[6] Thus this article is both a primer on thinking critically and Christianly about technology and a Christian critique of technology. With respect to the latter, it is not the first. Although the critiques of Jacques Ellul[7] and E. F. Schumacher[8] are not distinctively Christian, they reflect Christian principles. Albert Borgman[9] more directly addresses the impact of technology on the sacred, but it is from a mainstream or liberal Christian perspective. On the other hand, Stephen Monsma and the Fellows of the Calvin Center for Christian Scholarship critique technology from a more evangelical or reformed perspective.[10] Their thinking parallels my own in many respects. But my approach is significantly different in a number of ways.[11]

Below, I explain what I mean by thinking critically and Christianly about technology and define technology in several senses. I present three biblical principles and apply them to arrive at some fairly obvious judgments about technology as well as some not-so-obvious observations about how it changes the way we value things in manners inconsistent with those principles. I close with a broad conclusion about technology and some recommendations.

Definitions

By thinking critically about something, I mean engaging in a process of careful, principled judgment and evaluation.[12] It is principled in its articulation and application of a set of axiological principles,[13] and careful in its thorough and systematic use of them and in its precise language. It makes judgments and evaluations of the thing with respect to the principles to produce approbation and disapprobation and, perhaps, intentions and recommendations for behavior consistent with its findings. To think Christianly as well as critically about something means to judge and evaluate it with respect to principles that are distinctly Christian.

Thus, thinking critically and Christianly about technology means careful evaluation and judgment of technology with respect to Christian principles. It means making value judgments about technology from a Christian worldview, and it yields a Christian critique of technology. Put simply, it asks and

attempts to answer the question, "From a Christian perspective, is technology good or evil?" That may seem naively simplistic, but it is not. The fact that technology so thoroughly permeates contemporary life requires a thoughtful answer to this very question.

To think critically and Christianly about technology requires a definition of the term. While there are many of them,[14] the essence of technology is, I believe, best captured by a definition based on the term's etymology. The English word is derived from two Greek words, *techne* and *logos*. *Techne* means *art, skill, craft, the way, manner or means by which a thing is gained*.[15] This emphasizes practice or process, especially process in which physical states of the world—configurations of matter, energy, and information—are transformed to ones of greater value: goodness, utility, or beauty. With this emphasis on process involving the artist or craftsman, *techne* is inseparable from the practitioner,[16] and any tools of *techne* are instruments of the practitioner, overcoming his limitations and extending his capabilities to impart value to the world. *Logos* means *word, expressed thought, or reason*, the last sense equivalent to the Latin *ratio*.

From its roots, *technology* may thus be defined as the application of rational methods to extend human capabilities to realize valued states of the material world. It is a means of overcoming human limitations[17] and a practice or process in which its users are intimately involved. An instrument of value creation, technology is therefore an extension of human moral agency. Its application of rational methods distinguishes technology from other human endeavors, such as music and the visual arts, literature and poetry, and sports and entertainment. Although these may utilize technology, they are distinct from it in that they rely on mainly arational methods.[18] Technology's direct effect on the material world also distinguishes it from those processes aimed at achieving emotional or spiritual ends, like art or religion.

The word is commonly used in at least four senses, so to speak more precisely, I will use the following terms. *Technological objects* are the physical and conceptual things (tools, devices, systems, materials, methods, procedures) used as means to realize valued states of the material world. The process of devel-

oping technological objects is *technological innovation*. A *technology*, for example, computer technology, is a subset of technological objects. *Technological practice* is the process of choosing and using technological objects, and involves a reciprocal relationship in which the users of the technological objects affect the objects and the objects affect their users. By use of the unqualified term, *technology*, I mean technology in its broadest sense, encompassing all of these dimensions.

Principles

The Bible contains many references to technology, but they are, of course, to ancient technological objects and practice, and few of them offer any direct approbation or disapprobation. The Bible does, however, speak extensively about value, that is, goodness and morality. Indeed, it proclaims a hierarchy of good and sets forth certain corollary moral responsibilities corresponding to each level in that hierarchy. As technology exists for the realization of valued states of the world and is an extension of human moral agency, the Bible thus provides principles for thinking critically and Christianly about contemporary technology.[19]

There exist very few intrinsic goods,[20] perhaps only three.[21] The supreme good is individual and corporate communion with God. Jesus preached the kingdom of God[22] and told us to seek it first above all else,[23] thus declaring it the highest good, the *summum bonum*. Augustine named eternal life the supreme good,[24] which is consistent with Christ's teaching, for Jesus equates it with being in God's kingdom in the account of the rich young man.[25] Elsewhere in the gospels, eternal life is equated with salvation,[26] knowledge of God,[27] and unity with God through Christ.[28] We usually think of salvation or eternal life as being an individual fellowship with God, but Christ's teachings, especially in the Gospel of John, place such individual fellowship with God in the context of the fellowship of believers. I use the phrase, individual and corporate communion with God, to refer to these equivalent terms. As part of this special relationship we are privileged to have with God, we are to love God with all of our hearts, souls, minds, and strengths[29] and to place nothing before God in importance.[30] We are to acknowledge his sovereignty,[31] to ascribe glory to him,[32] to trust him,[33] to obey his commandments,[34] and to be humble before him.[35]

Below communion with God in the hierarchy of the good are human beings and their welfare.[36] God created man in his own image,[37] thereby giving human beings intrinsic value of great magnitude.[38] Indeed, God valued humans enough to lower himself to redeem them.[39] We are thus to love our neighbor as we love ourselves[40] and to treat others as we wish to be treated.[41] We are to live in righteousness,[42] humility,[43] peace and tranquility,[44] free from anxiety.[45] We are not to live in isolation, but in community.[46]

The natural world and its order and integrity, although lowest in the hierarchy of the good,[47] are nevertheless of great value. God repeatedly declared the lower creation very good[48] and associated with his valuing are certain responsibilities for humans as moral agents. We have been given the cultural mandate to "[b]e fruitful and multiply, and fill the earth, and subdue it."[49] We have also been given dominion over the earth,[50] but that dominion should be one of responsible stewardship[51] and not one of tyranny.

From these three intrinsic goods and their corollary moral responsibilities, John Calvin's admonitions as to "how we must use the present life and its helps,"[52] suggest three principles for thinking critically and Christianly about technology that address its instrumental value[53] in the realization of the intrinsic goods.

Principle 1:
Technology ought to facilitate and not hinder our communion with God and the fulfillment of our moral obligations to him.[54]

Principle 2:
Technology ought to facilitate and not hinder the preservation of human life and improvement of human welfare[55] *and the fulfillment of our moral obligations to people.*

Principle 3:
Technology ought to facilitate and not hinder the preservation of the natural world and its order and integrity and the fulfillment of our moral obligations to God's lower creation.

When technological practice yields states of the material world manifesting or conducive to these intrinsic goods and helps us in fulfilling these moral responsibilities, the technology involved has positive instrumental value (is good). When the opposite is true, technology has negative instrumental value (is evil). In ascribing value to technology in general, to a certain technology, or to a specific technological practice involving a particular technological object, the greatest weight must be assigned to its contribution to communion with God, lesser weight to its contribution to human life and welfare, and least weight to its effects on the natural world.

Application

Application of these principles easily yields approbation of technology. Sustainable technologies, like biofuels and recycling technologies, reduce our consumption of non-renewable natural resources (consistent with the third principle). We enjoy longer, healthier, more comfortable lives than did our ancestors, thanks to agricultural, construction, and medical technologies (second principle). From the middle of the first century to today, technological objects, including roads, boats, printing presses, and the internet, have facilitated the spread of the gospel (first principle).

Thinking more critically and Christianly about technology, however, reveals evils of technology more subtle and therefore potentially more dangerous. I will discuss four: (1) the ambivalence of technology, (2) the promotion of subsidiary goods, (3) the illusion of human sovereignty, and (4) technological distraction.

On the other hand, the byproducts of mining, agricultural, materials processing, and manufacturing technologies spoil the earth's land, air, and water, and render many of our remaining natural resources unfit for use (contrary to the third principle). Adverse drug reactions and human errors in the use of medical devices and procedures kill tens of thousands of Americans annually, and agricultural chemicals in soil, air, and water and those remaining on the foods we eat cause environmental illnesses which are sometimes fatal (second principle). Transportation and communication technologies carry messengers and messages contrary, even hostile, to the gospel (first principle).

Approbation and disapprobation like this could go on, and indeed they fill volumes. But even short lists of the obvious good and evil of technology are tedious: obvious good needs no correction and obvious evil is easy to see, if not to avoid. Thinking more critically and Christianly about technology, however, reveals evils of technology more subtle and therefore potentially more dangerous. I will discuss four.

The Ambivalence of Technology

First is the ambivalence of technology, a term coined by Jacques Ellul.[56] Whenever we create a new technology to realize some good, we must expect that it will bring evil too, both intended and unintended.

For example, airliners provide a valuable service to humanity by transporting millions of people quickly, safely, and in relative comfort to their destinations daily. Yet airliners harm the natural environment by producing noise and air pollution. Moreover, every year, around twenty large commercial transport aircraft accidents kill hundreds or thousands of passengers and people on the ground. More frighteningly, airliners were used as weapons in the September 11 terrorist attacks that took thousands of lives.

Another example is found in chemical fertilizers. They make it possible to grow crops in the quantities necessary to feed the world's burgeoning population, yet excessive and indiscriminate use can poison the environment. And in April 1995, Timothy McVeigh mixed chemical fertilizer with rac-

ing fuel to make the bomb with which he murdered 168 people in the Federal Building in Oklahoma City.

This pattern is universal: every technology created for good brings evil as well. In most cases, that evil is an unintended consequence of technological practice, but in others, technological objects originally intended for good are used for evil purposes. I can think of no technology that is exceptional in this regard and, therefore, not in violation of at least one of the principles.

The Promotion of Subsidiary Goods

Second, technology promotes subsidiary goods to primary importance, a phenomenon which follows a common pattern. First, the capacity to realize an intrinsic or instrumental primary good is established by a new technology (e.g., cars, computers, or cell phones). Then, gradually, subsidiary goods come to our attention. Subsidiary goods may be valued attributes of the technological objects themselves (e.g., compactness, light weight, versatility, economy, or physical or functional capacity) or valued attributes of the technological practice that yields the primary good (e.g., speed, convenience, efficiency, or economy).

As a result we begin devoting more and more time and resources to increasing the subsidiary goods. We call this "making the technology better" or "finding a better technology": smaller, faster, more powerful, cheaper, more convenient, more efficient, and so on. A point is reached at which we are devoting a disproportionate share of time and resources to increasing the subsidiary goods rather than realizing the primary good. While it is true that making the technology better has at least the potential to increase the primary good indirectly, there is a point of diminishing returns, at which additional time and resources would be more properly spent on realizing the primary good: "better is the enemy of good enough." But by this time it may be too late: the pattern has been set and the quest for the better has become an obsession.

Eventually the subsidiary goods achieve a kind of prominence over the primary good, even though they have no intrinsic or

instrumental value themselves. By virtue of the fact that it manifests them, the technology itself is exaggerated in importance and even takes on a kind of intrinsic value. Technological innovation and practice thus change the way we value away from a manner that is consistent with the three principles. In letting this happen, we may be like the foolish rich man who tore down his barns to build bigger ones and in so doing, forfeited his soul.[57]

The Illusion of Human Sovereignty

Third, technology contributes to the illusion of human sovereignty. God gave us dominion over the earth and we have accepted the role with enthusiasm. With agricultural technologies, we bend the natural world to our will to produce the food and fiber that we consume and wear and with which we shelter ourselves. Drilling and mining machines plumb the depths of the earth and sea for once inaccessible resources. With excavation equipment and explosives, we shape the landscape to make way for buildings and highways. Dams, dikes, and levees channel and control the natural flow of water, and construction and architectural technologies permit us to build houses, communities, and even large cities on sites once subject to frequent flooding.

Technology gives us power over our own bodies. With medical technologies, we have overcome many of the diseases and afflictions that plagued our ancestors. Hair colorings, cosmetics, medicines, and surgical procedures extend at least the appearance of youth. Medicines and surgeries prevent or counteract the undesired consequences of bodily passions, like unbridled sex and overeating. Some of our contemporaries even believe that genetic engineering, nanotechnology, robotics, and other technologies will make us immortal.[58]

Technology also gives us power over others. Locks, security systems, and firearms constrain the behaviors of those who would rob or otherwise harm us. Marketing, advertising, and propagandizing technologies shape economic and other social behavior. Stronger nations impose their wills on weaker nations with information and weapons systems.

It is true that people continue to die of afflictions associated with old age, that cures for certain diseases remain elusive, that insurgents not only survive high-tech weapons attacks but return from them to fight with renewed vigor, and that tsunamis and hurricanes still destroy villages, towns, and even cities. But the tremendous technological progress we have made in the last centuries naturally gives hope that even persistent nuisances like these will be overcome by technology. That, I believe, is not only a false hope, but an impious one.

It is not that these technologies are inherently evil, but that collectively, technology indulges our natural inclinations to put our confidence in ourselves as its creators rather than in God, the Creator of all. When we become ill, do we first turn to prayer or to medicine, or do we even routinely accompany medicine with prayer? Can we be surprised at the depravity around us when we no longer see fit to acknowledge God's sovereignty?[59] Technological practice not only alters the world in obvious ways, it changes us, bringing us to a state of confidence in human sovereignty that is in clear violation of the first principle.

Technological Distraction

Fourth, technology is a source of moral distraction, drawing our attention and effort from higher goods to lower goods. Luke tells of the visit of Jesus and his disciples to the home of Martha and Mary.[60] While Mary sat at the Lord's feet listening to him, Martha became distracted with all the preparations for her guests. She complained about Mary to Jesus, who responded, "Martha, Martha, you are worried and bothered about so many things; but only a few things are necessary, really only one, for Mary has chosen the good part, which shall not be taken away from her." It was not that Martha was doing something inherently evil, for hospitality is obedience to the second greatest commandment[61]; it was that Mary was doing something far better.

We all recognize the alternative described by the commonplace, "the lesser of two evils," as a kind of good. But in the conversation with Martha, Jesus implied what Leibniz later more explicitly declared, that the pursuit of the lesser of two goods, at the expense of the greater, is a kind of evil.[62] And that is often precisely the case with technology: Technological objects distract us from the higher good—especially the *summum bonum* of communion with God—by persistently drawing our attention to lower goods.

Technological objects enable or at least facilitate the realization of many, many goods: food, clothing, shelter, health, knowledge, entertainment, beauty, community—the list could go on forever. But there is a cost of acquiring and maintaining these goods, and that not only monetary. To realize them, we must allocate time and attention to the operation of the technological objects that provide them: cooking utensils, sewing machines, table saws, medical devices, computers, televisions, lawn mowers, and e-mail. Often, owing to their complexity (e.g., computers) or the physical danger they pose (e.g., lawn mowers), the use of technological objects to realize mundane goods requires our undivided attention: when we use them, that use occupies our minds to the extent that our thoughts are not free to rise to higher things.

From a Christian perspective, is technology good or evil? … The inescapable conclusion is that, instrumentally, technology is good, technology is evil, and the tendency of technology, like that of the human heart, mind, and body of which it is an extension, is toward evil.

Using technological objects requires that time and attention also be given to learning about them, acquiring them, learning how to use them, cleaning and maintaining them, and dealing with the undesirable consequences of their use. When we are done with them or tired of them we go to some trouble to dispose of them or give or sell them to someone else. A good deal of time is also spent in teaching others to do these things.

So technological objects both create many opportunities for the good and occupy our time and attention in their use and in their care. This situation is further compounded by the ubiquity of technological objects and their salience: technological objects are all about us and they are often conspicuous in their physical presence, virtually demanding our attention by their sights and sounds. The fact that goods can often be realized more quickly with technological objects than without them (if they can be realized at all without them) induces us to undertake more activities to realize those goods, for we naturally desire the good. The growing list of activities to pursue accelerates the pace of life in general and, in turn, increases the urgency of each individual activity. Unfortunately, even technologies designed to help us manage time more effectively, like electronic calendars, only make matters worse by encouraging us to pack more into each day, thereby increasing the number and urgency of mundane activities even more.

By definition, technological objects directly affect only the material world, so the goods that they provide are predominantly the lower goods, those addressed in principles two and three. Although the use of technological objects can indirectly contribute to the *summum bonum*, communion with God, the vast majority of the activities they support do not. The ubiquity and salience of technological objects and the pervasiveness and urgency of technologically supported activities can easily draw one's attention and time from God and his kingdom to lower things. Technological practice, which involves a reciprocal relationship between technological objects and their users, thus sets up patterns of valuing that are in conflict with the first principle.

Other Evils

Thinking critically and Christianly about technology reveals many other violations of the principles, but space limitations preclude all but the mention of a few of them. For example, technological objects increase the pace and the "busy-ness" of life to the detriment of spirituality.[63] Our present obsession with technological objects amounts to idolatry. Technology fuels the pervasive culture of materialism. The great power that technological objects give us seemingly obviates God's grace. It can lead to a tyrannical dominion of nature.

Conclusion

In the preceding pages, I have explained what I mean by thinking critically and Christianly about technology and have defined technology in several senses. I presented three biblical principles and applied them to arrive at some obvious and some not-so-obvious judgments about technology. To draw a broad conclusion from all this requires an answer to the question, "From a Christian perspective, is technology good or evil?"

Most would dismiss the question with the response that technology is value-neutral. Intrinsically speaking, I would agree, going even so far as to say that, aside from the rare device that is the object of a collector's or fancier's affections, technological objects have no intrinsic value at all. But by the definition I have used, technology considered in all its dimensions has instrumental value and that is how the question must be addressed. The answer has three parts.

From the evidence behind the approbation I have or could have offered, the first part of the answer is that technology is good. From the stated and possible disapprobation, the second part is that technology is evil. The third part of the answer is more difficult. Is technology *predominantly* good or evil, or is there a *tendency* in technological innovation and practice toward good or evil? While I have devoted more words to its condemnation than to its praise, I do not think that we can say that, on the whole, technology is good or that it is evil. Bentham's hedonic calculus notwithstanding, there are simply no metrics that can be

applied across disparate goods and evils, intrinsic or instrumental. But I do believe that there is an axiological tendency to technology that can be induced from the following considerations.

First, we live in a universe that tends to disorder, and disorder is more commonly associated with evil than with good. Technological objects are particularly vulnerable to the disorder of deterioration, which compromises both function and safety.[64]

Second, the human body and mind are fallible, and that leads to errors in the operation of technological objects, often with evil results. We have sensory and perceptual limitations that cloud our awareness. We forget important things to consider and do. We carry a host of cognitive biases that compromise our ability to make sound decisions and judgments. We have limited physical speed, accuracy, and strength that reduce our ability to affect our environments in the ways we intend. These fallibilities[65] manifest themselves not only in the frustrating difficulties we have in the operation of technological objects every day, like problems with can openers and computers, but in large-scale technological disasters like air crashes.[66] Moreover, not only do the fallible human users and operators of technological objects cause unintended evil,[67] fallible designers make design errors that sometimes lead to serious problems.[68]

Third, the human heart is sinful. We know from the Bible and from personal experience that humans are by nature evil,[69] and that evil nature is usually expressed with the aid of technological objects. The September 11 attacks, for example, used Boeing 767s.

Fourth, if Ellul and I are right about the ambivalence of technology, technological practice involving any technology brings evil as well as good. Some of that evil can be anticipated, but there will always be unknowns, evil surprises, as it were. Although some of the evil is intended, in general, most of it is not. For example, automation is often introduced to improve efficiency and reduce human drudgery and error, but automation also puts people out of jobs and sometimes seriously challenges the users and operators that remain.[70]

Fifth, technology amplifies and exacerbates the human tendency toward evil. Technological objects and technological practice set up a milieu that fosters evil behaviors and actually alters our value systems. Technology creates an environment in which speed, power, and efficiency dominate our thinking and the ends to which it propels us become merely matters of personal choice, one being equivalent to any other. Technology's many great successes encourage us to trust in our own capacities to solve our own material problems and to elevate our own material conditions, as if we were independent of God's power and grace. Technology distracts us from the higher good and conditions us to attend mostly to the lower good. Technology not only changes the material world. In these and many other ways, it changes us morally, and not for the better.

The inescapable conclusion is that, instrumentally, technology is good, technology is evil, and the tendency of technology, like that of the human heart, mind, and body of which it is an extension, is toward evil.

Some would challenge the significance of this conclusion, saying that technology's ambivalence and propensity for evil make it no different from any other human institution, like eating, sex, politics, or the university. To a certain extent I agree, but three factors distinguish technology from these other things. First, while most people acknowledge the obvious evil effects of technology, it is not apparent that they are aware of the potentially more dangerous and subtle effects technology has on us and on our valuing. Second, technology is an instrument of virtually all human institutions. Therefore, third, technology as an extension of human capabilities acts as an amplifier and increases the potential for abuse of other institutions.

My conclusion would seem to condemn the whole technological enterprise, including my own career in engineering education and research. But humans were created in God's image[71] and as God is creative, so we too are creative, and technology is a natural and proper manifestation of our creativity. For some of us, responsible technological innovation is a legitimate, even a noble, vocation, as Calvin would say, "a post assigned [us] by the Lord."[72] Technology is required to fulfill the cultural mandate[73] and the great commission.[74] The basic necessities of the world's population could not be met without technology, and technology is used not only out of necessity, but also for legitimate delight.[75]

Recommendations

Thus, to abandon technology completely would not be desirable, even if it were possible. Rather, prudent[76] technological innovation and practice are required. This is not a new idea, for Socrates placed prudence above ingenuity millennia ago,[77] nor is it unique today. E. F. Schumacher,[78] Jacques Ellul,[79] and other critics of technology have said as much in the last few decades, and even technologist Bill Joy recently urged great caution in certain technological innovation.[80]

Here is a great opportunity for Christians to be salt and light in a technological world,[81] for I believe that many of our frantic, disappointed, distressed, debt-ridden, distracted contemporaries are nearly ready for some good examples of technological prudence. Prudent technological practice involving any and all technological objects would be directed by ongoing, careful, and above all, prayerful attention to considerations such as those

presented in Table 1, a guide to prudent technological practice.

The guide is not intended to be a rigid framework and it falls short of addressing all of the complexities and subtleties one might encounter in dealing with this difficult challenge. Rather, it is intended as a tool to help one think critically and Christianly about one's technological practices with respect to the principles presented above. The levels of agreement one can give to the assertions in the main part of the guide and, more importantly, the thinking required to make those assessments, should be useful in determining how or even if the practice should be conducted. In most cases, prudence would dictate that some carefully considered limitations be placed on the practice, in terms of function (i.e., for what purposes the practice may be pursued), time (i.e., when it may be pursued), or space (i.e., where it may be pursued).[82]

The challenge of prudent technological innovation is harder, for the Christian innovator (applied scientist, engineer, or inventor) would have to consider the level of

Table 1. A Guide to Prudent Technological practice

Consider a technological practice involving one or more technological objects and rate your level of agreement with the following assertions. Practice includes acquisition, learning/training, preparation, use, consequence mitigation, and disposal.	SD = Strongly Disagree D = Disagree N = Neutral A = Agree SA = Strongly Agree
1. This practice places me or someone else in physical, mental, or emotional states that, to the best of my understanding, are conducive to communion with God.	SD D N A SA
2. This practice increases someone's awareness and understanding of God and his kingdom.	SD D N A SA
3. This practice does not require time, attention, or resources that I would otherwise devote to God.	SD D N A SA
4. This practice and its intended outcome in no way diminish my trust in God nor my dependence upon him for my or anyone else's spiritual or material good.	SD D N A SA
5. I acknowledge that this practice is possible and effective only through God's sovereignty, power, and grace.	SD D N A SA
6. This practice helps preserve someone's life or promotes someone's welfare.	SD D N A SA
7. This practice does not harm, annoy, or inconvenience anyone.	SD D N A SA
8. In this practice I do not seek power or status over others.	SD D N A SA
9. This practice does not require time, attention, or resources that I would otherwise devote to others, especially those dear to me.	SD D N A SA
10. This practice does not harm the natural world.	SD D N A SA
11. This practice uses amounts of natural resources commensurate with the good it yields.	SD D N A SA
12. If this practice replaces an older one (perhaps in that it involves a new technological object), it is not merely newer, faster, cheaper, smaller, or just more appealing to me. The primary good it is intended for is served much better.	SD D N A SA

If, in the above, the tendency is to …	then the practice should be …
(strongly) agree	subject only to normal Christian prudence.
be neutral	subject to functional, temporal, or spatial limitations.
disagree	subject to severe limitations.
strongly disagree	rejected or relinquished.

agreement that potential users of the new technological object would give to assertions such as those in the guide—a truly daunting task. But principled, prayerful thinking about those considerations should be helpful in deciding what to work on—or not.[83] Such thinking might be aided by, for example, something like Failure Modes and Effects Analysis (FMEA), a technique of proven effectiveness in anticipating and avoiding technical problems with devices and systems. A variant of FMEA to facilitate prudent technological innovation might consider failure modes suggested by the assertions in the guide.

Technology, like humans, may be fallen, but I believe that it has a role to play in God's kingdom, and therefore God intends the redemption of technology. If we are to be instruments of that redemption, we must learn prudent technological innovation and practice. For that, we must learn to think critically and Christianly about technology. ■

Acknowledgments

Notes

[1]Romans 12:2. Scripture taken from the *New American Standard Bible*, © 1960, 1962, 1963, 1968, 1971, 1972, 1973, 1975, 1977, by the Lockman Foundation. Used with permission.

[2]1 Thessalonians 5:21–22.

[3]Liddell and Scott, *Greek-English Lexicon* (Oxford: Oxford University Press, 1891/1996), s.v. *"dokimazo"* (δοκιμαζω).

[4]Gerhard Kittel, ed., *Theological Dictionary of the New Testament* II, trans. Geoffrey W. Bromiley (Grand Rapids, MI: Eerdmans, 1964), 255–60, s.v. *"dokimazo"* (δοκιμαζω).

[5]The views expressed in this article are those of the author and are not an official position of Oregon State University.

[6]This article was written by a Christian, primarily for Christians. But, independent of its sectarian Christian perspective, it is intended as an example of thinking critically about technology from the perspective of any worldview. Were a thinker from any of the world's major religions to follow the same approach, I believe that he would reach similar conclusions and recommendations.

[7]Jacques Ellul, a historian and sociologist of institutions and a lay theologian in the Reformed Church of France, certainly wrote *The Technological Society* (New York: Vintage Books, 1964), *The Technological System* (New York: Continuum, 1980), and *The Technological Bluff* (Grand Rapids, MI: Eerdmans, 1990) from a Christian perspective.

[8]A Christian perspective is also clear in E. F. Schumacher's *Small Is Beautiful* (New York: Harper & Row, 1973), which is primarily about economics, but addresses technology in that context.

[9]Albert Borgman gives a thoughtful critique of technology from a mainstream Christian perspective in *Power Failure* (Grand Rapids, MI: Brazos Press, 2003).

[10]Stephen V. Monsma, Clifford Christians, Eugene R. Dykema, Arie Leegwater, Egburt Schurman, and Lambert Van Poolen, *Responsible Technology* (Grand Rapids, MI: Eerdmans, 1986).

[11]I will point out how my approach differs from that of Monsma, et al., *Responsible Technology*, in several subsequent notes.

[12]To some readers, "thinking critically" will immediately suggest the concept of "critical thinking," but critical thinking focuses on developing rational thought processes for arriving at valid conclusions (cf. P. A. Facione, *Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction: "The Delphi Report"* [Millbrae, CA: The California Academic Press, 1990]). Critical thinking is thus limited almost exclusively to a logical dimension of thought. But human judgment is not limited to assessing the validity of assertions, and when the apostle Paul wrote of proving and examining, he was not speaking primarily of that. Many, if not most of our judgments are judgments of value. It is value on which I wish to concentrate, so I use the permutation "thinking critically" to distinguish it from critical thinking.

[13]Axiology, from the Greek *axios* (ἀξιος, s.v. "worthy," Liddell and Scott, *Greek-English Lexicon*), deals with value of all kinds, moral (i.e., the rightness of a human action) and non-moral (i.e., the goodness of a thing or condition). Therefore, axiological principles are standards of goodness and morality.

[14]Cf. Martin Heidegger, "The Question Concerning Technology" in *The Question Concerning Technology and Other Essays*, trans. William Lovitt (New York: Garland Publishing, 1977), 3–35; Ellul, *The Technological Society*, *The Technological System*, and *The Technological Bluff*; Ray Kurzweil, *The Age of Spiritual Machines* (New York: Viking, 1999).

[15]Liddell and Scott, *Greek-English Lexicon*, s.vv. *"techne"* (τέχνη) and *"logos"* (λόγος).

[16]That *techne* and therefore technology cannot be separated from the people that apply them, witness the surnames, Smith, Miller, and Carpenter.

[17]I am indebted to Paul Grabow for pointing out the importance of including the extension of human capabilities in any definition of technology (Paul Grabow, "An Alternative to an Instrumentalist View of Technology," paper presented at The Two Tasks National Faculty Leadership Conference, Alexandria, VA, 22–25 June 2006).

[18]A strict philosophical naturalist might argue that Leonardo da Vinci used his rational faculties to paint the Mona Lisa and that the appreciation of beauty in that painting merely reflects certain patterns of neural firings in the observer's brain and thus the masterpiece is technology. Another might say that the running back uses inductive and deductive methods to thread his course through opposing players so that the football he is carrying might be physically placed beyond the goal line and thus football is technology. I think both arguments push the definition a little too far.

[19]Monsma, et al. offer eight normative principles for technology (*Responsible Technology*, 71–5), based on Dooyeward's "modalities" or aspects of reality (Herman Dooyeward, *Roots of Western Culture: Pagan, Secular, and Christian Opinions* [Toronto: Wedge, 1975]). I find an organization of principles based on a biblical hierarchy of value to be more conducive to thinking Christianly about things. Moreover, in my view, Monsma, et al. omit the most important ones or only address them secondarily.

[20]Intrinsic goods are things that are good in and of themselves, that is, ends and not means.

[21]Aside from the three about to be mentioned, certain artifacts like works of art, artistic performances, and buildings may have intrinsic aesthetic value—or they may simply be instrumental to human happiness. I am not prepared to say at this time.

[22]Mark 1:14–15.

[23]Matthew 6:33.

[24]Augustine, *City of God*, XIX.IV.

[25]Mark 10:17–23.

[26]Mark 10:26–27.

[27]John 17:3.

[28]John 14:20; 17:20–23.

[29]Matthew 22:37–38; Mark 12:28–30.

[30]Exodus 20:3.

[31]1 Chronicles 28:9; Job 41:11; Psalm 83:18, 95:4, 103:19, 115:16, 139:16; Proverbs 3:6; Isaiah 33:13; Lamentations 3:37; John 19:11; Romans 1:28, 9:19; Ephesians 2:10, 4:6; Revelation 4:11, 19:6.

[32]1 Corinthians 10:31; Colossians 3:17, 23.

[33]Proverbs 3:5, 7, 13; Isaiah 31:1; John 14:1, 16:33.

[34]Deuteronomy 6:6–8, 11:8; Matthew 5:6, 10; Romans 13:14.

[35]Proverbs 3:34, 27:1; Isaiah 66:2; Matthew 5:3, 5.

[36]Matthew 6:26–30. But by declaring love of neighbor the subject of the *second* greatest commandment (Matthew 22:39), Jesus implicitly placed people and their welfare second in the hierarchy of the good.

[37]Genesis 1:27.

[38]Genesis 1:31.

[39]John 3:16.

[40]Leviticus 19:18; Matthew 19:19, 22:39; Galatians 5:14.

[41]Matthew 7:12, 22:39; 1 Thessalonians 5:15.

[42]Matthew 5:6, 10; Romans 13:14.

[43]Matthew 5:3, 5.

[44]1 Corinthians 14:23; 1 Timothy 2:1–2.

[45]Matthew 6:25; Luke 10:41,12:22-31; John 14:1; Philippians 4:6.

[46]Genesis 2:18; John 17:21.

[47]In the Sermon on the Mount, Jesus affirms the value of the non-human creation, using examples of the birds of the air and the grass of the field (Matthew 6:26–30), but clearly makes it inferior to the value of human beings.

[48]Genesis 1:10, 12, 18, 21, 25.

[49]Genesis 1:28, 9:1, 7; Revelation 21:24.

[50]Genesis 1:26, 28; Psalms 8:6.

[51]Genesis 2:15; Matthew 25:1–13, 14–30; Luke 15:11–32, 19:22–27.

[52]John Calvin, *Institutes of the Christian Religion*, trans. Fred Lewis Battles (Philadelphia: The Westminster Press, 1559/1960), bk. III, chap. X.

[53]Instrumental (or extrinsic) goods are means by which intrinsic goods are realized, directly or indirectly. The extent to which an instrumental good contributes to the realization of an intrinsic good, or to another good instrumental to realizing an intrinsic good, is its instrumental value.

[54]Monsma, et al., *Responsible Technology*, give inadequate emphasis to this principle, their principles focusing primarily on the two lower levels of the hierarchy of the good.

[55]Human welfare includes, but is not limited to safety, health, comfort, happiness, and social integration.

[56]Ellul, *The Technological Bluff.*

[57]Luke 12:16–21.

[58]Ray Kurzweil, *The Singularity is Near* (New York: Viking, 2005).

[59]Romans 1:28.

[60]Luke 10:38–42.

[61]Matthew 22:39.

[62]"For as a lesser evil is a kind of good, even so a lesser good is a kind of evil if it stands in the way of a greater good …" (Gottfried Leibniz, *Theodicy: Essays on the Justice of God and the Freedom of Man*, trans. E. M. Huggard [London: Routledge & Kegan Paul, 1951], Part 1, sec. 8).

[63]In Daniel 12:4, the prophet wrote "… until the end of time; many will go back and forth and knowledge will increase." I am not sure if there is a principle for us here or, if so, what it is. But Daniel seems to have described our time quite well.

[64]Examples of the evil effects of disorder in technological practice are plentiful in commercial aviation, one case in point being Alaska Airlines flight 261, 31 January 2000, where the deterioration of a horizontal stabilizer trim system component led to loss of control in flight. The ensuing crash into the Pacific Ocean off the California coast killed 88 passengers and crew (National Transportation Safety Board, *Aircraft Accident Report, Loss of Control and Impact with Pacific Ocean, Alaska Airlines Flight 261 McDonnell Douglas MD-83, N963AS, About 2.7 Miles North of Anacapa Island, California, January 31, 2000* [Washington, DC: National Transportation Safety Board, 2002, http://www.ntsb.gov/Events/2000/Aka261/default.htm]). Another example is TWA flight 800, 17 July 1996, where ignition of the flammable fuel/air mixture in a fuel tank caused an explosion that destroyed the aircraft over the Atlantic Ocean east of New York, and killed all of its 230 passengers and crew (National Transportation Safety Board, *Aircraft Accident Report, In-flight Breakup Over the Atlantic Ocean, Trans World Airlines Flight 800, Boeing 747-131, N93119, Near East Moriches, New York, July 17, 1996,* NTSB/

AAR-00/03 [Washington DC: National Transportation Safety Board, 2000, http://ntsb.gov/Publictn/2000/AAR0003.pdf]). Most of my examples of technological disasters are chosen from aviation, for much of my research career has been devoted to aviation safety. Moreover, aviation, which is relatively quite safe, serves to illustrate the point that even when we are incredibly careful in technological innovation and practice, as we are in air transportation, bad things still happen.

[65]Francis Bacon enumerated several of these fallibilities as his "idols of the tribe" in aphorisms 45–52 in Book I of *Novum Organum* (New York: P. F. Collier & Son, 1900). More up-to-date and better attested summaries are presented by C. D. Wickens and J. G. Hollands (*Engineering Psychology*, 3rd ed. [Upper Saddle River, NJ: Prentice Hall, 2000]).

[66]Considering human fallibility and error, here again aviation provides examples, one being the loss of Eastern Airlines flight 401 in 1972, where the flight crew became distracted by an equipment problem and allowed the aircraft to descend into the ground. The crash killed 99 passengers and crew and injured 75 more (National Transportation Safety Board, *Aircraft Accident Report: Eastern Airlines, Incorporated, L-1011, N310EA, Miami, Florida, December 29, 1972*, PB-222 359 [Washington: National Transportation Safety Board, 1973]). The worst aviation disaster in history, in which two Boeing 747s collided on a runway at Tenerife, Canary Islands, killing 583 passengers, was precipitated by a miscommunication between a tower controller and a pilot. (Flight Safety Foundation, Aviation Safety Network database [http://aviation-safety.net/database/record.php?id=19770327-0] and [http://aviation-safety.net/database/record.php?id=19770327-1], last accessed 5 July 2007).

[67]To generalize the aviation examples given so far, more than 60% of aircraft accidents are due primarily to pilot error (Boeing Commercial Airplane Group, *Statistical Summary of Commercial Jet Airplane Accidents, Worldwide Operations, 1959-2004* [Seattle, WA: Boeing Commercial Airplane Group, 2005]). As cited in the text, between 48,000 and 98,000 Americans die each year due to medical errors (L. T. Kohn, J. M. Corrigan, and M. S. Donaldson, eds., *To Err Is Human: Building a Safer Health System* [Washington, DC: Institute of Medicine, 2000]). The great technological disasters of the twentieth century—including the Titanic, Tenerife, Three Mile Island, Chernobyl, and Bhopal—were all due largely to human error.

[68]The in-flight loss of control of China Eastern Airlines flight 583 in 1993 (two fatalities, 149 injuries, major damage to the aircraft) was due in part to the flawed design of a flight deck control lever (National Transportation Safety Board, "Brief of Accident DCA93MA037" [Washington, DC: National Transportation Safety Board, 1994, http://ntsb.gov/ntsb/GenPDF.asp?id=DCA93MA037&rpt=fi]). The losses of Alaska Airlines flight 261 and TWA flight 800 can be partly attributed to design deficiencies as well.

[69]That human nature is evil is said to be the only empirically verifiable claim of Christianity. There is certainly ample biblical authority for it. Genesis 3, 6:5, 8:21; 2 Chronicles 6:36; Psalms 51:5, 143:2; Ecclesiastes 7:20, 9:3; Isaiah 53:6; Jeremiah 17:9; Matthew 12:34; John 3:19; Romans 3:23, 5:12; Galatians 5:17; Ephesians 2:3.

[70]Computer-based aircraft automation was introduced in the last decades of the twentieth century in large part to reduce pilot error, which was always a major cause of aircraft accidents. This was partially successful in that certain kinds of navigational and flight control errors were virtually eliminated by flight management systems and advanced autopilots. But new, unexpected and significant errors emerged as a consequence. For example, autopilots were introduced that provide a variety of ways to control an airplane's flight path. These require the pilots to select a mode of operation, then set one or more parameters. In 1992, while approaching Strasbourg, France, for a landing, the flight crew of an Air Inter Airbus A320 selected an autopilot mode then set the autopilot parameter for a *different* mode, causing the aircraft to descend more rapidly than appropriate and impact the ground short of the runway, killing 87 passengers and crew (Investigation Commission of Ministry of Transport—France, *Rapport de la Commission d'Enquete sur l'Accident survenu le 20 Janvier 1992 pres du Mont Sainte Odile (Bas Rhin) a l'Airbus A.320 Immatricule F-GGED*

Exploite par lay Compagnie Air Inter, official English translation from the Ministere de l'Equipement, des Transports et du Tourisme, France, Ministere de l'Equipement, des Transports et du Tourisme, [Paris, France: Investigation Commission of Ministry of Transport—France, 1993]). Newer aircraft automation allows the navigation systems to be pre-programmed to fly a specific route. In 1979, a DC-10's navigation system was programmed to fly a new route for a sight-seeing tour over Antarctica and the plane's crew was not informed of the change. They permitted the aircraft to fly into a mountain, destroying the airplane and killing all 257 people on board. (Flight Safety Foundation, AviationSafetyNetwork database [http://aviation-safety.net/database/record.php?id=19791128-0]). Automation-related errors like these, though they could in principle have been foreseen, were not anticipated to the extent that effective countermeasures were introduced to prevent them.

[71]Genesis 1:27.

[72]John Calvin, *Institutes of the Christian Religion*, III.X.VI.

[73]Genesis 1:28.

[74]Matthew 28:19–20.

[75]Ecclesiastes 2:24–25, Calvin, *Institutes of the Christian Religion*, III.X.I.

[76]Proverbs 22:3; Luke 14:28–32; 1 Timothy 3:2. To be prudent is to exercise restraint. "Prudence differs from wisdom in this, that prudence implies more caution and reserve than wisdom, or is exercised more in foreseeing and avoiding evil, than in devising and executing that which is good" (Noah Webster, *An American Dictionary of the English Language*, facsimile ed. [San Francisco: Foundation for American Christian Education, 1828/1967], s.v. "prudence").

[77]Of Socrates, Xenophon wrote: "Skill in speaking and efficiency in affairs, therefore, and ingenuity, were not the qualities he was eager to foster in his companions. He held that they first needed to acquire prudence. For he believed that those faculties, unless accompanied by prudence, increased in their possessors' injustice and power for mischief" (Xenophon, *Memorabilia*, IV.III.I). In Xenophon's accounts of Socrates in *Memorabilia* and *Oeconomicus* may be found more ancient wisdom for our times.

[78]Schumacher, *Small Is Beautiful*.

[79]Ellul, *The Technological Society*, *The Technological System*, and *The Technological Bluff*.

[80]Bill Joy is co-founder and chief scientist of Sun Microsystems, a firm that has played a major role in the development of the internet. In a controversial critique of technology, Joy wrote: "And if our own extinction is a likely, or even possible, outcome of our technological development, shouldn't we proceed with great caution?" ("Why the Future Doesn't Need Us," *Wired* 8.04, [http://wired.com/wired/archive/8.04/joy.html]). Joy was reacting to Ray Kurzweil's *The Age of Spiritual Machines*, which describes a "utopian" future where we achieve a happy immortality through genetic engineering, nanotechnology, and robotics. Based on Joy's experience with the fragility of engineered systems, he is not optimistic that things will go as well as Kurzweil expects.

[81]Matthew 5:13–16.

[82]For example, at present, I use the internet almost exclusively for my work and almost always in my office, and I do not use a cellular telephone at all. I do not mean to imply by this that all Christians should do likewise.

[83]For example, a Christian electrical engineer employed in the design of expensive, high-end consumer electronics might become increasingly concerned about the assessments potential users of the devices would have to give to considerations 1–5 and 9–12. A growing awareness that the benefits of the new technologies (consideration 6) would accrue almost exclusively to wealthy, privileged users might ultimately persuade him to take a job opportunity to design control systems for small-scale, solar- or biofuel-powered electrical generating equipment for small communities in under-developed nations. By this I do not mean to trivialize the genuine difficulties of a mid-career professional facing such a dilemma nor do I urge that anyone use this as a literal model. Equally plausible and less extreme measures are possible. For instance, while my earlier research was directed to military technology, I have been fortunate to be able to focus my more recent innovative activities on understanding and mitigating the ill effects of human error in civil aviation and medicine.

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