Summer Reading: Technology Combo.


that the brain operates according to the same formal mathematical rules as a computer does—that, in other words, the brain and the computer speak the same language. But that’s a fallacy born of our desire to explain phenomena we don’t understand in terms we do understand. John von Neumann himself warned against falling victim to this fallacy. “When we talk about mathematics,” he wrote toward the end of his life, “we may be discussing a secondary language, built on the primary language truly used by our central nervous system.” Whatever the nervous system’s language may be, “it cannot fail to differ considerably from what we consciously and explicitly consider as mathematics.”

It’s also a fallacy to think that the physical brain and the thinking mind exist as separate layers in a precisely engineered “architecture.” The brain and the mind, the neuroplasticity pioneers have shown, are exquisitely intertwined, each shaping the other. As Ari Schulman wrote in “Why Minds Are Not like Computers,” a 2009 New Atlantis article, “Every indication is that, rather than a neatly separable hierarchy like a computer, the mind is a tangled hierarchy of organization and causation. Changes in the mind cause changes in the brain, and vice versa.” To create a computer model of the brain that would accurately simulate the mind would require the replication of “every level of the brain that affects and is affected by the mind.” Since we’re nowhere near disentangling the brain’s hierarchy, much less understanding how its levels act and interact, the fabrication of an artificial mind is likely to remain an aspiration for generations to come, if not forever.

Google is neither God nor Satan, and if there are shadows in the Googleplex they’re no more than the delusions of grandeur. What’s disturbing about the company’s founders is not their boyish desire to create an amazingly cool machine that will be able to outthink its creators, but the pinched conception of the human mind that gives rise to such a desire.

Socrates was right. As people grew accustomed to writing down their thoughts and reading the thoughts others had written down, they became less dependent on the contents of their own memory. What once had to be stored in the head could instead be stored on tablets and scrolls or between the covers of codices. People began, as the great orator had predicted, to call things to mind not “from within themselves, but by means of external marks.” The reliance on personal memory diminished further with the spread of the letterpress and the attendant: expansion of publishing and literacy. Books and journals, at hand in libraries or on the shelves in private homes, became supplements to the brain’s biological storehouse. People didn’t have to memorize everything anymore. They could look it up.

But that wasn’t the whole story. The proliferation of printed pages had another effect, which Socrates didn’t foresee but may well have welcomed. Books provided people with a far greater and more diverse supply of facts, opinions, ideas, and stories than had been available before, and both the method and the culture of deep reading encouraged the commitment of printed information to memory.
In the seventh century, Isidore, the bishop of Seville, remarked how reading "the sayings" of thinkers in books "render[ed] their escape from memory less easy." Because every person was free to chart his own course of reading, to define his own syllabus, individual memory became less of a socially determined construct and more the foundation of a distinctive perspective and personality. Inspired by the book, people began to see themselves as the authors of their own memories. Shakespeare has Hamlet call his memory "the book and volume of my brain."

In worrying that writing would enfeeble memory, Socrates was, as the Italian novelist and scholar Umberto Eco says, expressing "an eternal fear: the fear that a new technological achievement could abolish or destroy something that we consider precious, fruitful, something that represents for us a value in itself, and a deeply spiritual one." The fear in this case turned out to be misplaced. Books provide a supplement to memory, but they also, as Eco puts it, "challenge and improve memory; they do not narcotize it."

The Dutch humanist Erasmus, in his 1512 textbook De Copia, stressed the connection between memory and reading. He urged students to annotate their books, using "an appropriate little sign" to mark "occurrences of striking words, archaic or novel diction, brilliant flashes of style, adages, examples, and pithy remarks worth memorizing." He also suggested that every student and teacher keep a notebook, organized by subject, "so that whenever he lights on anything worth noting down, he may write it in the appropriate section." Transcribing the excerpts in longhand, and rehashing them regularly, would help ensure that they remained fixed in the mind. The passages were to be viewed as "kinds of flowers," which, plucked from the pages of books, could be preserved in the pages of memory.

Erasmus, who as a schoolboy had memorized great swaths of classical literature, including the complete works of the poet Horace and the playwright Terence, was not recommending memorization for memorization's sake or as a rote exercise for retaining facts. To him, memorizing was far more than a means of storage. It was the first step in a process of synthesis, a process that led to a deeper and more personal understanding of one's reading. He believed, as the classical historian Erika Rummel explains, that a person should "digest or internalize what he learns and reflect rather than slavishly reproduce the desirable qualities of the model author." Far from being a mechanical, mindless process, Erasmus's brand of memorization engaged the mind deeply. It required, Rummel writes, "creativity and judgment."

Erasmus's advice echoed that of the Roman Seneca, who also used a botanical metaphor to describe the essential role that memory plays in reading and in thinking. "We should imitate bees," Seneca wrote, "and we should keep in separate compartments whatever we have collected from our diverse reading, for things conserved separately keep better. Then, diligently applying all the resources of our native talent, we should mingle all the various nectars we have tasted, and then turn them into a single sweet substance, in such a way that, even if it is apparent where it originated, it appears quite different from what it was in its original state." Memory, for Seneca as for Erasmus, was as much a crucible as a container. It was more than the sum of things remembered. It was something newly made, the essence of a unique self.

Erasmus's recommendation that every reader keep a notebook of memorable quotations was widely and enthusiastically followed. Such notebooks, which came to be called "commonplace books," or just "commonplaces," became fixtures of Renaissance schooling. Every student kept one. By the seventeenth century, their use had spread beyond the schoolhouse. Commonplaces were viewed as necessary tools for the cultivation of an educated mind. In 1623, Francis Bacon observed that "there can hardly be anything more useful" as "a sound help for the memory" than "a good and learned Digest of Common Places." By aiding the recording of written works in memory, he wrote, a well-maintained commonplace "supplies matter to invention." Through the eighteenth century, according to American
University linguistics professor Naomi Baron, "a gentleman's commonplace book" served "both as a vehicle for and a chronicle of his intellectual development."8

The popularity of commonplace books ebbed as the pace of life quickened in the nineteenth century, and by the middle of the twentieth century memorization itself had begun to fall from favor. Progressive educators banished the practice from classrooms, dismissing it as a vestige of a less enlightened time. What had long been viewed as a stimulus for personal insight and creativity came to be seen as a barrier to imagination and then simply as a waste of mental energy. The introduction of new storage and recording media throughout the last century—audiotapes, videotapes, microfilm and microfiche, photocopiers, calculators, computer drives—greatly expanded the scope and availability of "artificial memory." Committing information to one's own mind seemed ever less essential. The arrival of the limitless and easily searchable data banks of the Internet brought a further shift, not just in the way we view memorization but in the way we view memory itself. The Net quickly came to be seen as a replacement for, rather than just a supplement to, personal memory. Today, people routinely talk about artificial memory as though it's indistinguishable from biological memory.

Clive Thompson, the Wired writer, refers to the Net as an "outboard brain" that is taking over the role previously played by inner memory. "I've almost given up making an effort to remember anything," he says, "because I can instantly retrieve the information online." He suggests that "by offloading data onto silicon, we free our own gray matter for more genuinely 'human' tasks like brainstorming and daydreaming."9 David Brooks, the popular New York Times columnist, makes a similar point. "I had thought that the magic of the information age was that it allowed us to know more," he writes, "but then I realized the magic of the information age is that it allows us to know less. It provides us with external cognitive servants—silicon memory systems, collaborative online filters, consumer preference algorithms and networked knowledge. We can burden these servants and liberate ourselves."10

Peter Suderman, who writes for the American Scene, argues that, with our more or less permanent connections to the Internet, "it's no longer terribly efficient to use our brains to store information." Memory, he says, should now function like a simple index, pointing us to places on the Web where we can locate the information we need at the moment we need it: "Why memorize the content of a single book when you could be using your brain to hold a quick guide to an entire library? Rather than memorize information, we now store it digitally and just remember what we stored." As the Web "teaches us to think like it does," he says, we'll end up keeping "rather little deep knowledge" in our own heads.11 Don Tapscott, the technology writer, puts it more bluntly. Now that we can look up anything "with a click on Google," he says, "memorizing long passages or historical facts" is obsolete. Memorization is "a waste of time."12

Our embrace of the idea that computer databases provide an effective and even superior substitute for personal memory is not particularly surprising. It culminates a century-long shift in the popular view of the mind. As the machines we use to store data have become more voluminous, flexible, and responsive, we've grown accustomed to the blurring of artificial and biological memory. But it's an extraordinary development nonetheless. The notion that memory can be "outsourced," as Brooks puts it, would have been unthinkable at any earlier moment in our history. For the Ancient Greeks, memory was a goddess: Mnemosyne, mother of the Muses. To Augustine, it was "a vast and infinite profundity," a reflection of the power of God in man.13 The classical view remained the common view through the Middle Ages, the Renaissance, and the Enlightenment—up to, in fact, the close of the nineteenth century. When, in an 1892 lecture before a group of teachers, William James declared that "the art of remembering is the art of thinking," he was stating the obvious.14 Now, his words seem old-fashioned. Not only has memory lost its
civility; it's well on its way to losing its humanness. Mnemosyne has become a machine.

The shift in our view of memory is yet another manifestation of our acceptance of the metaphor that portrays the brain as a computer. If biological memory functions like a hard drive, storing bits of data in fixed locations and serving them up as inputs to the brain's calculations, then offloading that storage capacity to the Web is not just possible but, as Thompson and Brooks argue, liberating. It provides us with a much more capacious memory while clearing out space in our brains for more valuable and even "more human" computations. The analogy has a simplicity that makes it compelling, and it certainly seems more "scientific" than the suggestion that our memory is like a book of pressed flowers or the honey in a beehive's comb. But there's a problem with our new, post-Internet conception of human memory. It's wrong.

After demonstrating, in the early 1970s, that "synapses change with experience," Eric Kandel continued to probe the nervous system of the lowly sea slug for many years. The focus of his work shifted, though. He began to look beyond the neuronal triggers of simple reflex responses, such as the slug's withdrawal of its gill when touched, to the much more complicated question of how the brain stores information as memories. Kandel wanted, in particular, to shed light on one of the central and most perplexing riddles in neuroscience: how, exactly, does the brain transform fleeting short-term memories, such as the ones that enter and exit our working memory every waking moment, into the long-term memories that can last a lifetime?

Neurologists and psychologists had known since the end of the nineteenth century that our brains hold more than one kind of memory. In 1885, the German psychologist Hermann Ebbinghaus conducted an exhausting series of experiments, using himself as the sole subject, that involved memorizing two thousand nonsense words. He discovered that his ability to retain a word in memory strengthened the more times he studied the word and that it was much easier to memorize a half dozen words at a sitting than to memorize a dozen. He also found that the process of forgetting had two stages. Most of the words he studied disappeared from his memory very quickly, within an hour after he rehearsed them, but a smaller set stayed put much longer—they slipped away only gradually. The results of Ebbinghaus's tests led William James to conclude, in 1890, that memories were of two kinds: "primary memories," which evaporated from the mind soon after the event that inspired them, and "secondary memories," which the brain could hold onto indefinitely.15

At around the same time, studies of boxers revealed that a concussive blow to the head could bring on retrograde amnesia, erasing all memories stored during the preceding few minutes or hours while leaving older memories intact. The same phenomenon was noted in epileptics after they suffered seizures. Such observations implied that a memory, even a strong one, remains unstable for a brief period after it's formed. A certain amount of time seemed to be required for a primary, or short-term, memory to be transformed into a secondary, or long-term, one.

That hypothesis was backed up by research conducted by two other German psychologists, Georg Müller and Alfons Pilzecker, in the late 1890s. In a variation on Ebbinghaus's experiments, they asked a group of people to memorize a list of nonsense words. A day later, they tested the group and found that the subjects had no problem recalling the list. The researchers then conducted the same experiment on another group of people, but this time they had the subjects study a second list of words immediately after learning the first list. In the next day's test, this group was unable to remember the initial set of words. Müller and Pilzecker then conducted one last trial, with another twist. The third group of subjects memorized the first list of words and then, after a delay of two hours, were given the second list to study. This group, like the first, had little trouble
remembering the initial list of words the next day. Müller and Pilzecker concluded that it takes an hour or so for memories to become fixed, or "consolidated," in the brain. Short-term memories don't become long-term memories immediately, and the process of their consolidation is delicate. Any disruption, whether a jab to the head or a simple distraction, can sweep the nascent memories from the mind. 46

Subsequent studies confirmed the existence of short-term and long-term forms of memory and provided further evidence of the importance of the consolidation phase during which the former are turned into the latter. In the 1960s, University of Pennsylvania neurologist Louis Flexner made a particularly intriguing discovery. After injecting mice with an antibiotic drug that prevented their cells from producing proteins, he found that the animals were unable to form long-term memories (about how to avoid receiving a shock while in a maze) but could continue to store short-term ones. The implication was clear: long-term memories are not just stronger forms of short-term memories. The two types of memory entail different biological processes. Storing long-term memories requires the synthesis of new proteins. Storing short-term memories does not. 47

Inspired by the groundbreaking results of his earlier Aplysia experiments, Kandel recruited a team of talented researchers, including physiological psychologists and cell biologists, to help him plumb the physical workings of both short-term and long-term memory. They began to meticulously trace the course of a sea slug's neuronal signals, "one cell at a time," as the animal learned to adapt to outside stimuli such as pokes and shocks to its body. 48 They quickly confirmed what Ebbinghaus had observed: the more times an experience is repeated, the longer the memory of the experience lasts. Repetition encourages consolidation. When they examined the physiological effects of repetition on individual neurons and synapses, they discovered something amazing. Not only did the concentration of neurotransmitters in synapses change, altering the strength of the existing connections between neurons, but the neurons grew entirely new synaptic terminals. The formation of long-term memories, in other words, involves not only biochemical changes but anatomical ones. That explained, Kandel realized, why memory consolidation requires new proteins. Proteins play an essential role in producing structural changes in cells.

The anatomical alterations in the slug's relatively simple memory circuits were extensive. In one case, the researchers found that, before a long-term memory was consolidated, a particular sensory neuron had some thirteen hundred synaptic connections to about twenty-five other neurons. Only about forty percent of those connections were active—in other words, sending signals through the production of neurotransmitters. After the long-term memory had been formed, the number of synaptic connections had more than doubled, to about twenty-seven hundred, and the proportion that were active had increased from forty percent to sixty percent. The new synapses remained in place as long as the memory persisted. When the memory was allowed to fade—by discontinuing the repetition of the experience—the number of synapses eventually dropped to about fifteen hundred. The fact that, even after a memory is forgotten, the number of synapses remains a bit higher than it had been originally helps explain why it's easier to learn something a second time.

Through the new round of Aplysia experiments, Kandel wrote in his 2006 memoir In Search of Memory, "we could see for the first time that the number of synapses in the brain is not fixed—it changes with learning! Moreover, long-term memory persists as long as the anatomical changes are maintained." The research also revealed the basic physiological difference between the two types of memory: "Short-term memory produces a change in the function of the synapse, strengthening or weakening preexisting connections; long-term memory requires anatomical changes." 49 Kandel's findings fit seamlessly with the discoveries being made about neuroplasticity by Michael Merzenich and others. Further experiments soon made it clear that the biochemical and structural changes involved
in memory consolidation are not limited to slugs. They also take place in the brains of other animals, including primates.

Kandel and his colleagues had unlocked some of the secrets of memory at the cellular level. Now, they wanted to go deeper—to the molecular processes within the cells. The researchers were, as Kandel later put it, "entering completely uncharted territory."

They looked first at the molecular changes that occur in synapses as short-term memories are formed. They found that the process involves much more than just the transmission of a neurotransmitter—glutamate—in this case—from one neuron to another. Other types of cells, called interneurons, are also involved. The interneurons produce the neurotransmitter serotonin, which fine-tunes the synaptic connection, modulating the amount of glutamate released into the synapse. Working with the biochemists James Schwartz and Paul Greengard, Kandel discovered that the fine-tuning occurs through a series of molecular signals. The serotonin released by the interneuron binds to a receptor on the membrane of the presynaptic neuron—the neuron carrying the electric pulse—which starts a chemical reaction that leads the neuron to produce a molecule called cyclic AMP. The cyclic AMP in turn activates a protein called kinase A, a catalytic enzyme that spurs the cell to release more glutamate into the synapse, thereby strengthening the synaptic connection, prolonging the electrical activity in the linked neurons, and enabling the brain to maintain the short-term memory for seconds or minutes.

The next challenge facing Kandel was to figure out how such briefly held short-term memories could be transformed into much more permanent long-term memories. What was the molecular basis of the consolidation process? Answering that question would require him to enter the realm of genetics.

In 1983, the prestigious and well-financed Howard Hughes Medical Institute asked Kandel, together with Schwartz and the Columbia University neuroscientist Richard Axel, to head a research group in molecular cognition, based at Columbia. The group soon succeeded in harvesting neurons from larval *Aplysia* and using them to grow.

as a tissue culture in the laboratory, a basic neural circuit incorporating a presynaptic neuron, a postsynaptic neuron, and the synapse between them. To mimic the action of the modulating interneurons, the scientists injected serotonin into the culture. A single squirt of serotonin, replicating a single learning experience, triggered, as expected, a release of glutamate—producing the brief strengthening of the synapse that is characteristic of short-term memory. Five separate squirts of serotonin, in contrast, strengthened the existing synapse for days and also spurred the formation of new synaptic terminals—changes characteristic of long-term memory.

What happens after repeated injections of serotonin is that the enzyme kinase A, along with another enzyme, called MAP, moves from the neuron's outer cytoplasm into its nucleus. There, kinase A activates a protein called CREB-1, which in turn switches on a set of genes that synthesize the proteins the neuron needs to grow new synaptic terminals. At the same time, MAP activates another protein, CREB-2, which switches off a set of genes that inhibit the growth of new terminals. Through a complex chemical process of cellular "marking," the resulting synaptic changes are concentrated at particular regions on the surface of the neuron and perpetuated over long periods of time. It is through this elaborate process, involving extensive chemical and genetic signals and changes, that synapses become able to hold memories over the course of days or even years. "The growth and maintenance of new synaptic terminals," writes Kandel, "makes memory persist." The process also says something important about how, thanks to the plasticity of our brains, our experiences continually shape our behavior and identity: "The fact that a gene must be switched on to form long-term memory shows clearly that genes are not simply determinants of behavior but are also responsive to environmental stimulation, such as learning."
were simple ones. They involved the storage of what psychologists call "implicit" memories—the unconscious memories of past experiences that are recalled automatically in carrying out a reflexive action or rehearsing a learned skill. A slug calls on implicit memories when retracting its gill. A person draws on them when dribbling a basketball or riding a bike. As Kandel explains, an implicit memory "is recalled directly through performance, without any conscious effort or even awareness that we are drawing on memory."

When we talk about our memories, what we're usually referring to are the "explicit" ones—the recollections of people, events, facts, ideas, feelings, and impressions that we're able to summon into the working memory of our conscious mind. Explicit memory encompasses everything that we say we "remember" about the past. Kandel refers to explicit memory as "complex memory"—and for good reason. The long-term storage of explicit memories involves all the biochemical and molecular processes of "synaptic consolidation" that play out in storing implicit memories. But it also requires a second form of consolidation, called "system consolidation," which involves concerted interactions among far-flung areas of the brain. Scientists have only recently begun to document the workings of system consolidation, and many of their findings remain tentative. What's clear, though, is that the consolidation of explicit memories involves a long and involved "conversation" between the cerebral cortex and the hippocampus.

A small, ancient part of the brain, the hippocampus lies beneath the cortex, folded deep within the medial temporal lobes. As well as being the seat of our navigational sense—it's where London cabbies store their mental maps of the city's roads—the hippocampus plays an important role in the formation and management of explicit memories. Much of the credit for the discovery of the hippocampus's connection with memory storage lies with an unfortunate man named Henry Molaison. Born in 1926, Molaison was stricken with epilepsy after suffering a severe head injury in his youth. During his adult years, he experienced increasingly debilitating grand mal seizures. The source of his affliction was eventually traced to the area of his hippocampus, and in 1953 doctors removed most of the hippocampus as well as other parts of the medial temporal lobes. The surgery cured Molaison's epilepsy, but it had an extraordinarily strange effect on his memory. His implicit memories remained intact, as did his older explicit memories. He could remember the events of his childhood in great detail. But many of his more recent explicit memories—some dating back years before the surgery—had vanished. And he was no longer able to store new explicit memories. Events slipped from his mind moments after they happened.

Molaison's experience, meticulously documented by the English psychologist Brenda Milner, suggested that the hippocampus is essential to the consolidation of new explicit memories but that after a time many of those memories come to exist independently of the hippocampus. Extensive experiments over the last five decades have helped untangle this conundrum. The memory of an experience seems to be stored initially not only in the cortical regions that record the experience—the auditory cortex for a memory of a sound, the visual cortex for a memory of a sight, and so forth—but also in the hippocampus. The hippocampus provides an ideal holding place for new memories because its synapses are able to change very quickly. Over the course of a few days, through a still mysterious signaling process, the hippocampus helps stabilize the memory in the cortex, beginning its transformation from a short-term memory into a long-term one. Eventually, once the memory is fully consolidated, it appears to be erased from the hippocampus. The cortex becomes its sole holding place. Fully transferring an explicit memory from the hippocampus to the cortex is a gradual process that can take many years. That's why so many of Molaison's memories disappeared along with his hippocampus.

The hippocampus seems to act as something like an orchestra conductor in directing the symphony of our conscious memory.
Beyond its involvement in fixing particular memories in the cortex, it is thought to play an important role in weaving together the various contemporaneous memories—visual, spatial, auditory, tactile, emotional—that are stored separately in the brain but that coalesce to form a single, seamless recollection of an event. Neuroscientists also theorize that the hippocampus helps link new memories with older ones, forming the rich mesh of neuronal connections that give memory its flexibility and depth. Many of the connections between memories are likely forged when we’re asleep and the hippocampus is relieved of some of its other cognitive chores. As the psychiatrist Daniel Siegel explains in his book *The Developing Mind*, “Though filled with a combination of seemingly random activations, aspects of the day’s experiences, and elements from the distant past, dreams may be a fundamental way in which the mind consolidates the myriad of explicit recollections into a coherent set of representations for permanent, consolidated memory.”

When our sleep suffers, studies show, so, too, does our memory.

Much remains to be learned about the workings of explicit and even implicit memory, and much of what we now know will be revised and refined through future research. But the growing body of evidence makes clear that the memory inside our heads is the product of an extraordinarily complex natural process that is, at every instant, exquisitely tuned to the unique environment in which each of us lives and the unique pattern of experiences that each of us goes through. The old botanical metaphors for memory, with their emphasis on continual, indeterminate organic growth, are, it turns out, remarkably apt. In fact, they seem to be more fitting than our new, fashionably high-tech metaphors, which equate biological memory with the precisely defined bits of digital data stored in databases and processed by computer chips. Governed by highly variable biological signals, chemical, electrical, and genetic, every aspect of human memory—the way it’s formed, maintained, connected, recalled—has almost infinite gradations. Computer memory exists as simple binary bits—ones and zeros—that are processed through fixed circuits, which can be either open or closed but nothing in between.

Kobi Rosenblum, who heads the Department of Neurobiology and Ethology at the University of Haifa in Israel, has, like Eric Kandel, done extensive research on memory consolidation. One of the salient lessons to emerge from his work is how different biological memory is from computer memory. “The process of long-term memory creation in the human brain,” he says, “is one of the incredible processes which is so clearly different than ‘artificial brains’ like those in a computer. While an artificial brain absorbs information and immediately saves it in its memory, the human brain continues to process information long after it is received, and the quality of memories depends on how the information is processed.”

Biological memory is alive. Computer memory is not.

Those who celebrate the “outsourcing” of memory to the Web have been misled by a metaphor. They overlook the fundamentally organic nature of biological memory. What gives real memory its richness and its character, not to mention its mystery and fragility, is its contingency. It exists in time, changing as the body changes. Indeed, the very act of recalling a memory appears to restart the entire process of consolidation, including the generation of proteins to form new synaptic terminals. Once we bring an explicit long-term memory back into working memory, it becomes a short-term memory again. When we reconsolidate it, it gains a new set of connections—a new context. As Joseph LeDoux explains, “The brain that does the remembering is not the brain that formed the initial memory. In order for the old memory to make sense in the current brain, the memory has to be updated.” Biological memory is in a perpetual state of renewal. The memory stored in a computer, by contrast, takes the form of distinct and static bits; you can move the bits from one storage drive to another as many times as you like, and they will always remain precisely as they were.
The proponents of the outsourcing idea also confuse working memory with long-term memory. When a person fails to consolidate a fact, an idea, or an experience in long-term memory, he’s not “freeing up” space in his brain for other functions. In contrast to working memory, with its constrained capacity, long-term memory expands and contracts with almost unlimited elasticity, thanks to the brain’s ability to grow and prune synaptic terminals and continually adjust the strength of synaptic connections. “Unlike a computer,” writes Nelson Cowan, an expert on memory who teaches at the University of Missouri, “the normal human brain never reaches a point at which experiences can no longer be committed to memory; the brain cannot be full.”31 Says Torkel Klingberg, “The amount of information that can be stored in long-term memory is virtually boundless.”32 Evidence suggests, moreover, that as we build up our personal store of memories, our minds become sharper. The very act of remembering, explains clinical psychologist Sheila Crowell in The Neurobiology of Learning, appears to modify the brain in a way that can make it easier to learn ideas and skills in the future.33

We don’t constrain our mental powers when we store new long-term memories. We strengthen them. With each expansion of our memory comes an enlargement of our intelligence. The Web provides a convenient and compelling supplement to personal memory, but when we start using the Web as a substitute for personal memory, bypassing the inner processes of consolidation, we risk emptying our minds of their riches.

In the 1970s, when schools began allowing students to use portable calculators, many parents objected. They worried that a reliance on the machines would weaken their children’s grasp of mathematical concepts. The fears, subsequent studies showed, were largely unwarranted.34 No longer forced to spend a lot of time on routine calculations, many students gained a deeper understanding of the principles underlying their exercises. Today, the story of the calculator is often used to support the argument that our growing dependence on online databases is benign, even liberating. In freeing us from the work of remembering, it’s said, the Web allows us to devote more time to creative thought. But the parallel is flawed. The pocket calculator relieved the pressure on our working memory, letting us deploy that critical short-term store for more abstract reasoning. As the experience of math students has shown, the calculator made it easier for the brain to transfer ideas from working memory to long-term memory and encode them in the conceptual schemas that are so important to building knowledge. The Web has a very different effect. It places more pressure on our working memory, not only diverting resources from our higher reasoning faculties but obstructing the consolidation of long-term memories and the development of schemas. The calculator, a powerful but highly specialized tool, turned out to be an aid to memory. The Web is a technology of forgetfulness.

What determines what we remember and what we forget? The key to memory consolidation is attentiveness. Storing explicit memories and, equally important, forming connections between them requires strong mental concentration, amplified by repetition or by intense intellectual or emotional engagement. The sharper the attention, the sharper the memory. “For a memory to persist,” writes Kindel, “the incoming information must be thoroughly and deeply processed. This is accomplished by attending to the information and associating it meaningfully and systematically with knowledge already well established in memory.”35 If we’re unable to attend to the information in our working memory, the information lasts only as long as the neurons that hold it maintain their electric charge—a few seconds at best. Then it’s gone, leaving little or no trace in the mind.

Attention may seem ethereal—a “ghost inside the head,” as the developmental psychologist Bruce McCandliss says36—but it’s a genuine physical state, and it produces material effects throughout the brain. Recent experiments with mice indicate that the act of pay-
ing attention to an idea or an experience sets off a chain reaction that crisscrosses the brain. Conscious attention begins in the frontal lobes of the cerebral cortex, with the imposition of top-down, executive control over the mind’s focus. The establishment of attention leads the neurons of the cortex to send signals to neurons in the midbrain that produce the powerful neurotransmitter dopamine. The axons of these neurons reach all the way into the hippocampus, providing a distribution channel for the neurotransmitter. Once the dopamine is funneled into the synapses of the hippocampus, it jump-starts the consolidation of explicit memory, probably by activating genes that spur the synthesis of new proteins.37

The influx of competing messages that we receive whenever we go online not only overloads our working memory; it makes it much harder for our frontal lobes to concentrate our attention on any one thing. The process of memory consolidation can’t even get started. And, thanks once again to the plasticity of our neuronal pathways, the more we use the Web, the more we train our brain to be distracted—to process information very quickly and very efficiently but without sustained attention. That helps explain why many of us find it hard to concentrate even when we’re away from our computers. Our brains become adept at forgetting, inept at remembering. Our growing dependence on the Web’s information stores may in fact be the product of a self-perpetuating, self-amplifying loop. As our use of the Web makes it harder for us to lock information into our biological memory, we’re forced to rely more and more on the Net’s capacious and easily searchable artificial memory, even if it makes us shallower thinkers.

The changes in our brains happen automatically, outside the narrow compass of our consciousness, but that doesn’t absolve us from responsibility for the choices we make. One thing that sets us apart from other animals is the command we have been granted over our attention. “Learning how to think” really means learning how to exercise some control over how and what you think,” said the novelist David Foster Wallace in a commencement address at Kenyon College in 2005. “It means being conscious and aware enough to choose what you pay attention to and to choose how you construct meaning from experience.” To give up that control is to be left with “the constant gnawing sense of having had and lost some infinite thing.”39 A mentally troubled man—he would hang himself two and a half years after the speech—Wallace knew with special urgency the stakes involved in how we choose, or fail to choose, to focus our mind. We cede control over our attention at our own peril. Everything that neuroscientists have discovered about the cellular and molecular workings of the human brain underscores that point.

Socrates may have been mistaken about the effects of writing, but he was wise to warn us against taking memory’s treasures for granted. His prophecy of a tool that would “implant forgetfulness” in the mind, providing “a recipe not for memory, but for reminder,” has gained new currency with the coming of the Web. The prediction may turn out to have been merely premature, not wrong. Of all the sacrifices we make when we devote ourselves to the Internet as our universal medium, the greatest is likely to be the wealth of connections within our own minds. It’s true that the Web is itself a network of connections, but the hyperlinks that associate bits of online data are nothing like the synapses in our brain. The Web’s links are just addresses, simple software tags that direct a browser to load another discrete page of information. They have none of the organic richness or sensitivity of our synapses. The brain’s connections, writes Ari Schulman, “don’t merely provide access to a memory; they in many ways constitute memories.”39 The Web’s connections are not our connections—and no matter how many hours we spend searching and surfing, they will never become our connections. When we outsource our memory to a machine, we also outsource a very important part of our intellect and even our identity. William James, in concluding his 1892 lecture on memory, said, “The connecting is the thinking.” To which could be added, “The connecting is the self.”
"I project the history of the future," wrote Walt Whitman in one of the opening verses of Leaves of Grass. It has long been known that the culture a person is brought up in influences the content and character of that person's memory. People born into societies that celebrate individual achievement, like the United States, tend, for example, to be able to remember events from earlier in their lives than do people raised in societies that stress communal achievement, such as Korea. Psychologists and anthropologists are now discovering that, as Whitman intuited, the influence goes both ways. Personal memory shapes and sustains the "collective memory" that underpins culture. What's stored in the individual mind—events, facts, concepts, skills—is more than the "representation of distinctive personhood" that constitutes the self, writes the anthropologist Pascal Boyer. It's also "the crux of cultural transmission." Each of us carries and projects the history of the future. Culture is sustained in our synapses.

The offloading of memory to external data banks doesn't just threaten the depth and distinctiveness of the self. It threatens the depth and distinctiveness of the culture we all share. In a recent essay, the playwright Richard Foreman eloquently described what's at stake. "I come from a tradition of Western culture," he wrote, "in which the ideal (my ideal) was the complex, dense and 'cathedral-like' structure of the highly educated and articulate personality—a man or woman who carried inside themselves a personally constructed and unique version of the entire heritage of the West." But now, he continued, "I see within us all (myself included) the replacement of complex inner density with a new kind of self—evolving under the pressure of information overload and the technology of the 'instantly available.'" As we are drained of our "inner repertory of dense cultural inheritance," Foreman concluded, we risk turning into "pancake people—spread wide and thin as we connect with that vast network of information accessed by the mere touch of a button."
“In today’s culture of technology too, the Gospel is the guide and the permanent paradigm of inculturation, purifying, healing and elevating the best features of... the new forms of communication.”

— Pope Benedict XVI

Technology and the New Evangelization: Criteria for Discernment

Fr. Jonah Lynch, FSCB & Michelle K. Borras
Two of the redeemed from the “great multitude, whom no one could number, from every tribe, tongue, people, and nation, standing before the throne and before the Lamb” (Revelation 7:9). The elect who have risen are holding the tools with which they glorified God during their earthly life. From the Wall of the Parousia, Redemptoris Mater Chapel, Vatican City. The mosaics of the chapel were completed by Fr. Marko Ivan Rupnik and the artists of Centro Aletti in 1999. Image courtesy of Centro Aletti.
Technology and the New Evangelization: Criteria for Discernment

Fr. Jonah Lynch, FSCB & Michelle K. Borras
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How can the Church use new technologies to further her mission? This is a widely asked question among bishops and priests, laypeople who rightly desire to live their faith in the modern world, and missionaries who want to proclaim the Gospel “in season and out of season” (2 Timothy 4:2), with every tool available. At the same time, parents are worried about the possible negative effects of new technologies, educators are scrambling to use them to improve their teaching, with mixed results, and innovation continues at a blinding pace, leaving everyone playing catch-up. The purpose of this pamphlet is to untangle a few of the strands in this complicated story, and to offer a Catholic reading of their significance.

In order to do so, I would like to take an intuitive approach. I will begin with a few examples of the changes that we have lived through in the last few decades. This will allow us to take a closer look at some of the underlying questions about technology. In particular, it will help us to see that technology is not just a simply neutral tool which one can
use for any purpose one wishes. More examples will follow to aid in fleshing out the argument. In conclusion, I will recall some essential points of the Church’s mission in the world and start to make the connections with the preceding reflections on technology. Let us start with a brief premise.

**A Premise**

All of Christian life rests on two principle mysteries: the Holy Trinity and the Incarnation. The Trinity is the name we give to the fathomless beauty of communion in God himself, the perfect unity of three Persons who are nevertheless distinct one from another. To participate in this unity is one of the deepest desires a human person has: to live in the depths of love, friendship and communion, yet without dissolving one’s identity in the crowd. We deeply want to be connected to other people, to love and be loved, because we are “image and likeness” of God himself, who is Trinity. It is not hard to see that this desire for communion is at the heart of what has made social networking undergo such explosive growth in the last decade.

In 2009, Benedict XVI said: “Desire for communication and friendship is rooted in our very nature as human beings and cannot be adequately understood as a response to technical innovations. In the light of the biblical message, it should be seen primarily as a reflection of our participation in the communicative and unifying Love of God, who desires to make of all humanity one family.”

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The other deepest mystery of our faith, the Incarnation, is the bridge that links two worlds which otherwise would have remained apart. In Jesus Christ, God is revealed and made present in our midst. And not only: the flesh itself, that part of the human person which seemed destined only for decay and death, is revealed to be of crucial importance. Not only did God himself take on flesh, but in his resurrection he shows the eternal, transfigured destiny of the human body. Mary already participates in this destiny. So, by the grace of God, may we.

From its very beginnings, Christianity has faced a perennial temptation to underestimate the importance of the body. In past centuries, many crucial dogmatic disputes arose in this regard, and many of the most dangerous heresies have devalued the body. Some philosophies situated the origin of evil in physical reality, and the Good in an exclusively spiritual realm.

Our Christian tradition, on the other hand, has always affirmed the goodness of all creation. Every generation of Christians has had to re-learn to think of Jesus Christ as “true man and true God,” without excessively underlining one part of this expression to the detriment of the other. When we speak of Christ’s “body and blood, soul and divinity” present in the Eucharist, we are speaking of this surprising union between apparent opposites, physical and spiritual. In the twenty centuries of the Church’s life, much clarity has been brought to these definitions, yet they retain a fundamental mystery which has never been and never can be exhausted.
Let us move on now to our subject, beginning with a few examples taken from everyday life.

A Few Examples

When I was a boy, my father worked in an insurance agency. He left the house around eight, and returned home at five-thirty. During that time, he made many phone calls, wrote many letters, and met many people. But from five-thirty in the evening until the following morning, he did none of these things. There was a clear distinction between the workplace and the home. Everyone felt it: even if you knew the home phone number of your employee, it was not right to disturb him at home except for a grave emergency.

Twenty years later, my father still worked for an insurance agency. But by now, even on vacation, he had to check his voice mail, respond to work calls on his cell phone, and write emails on his blackberry. There was no longer a clear distinction between home and work. The causes of this situation are complex. One of them is the very fact that a cell phone is not linked to a specific physical location. This inevitably weakens the perception that you might be “disturbing” the person you are calling. That sense was stronger when the phone number was directly linked to a place: a work call on the home number had better be important.

What was once objectively linked to physical locations is now determined only by our will: we must turn off the phone in order to safeguard the silence of an import-
ant conversation, a liturgical celebration, or a meal with friends. And often, even if we have decided to turn off our own phone, those around us have not. A few decades ago, a parishioner would have had to make an exceptionally rude decision to interrupt the Mass during the consecration with a loud noise. Today it takes a decision on the part of all the parishioners to avoid interrupting the Mass with a ringing cell phone.

Let’s take a look at another example: online chat. On my Gmail account, I can see when some of my close friends are online. Clicking on their name opens a chat window, which on occasion I use to say hello to people I did not plan on contacting, but whom I simply notice online. Some time ago, I was chatting with a friend who lives in Spain, whom I rarely see. Our conversation went something like this:

Me: “Hey Jack, how are you?”
Jack: “Good, you?”
Me: “Fine. So how’s work?”
Jack: “Ok, a bit down cuz of the crisis.”
Me: “How bout your girlfriend?”

While the other person is typing a response, the Gmail chat window shows a phrase which reads “Jack is typing....” That phrase remains visible as long as the other person is actually typing; when he stops, the phrase disappears a short while later. After my last question, by watching that message I could tell that Jack typed something, then stopped, then started typing again, then a long pause, and after about two minutes I received his reply: “Fine.”
What happened in the meantime? Did he start saying something else, change his mind, and then send me a one-liner? Or did he receive a phone call or an email? Or did he go get a drink of water? I’ll never know.

This taught me something about chat. It brings people closer together – I wasn’t planning on talking with my far-away friend, but the chat window made it possible to have a brief contact. At the same time, chat creates a distance which isn’t there in other forms of long-distance communication. For example, on the phone it would have been easier to interpret that long pause. I probably would have been able to make out if things were really “fine” or not between him and his girlfriend. Chat, on the other hand, made that silence completely illegible.

A third example: television. The availability of many channels makes it possible to leap continuously from one world to another (this is true of three or four, let alone with five hundred channels on satellite TV). This experience conditions us to think that the world is not first “given,” but chosen. You want to feel something in particular? Then choose the program that will make you feel relaxed, excited, fearful, joyful, sentimental and so forth. Or you do not know what you want to feel, so you begin to zap through the channels, stopping for a few seconds on the images that most instinctively attract you.

Television screens have a character that is completely different from every other object. They seem almost magical. They attract our eyes with a power that not even the great masters’ oil paintings can command. What’s more, they are
totipotent, they can become any image: on the screen one can watch a comedy, the Pope celebrating the Way of the Cross on Good Friday, or a porn flick. These are three experiences which more naturally would be located in three very different places: the theatre, the church and the brothel, but which can live together in apparent harmony on a living room television screen.

One final word about television will bring us to a first conclusion. In *Amusing Ourselves to Death*, Neil Postman writes:

> It is implausible to imagine that anyone like our twenty-seventh president, the multi-chinned, three-hundred-pound William Howard Taft, could be put forward as a presidential candidate in today’s world. The shape of a man’s body is largely irrelevant to the shape of his ideas when he is addressing a public in writing or on the radio or, for that matter, in smoke signals. But it is quite relevant on television. The grossness of a three-hundred-pound image, even a talking one, would easily overwhelm any logical or spiritual subtleties conveyed by speech. For on television, discourse is conducted largely through visual imagery, which is to say that television gives us a conversation in images, not words.... You cannot do political philosophy on television. Its form works against the content.²

The three examples we have briefly examined help us to see that, with a small change, Postman’s final phrase, “Its form modifies its content,” could describe all three technologies we have discussed. The cell phone changes our perception of space and privacy; chat obscures the meaning of silence, and changes the kind of things which can
and cannot be said clearly; television alters our relationship with the world in many important ways. More generally, we could say that every technology carries with it a change in our approach to and relationship with the world.

**Technology Is Not Neutral**

The changes in our approach to the world brought about through the use of technology are quite important. In particular, much depends on *which* aspects of life are made easier and which ones are made more difficult through a given technology. In my conclusion, I will propose that we ask first of all *what* we wish to do or say through technology, in order to be conscious of the gains and losses incurred through its use. But first, we must tackle a common misconception.

Very frequently, we say or hear others say that technology is neutral, and everything depends on how you use it. The analogy is made to older tools: a knife, it is said, is neither good nor bad, and can be used either to slice bread or to kill a man. I would like to face this question head-on.

First, I need to clarify that in saying that technology is not neutral, I am not saying that it is intrinsically evil. By “neutral” we usually mean – taking things to the extreme – that internet was not invented by the devil. And even if there were a whiff of sulphur involved, it is undeniable that along with the bad, many good things can be found on the internet. Thus, we presume, the only real problem is to use the internet and other technologies well. The problem is
that at this point we tend to make an unjustified leap. That is, we tend to think that only the user uses the technology. But this is not true; it is also the technology that “uses” its user. Every tool has an impact on the person using it. In that sense, they are not neutral.

The foregoing examples can be understood more clearly if we briefly mention a recent development in neuroscience called “neuroplasticity.” The term indicates the fact that experience modifies the human brain in physically measurable ways, including the growth and death, the strengthening and weakening of dendrites (something like connecting wires) between neurons, and the reprogramming of groups of neurons for new functions. These developments have been discussed in many recent books, to which I refer the interested reader. For our purposes, it is enough to state that the changes which occur in the brain as a result of repeated activity can have substantial consequences.

A personal example which I would like to mention has to do with reading and prayer. At one point in my life as a priest, I spent a lot of time speed-reading textbooks, news web sites, and educational studies while working on a Master’s degree. I became good at multitasking and quickly finding relevant information for the papers I wrote. At the same time, I experienced a growing difficulty in keeping my mind on one thing at a time, in particular when reading complicated theological works and while praying my breviary. My eyes kept jumping down a few lines, looking for key-words, and not following the more leisurely pace of the biblical text. At first, this did not seem to be a serious
problem, and I kept pressing ahead. When a friend gave me a copy of Nicolas Carr’s The Shallows, I realized that my experience was more important than I had first thought. Carr shows in his book that the kind of reading I was doing was literally re-wiring my brain!

Once it was thought the brain reached a substantially fixed form with physical maturity, and it worked more or less like a computer. Carr’s book helped me see that the reality is quite different. Neurons continually form new connections between themselves. We were born with some neurological structures, but these structures are profoundly modified by experience. The meaning and importance of this discovery is hard to overestimate.

One of the underlying dynamics is called Hebb’s rule, formulated by the Canadian neuro-scientist Donald Hebb in 1949: “Cells that fire together wire together.” If two neurons more or less in the same area of the brain are stimulated at the same time by an experience, they can form physical connections between themselves through the growth of new dendrites. More recently Edward Todd and Michael Merzenich have demonstrated that there are other possible mechanisms. Not only does experience generate neurological structures, strengthening and weakening the links between neurons, but it can also make entire groups of neurons change roles. Thus, for example, stroke victims can recover body movement by “reprogramming” the neurons in an undamaged area, which then substitute for the damaged neurons.4
And that isn’t all. It is sufficient that an experience be “remembered” in order to strengthen the connections in play. A notable example of this phenomenon regards musical practice. One can practice even by only thinking of playing, without actually touching the keyboard of a piano, and really improve. A study done in 1995 by Alvero Pascual-Leone demonstrated that a group of pianists who only imagined playing certain notes registered the same changes in their brains as others who actually played the keyboard! When connections are strengthened between neurons, they can become the easiest route of communication. That is how habits are formed, both of action and of thought. All of this has deep implications for our relationship with reality.

We become what we think, what we see, what we read, and what we do. This is not a mystical affirmation; on a neurological level, our experiences never leave us unchanged. They modify us, for better and for worse, creating or strengthening new connections in our brains, weakening or eliminating others, forming us in the image of our actions, thoughts, desires, and tools.

If there is a two-way relationship between a tool and its user, between man and technology, which are the tools we would most like to resemble? Reading the Scripture creates a powerful capacity for reasoning and an attention to subtle detail that man does not naturally have. It can only be acquired by long experience, and by the decision to concentrate on certain types of reading. Meditating the lives of the Saints helps us to form our will and our intelligence
to the highest standards. Good moral action creates virtuous habits. In other words, all of the above actions partially rewire our brains in the image of those same actions.

In this brief pamphlet, there is not enough space to go any further with this line of reasoning.\(^6\) I hope that these comments help at least to see that the question we began with – “How can the Church use new technologies to further her mission?” – does not have an easy answer, precisely because the technologies themselves modify the messages they carry. This is not a new problem; every form of communication shares in it. But it is a particularly important problem today, as a result of the continual acceleration in development and use of communication technologies.

In the context of this discussion of technology and its influence on the human person, I would like to continue our reflection by recalling our premise about the Trinity and the Incarnation, and bring to bear some insights generated by the Christian tradition.

**Communion and Communication**

The desire for communion seems to me to be one point where we should aim our attention. We should first look at the deep reasons which push men and women constantly to search for new means of communication, rather than on the technical methodology, which in any case rapidly changes and which must constantly be re-learned. At the same time, we should reflect critically upon our successes and failures in this search for communion.
In his message for the 2011 International Day of Social Communications, Pope Benedict XVI asked:

Who is my ‘neighbor’ in this new world? Does the danger exist that we may be less present to those whom we encounter in our everyday life? Is there a risk of being more distracted because our attention is fragmented and absorbed in a world ‘other’ than the one in which we live? Do we have time to reflect critically on our choices and to foster human relationships which are truly deep and lasting? It is important always to remember that virtual contact cannot and must not take the place of direct human contact with people at every level of our lives.7

In reality he was repeating, in more vibrant language, what he says in *Verbum Domini*:

Among the new forms of mass communication, nowadays we need to recognize the increased role of the internet, which represents a new forum for making the Gospel heard. Yet we also need to be aware that the virtual world will never be able to replace the real world, and that evangelization will be able to make use of the virtual world offered by the new media in order to create meaningful relationships only if it is able to offer the personal contact which remains indispensable.8

Would confession by telephone, fax, email or chat be the same thing, with respect to the encounter with divine mercy through the priest present in the confessional? Wouldn’t it be much more abstract and cold (besides being invalid)? Can you ask your girlfriend to marry you on Skype? It seems to me that virtual communication can be a sup-
port to relationships, but it cannot make them grow and mature with the speed, depth and honesty that only personal, physical communication can guarantee.

The history of the Church is full of fine examples of people like St. Paul, who tried to communicate their faith with whatever new forms of communication were available at the time. I am also thinking of the scribes who copied pages and pages of manuscripts, as well as more recent television evangelizers including the American Fulton Sheen, or the incredible energy of the Polish priest Maximilian Kolbe, who founded newspapers and even cities before his death as a martyr in Auschwitz. Finally let us remember the powerful influence of Pope John Paul II or Mother Teresa: they had a luminous and convincing presence even on the television screen. Yet I cannot help but think that these people’s actions have born true fruit according to the measure in which they favoured interpersonal relationships, in small, local communities.

Another Church document produced by the Pontifical Council for Social Communications in 2002 says: “Virtual reality cannot substitute the real presence of Christ in the Eucharist, the sacramental reality of the other sacraments and the liturgical celebrations participated in a human community in flesh and blood. On the internet there are no sacraments.” In other words, the fundamental problem for Catholics seems not to be so much about conquering the spaces of the web for Christ, but rather to live with Christ and the Church in the sacraments. Those who do
so will “Christ-ify” every place in which they live, including the internet.

**The Incarnation in the Age of Facebook**

I recently received an email from a friend named Anna. She wrote to me of a particularly dramatic day in which she discovered the friendship of a person dear to her. The letter was beautiful, a simple and moving story. Then, a few weeks later I was speaking with a mutual friend about this message, she revealed she too had received the same email. But wasn’t it an email sent to me? Or was it more like a newspaper article, copied for ease and sent to several people? And then again, why do we tend to feel disappointed when we discover this sort of thing? Why should the letter be less valuable if it were sent to others as well?

The same thing is true for works of art. At Christie’s auction house, originals are worth millions, and reproductions, even when they are not distinguishable to the buyer, are worth no more than a few thousand dollars. Also, when an artist makes several copies of a work, like in the case of prints and woodcuts, she numbers them. It is not the same thing to have an original or a copy. It is not the same thing to have a mass-produced poster, or print number 53 out of 100.

What changes in the case of a personal letter? The valuation of the person changes. Anna wrote a message which, in order to save time, she sent to others. But the message was thereby taken out of the intimate context of a friendship between sender and receiver. Only the text was left,
without the complicated web of intention, form, and suggestion which exists only within an unrepeatable personal relationship. One sign of the falseness of this sort of action is the sense of guilt it creates, which can be found in the fact that the sender tends to hide the fact that it was a message sent to several people. Christmas cards are usually signed by hand, even if the rest is pre-printed.

Most of us want to be esteemed more than we deserve. Take Facebook profile photos: most don’t necessarily reflect what a person really is, but rather what he or she would like to seem. It is a small and absolutely pardonable vanity, but it unveils a way of being that eats away at friendship, that very communion that we most desire. Through these little insincerities comes a mentality in which appearance is more important than truth, and that is an obstacle to love.

But what does all this have to do with Web 2.0? On blogs or social networks, each person is an emitter of information, and most messages are sent out into the ether to a plurality of receivers. This is something different than a conversation among friends. In an essay-letter written to Facebook (as though it were a person), Adam Briggle faces this problem of mass communication:

Because of the mixed audience potentially viewing these public expressions ... I do not feel all that free. In fact, I begin to sympathize with the mass media broadcasting corporations that have to produce content suitable for everyone. In these spaces, I am not playing with my identity or expressing myself so much as trying to purify a neutral self suitable for broadcasting to the
viewing mass. It is the art of self-censorship in an attempt to handle the collision of life contexts that normally remain separate. I have seen innocent comments spin out a thread of rancour, because what is best said to one is best said otherwise to another and not at all to a third.9

Seen from one’s own point of view this may not be very convincing. “All right, virtual communities may not be as strong as real ones, but does it really matter?” It is easier to understand if we look at it from the point of view of the receiver. Even if I write carbon copy messages to save time, I would prefer that my friends write to me as an individual on a private, one to one basis. I would like to have our conversation happen with a balanced rhythm between speaking and listening. I would like our friendship to be full of sincere charity. Exactly what I do to others almost without thinking, I wouldn’t want to be done to me.

When I go onto an internet forum to try and solve a problem with my computer, I can rapidly access the conflated knowledge of many thousands of people. And I am often able to find a solution quickly, but I tend to reduce these people to mere givers of information, which is something less than persons. On the other hand, I would not like to be treated as a simple giver of information but as an unrepeatable being. I am not a mere event among events. I am not a mere function among functions, or a drop in the ocean. The concept of personhood, of which the Christian West is justly proud, affirms that every man and woman is a whole, an infinite. I am a unique event, and I find in the
unrepeatability of the flesh and of local human relationships, the necessary base for the strong and lively friendships that I seek.

The Body and Love

In elementary school, we used to pass love notes between students. They were ridiculous for how direct they were. I think I once wrote to a girl: “Would you like to be my girlfriend?”, with two boxes to check, “yes” and “no.” In high school things were more complicated and I usually did not have the courage to ask the question in person, so I tried on the phone. I was there straining to the outmost to interpret the microseconds of each pause and the tones of the voice, in order to understand the real intentions of my friend. I remember that certain relationships were in a sense doubled: there was the telephone relationship and the relationship in person during the school day. Rivers of words which we said in the evening did not seem to survive the light of the next day.

When I finally had a girlfriend, I immediately realized that being together was completely different from these interminable telephone conversations. In the first place it was much more difficult to mask my feelings. When I was tired, or tired of sweet words, I could not hide behind some monosyllable pronounced here or there on the phone. I was all of one piece, readable every instant and not only when I came out of my silence. The look in my eyes said more than many words. The caresses I had so deeply desired
were a sign of love, but they quickly became empty and we felt the need to find words ever stronger and gestures ever more daring, to say the same emotion. How strange it is, and how clumsy you feel, when you realize that an excess of expression stifles love!

This is significant because it helps us to understand that the language of love, like other languages and other fundamental experiences, is infinitely variable. It requires all the senses and all the expressive registers, even just to approach from afar that which we would like to express. It helps us to intuit that every communication that does not include the physical presence of people, but is presented only with words, images and sounds mediated through a machine, loses the greater part of its effectiveness, even with the addition of smilies. A word written in a text message does not have the individuality of a word written by hand, which betrays the haste or the care, as well as the personality, of the person writing. The language of love, like the language of religion, needs personal, bodily communication.

We can trust a person, not a message. We can feel a leaping in the heart for someone who is here now with us. We can see his face, evaluate the sincerity of his smile, the purity of his gaze. We can shake his hand and measure his conviction, and his human warmth. In my body I experience the beauty of relationships, of which the physical limits are not a mortal shell, but a permeable boundary that permits communion. Precisely because my hand is not the same as that of the person who is shaking it, it is beautiful that our two hands be united. If there were no bound-
ary, nor could there be the surprise and gratitude that we experience for the nearness of another.

In the flesh there is less confusion. First of all because there is a certain sense of modesty in front of a physical presence, which helps to not rush, to not pretend the fusion of our souls on the first date. And in the meantime, thanks to the continual corporeal messages which arrive through gestures, tone of voice, facial expressions, pauses and so forth, we get an idea of the other person without having to bring everything out into the forced clarity and typical impoverishment of direct discourse. Tip-toeing around certain themes is not necessarily a lack of love for the truth. It can very well express respect for the freedom and subtlety of certain truths. Some themes are like the cyclamens which can only live under the shadows of the trees in forest. Direct light kills them.

This brings us to ask a surprising question: could it be the case that the very limits imposed by physical reality have a positive meaning? Could it be that the desire to extend those limits, conquering space and time with ever more powerful means of travel and communication, is not always a useful desire?

**Limits and the Infinite**

As a young seminarian, I once spent a summer together with a hospital chaplain, Fr. Vincent. I accompanied him while he visited the sick. One hot July morning, we heard screaming in the hospital hallway. The voice was coming
from an isolation room where a woman named Rachel was dying of cancer. The nurses couldn’t do anything to control her pain. On a busy floor with many other patients to care for, they stayed away from the screaming. They were very generous nurses, willing to do anything they could to help, but when there was nothing left to do, they didn’t feel comfortable staying with that woman.

Fr. Vincent followed the sound. He entered and closed the door. Then he got on his knees and started screaming with her. She screamed, “Oh God!” and he screamed, “Oh God, help her! Help her!” He held her hand. At least that way she knew that someone was praying with her. We were there for a long time. At a certain point she changed from “Why, oh why, God? Oh, stop, stop!” into “I offer, I offer, I offer it!” In the last moments of her life, despair became hope.

When I see paintings or icons which portray Christ’s descent into hell, I think of that moment. Fr. Vincent’s hand was like Christ’s hand, reaching into the dark pit of despair and blasphemy to bring light and hope. In fact, it is not too much to say that his hand was Christ’s hand bringing about Rachel’s salvation. This is the striking reality of Christ’s singular love for each person, which he wishes to express through his Body, the Church.

That moment illuminated for me one of the reasons Jesus was willing to entrust his entire Church to the fragile, “inefficient” one-to-one communication he inaugurated with his disciples: nothing else works. No long-distance care would have been sufficient for Rachel. The only possible response to her need, after every medicine had
been tried, every palliative care given, was the hand and the voice of a human person in the same room with her. And that was the vehicle for her salvation, for her to learn to believe that God does not abandon us, and to trust that even her suffering itself could find meaning in his Cross.

This is not to say that all the efforts of the doctors and nurses were useless, far from it. They absolutely were useful, just secondary. What was fundamental was the human contact that could only come about in a one-to-one encounter. There was no way to multiply Fr. Vincent’s effectiveness through advances in communication technology. The only thing good enough for Rachel that July morning was his hand in hers.

This story helps us to see that the question we began with, “how can the Church use new technologies to further her mission?” must be asked as a secondary question. The Church must “sift everything,” retaining what is good (cf. 1 Thessalonians 5:21), but she must never forget that she had her beginnings in the singular, specific, personal love of Jesus for his disciples. No technical progress can ever make that kind of relationship go out of date.

The same truth is visible in many other areas of Christian life. A married couple must accept many limits in their life together – the limits caused by the personalities of the two spouses, by their social situation, by their children, by illnesses or accidents, and so forth. Yet it is precisely within those limitations that the couple may experience the fulfillment and beauty of their vocation. The alternatives to faithfulness do not lead to happiness. A missionary priest
may be rightly full of the desire to carry God’s Kingdom to all men and women – but if he does not care for one community, his own flock, he will end up dispersed in activity and bear little fruit.

The Church exists because people are wounded. Her goal is not just to proclaim the Good News efficiently, and then move on to do something else, but physically to be the Body of Christ. All of Christian life rests within the experience of the sacraments, the liturgy, the communion of the Church, and the mystery of God’s time. Wounds take time to heal, and often a doctor cannot speed up their healing. He must be willing to wait, to consider each person as completely unique, completely worthy of his entire attention. He must not rush from patient to patient, in an attempt to care for greater numbers, to the detriment of the quality of the care itself. In his just desire to do more good, he must not end up considering his patients simply as problems and not as people.

In a similar way, a missionary must attend to the other, waiting for him to open himself to Christ, and be willing to wait as long as necessary. That puts a rather low limit on the number of people he can care for adequately, but only in accepting this limit is his work truly fruitful. I believe that this is what Christ showed us in his own pedagogical approach, which focused much of its attention on a very small group of men.

It seems reasonable to doubt that new technologies will fundamentally revolutionize human life as a whole and, with it, the new evangelization. Jesus Christ, who “reveals
man to himself,”¹⁰ is not an intermediate stage in evolution. He represents the fullness of humanity, the height to which we can aspire through his grace, not a stepping-stone on our way to becoming cyborgs. We should not think, therefore, that technological developments have already brought about, or will bring about in the future, a fundamental change in the structure of the human person.

As I tried to show with the story about the chaplain, what is truly essential often cannot be given and received except in person. And that outstretched hand, Christ present revealing his personal, singular love for me and for you, is the very content of the new evangelization.

In conclusion, we must be careful that our question about how to use new technologies does not supplant the more important question: what are we trying to use them to do?
The task of Christians to proclaim the Gospel “in season and out of season” (2 Timothy 4:2) necessarily entails discernment regarding the means with which we carry out this charge. An encounter of the Christian message with today’s “culture of technology” requires a keen sense of discernment, since the Word of God both judges and saves, “purifying, healing, and elevating the best features” of any human culture. For this reason, we wish to offer a few basic guidelines in our effort to inculturate the Gospel for the increasingly digitized men and women of today.

1. The Centrality of the Incarnation
We are proclaiming the Good News of the Incarnation of the Son of God, who took on the whole of human nature in order to save us. Through his passion, death, and resurrection, he redeems the human person – body, soul, and spirit – in communion with all of humanity and with God. Since
the Gospel is a message of the incarnate Love that alone saves, it can only be proclaimed adequately in an incarnate way. In other words, the proclamation of the Gospel corresponds to its content and is convincing only when it is embodied in the lives of the persons proclaiming it, and when it leads to a concrete encounter with Christ’s Church. Many means are helpful in the effort to proclaim the Gospel, including art and imagery, reasoned argument, and the dissemination of information about the faith. However, none of these means can stand by itself. Each must have as its origin, abiding orientation and explicit goal a concrete encounter with the Love that saves.

The Gospel must always have a “face”: first, the face of my neighbor who proclaims it to me and loves me, in whom I begin to understand what it means to seek God’s face. In Pope Benedict’s words, “Even when it is proclaimed in the virtual space of the web, the Gospel demands to be incarnated in the real world and linked to the real faces of our brothers and sisters, those with whom we share our daily lives. Direct human relations always remain fundamental for the transmission of the faith!” Only such direct human relations can communicate the Love of God that humanizes man and draws him into genuine communion. We can truly love one another only with our voice, hands, presence, and patience; thus, all digital means must be evaluated against and serve this norm of love.
**Guideline for discernment**

In all use of technological means for the proclamation of the Gospel, we must remain attentive to those dimensions of the digital culture that do not encourage – or are incompatible with – belief in the centrality of the Incarnation. To the greatest extent possible, we must avoid contributing to the culture of disembodiment and loneliness Pope Benedict describes, and respond to his call to a commitment to promote “a humanizing communication”:

> Today many young people, stunned by the infinite possibilities offered by computer networks or by other forms of technology, establish methods of communication that do not contribute to their growth in humanity. Rather they risk increasing their sense of loneliness and disorientation. In the face of these phenomena I have spoken ... of ... a challenge to which one can and should respond with creative intelligence, committing oneself to promote a humanizing communication which stimulates a critical eye and the capacity to evaluate and discern.⁴

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**2. A Free Gift**

The Gospel is convincingly proclaimed by “the beauty of Christian life,” which “is even more effective than art and imagery.... In the end, love alone is worthy of faith and proves credible.... [A] Christian life lived in fullness speaks without words.”⁵ Confronted with such an incarnate message, we begin to understand that the Gospel is not something we can give to ourselves or control; it is not simply
subject to our prior interests and choice. We do not choose it in the way that we would choose to read one news outlet rather than another, or make one online purchase rather than another. It is a free gift of love that calls for a response of love: “The truth of the Gospel is not something to be consumed or used superficially; rather it is a gift that calls for a free response.”

**Guideline for discernment**

We must remain vigilant with respect to the anonymity and consumerism toward which the culture of digital communications predisposes us. Hence, we strive to propose thoughtful content that is clearly oriented toward an experience of the Gospel as a *gift*, which we receive and give to others in “relationships which are truly deep and lasting.” In the content as well as the method of our communication, the inauthenticity, distraction, and lack of critical reflection that are generated by the prevailing digital culture must be seen, judged, and transformed in the light of God’s Word.

3. **“Silence and Word: Path of Evangelization”**

There is no genuine proclamation or reception of the Gospel that does not involve, as an essential and abiding dimension, an encounter with God’s mystery and the power of his Word. For this reason, the proclamation of the faith always entails an education in silence. Silence is necessary for prayer and for effective communication. As Pope
Benedict reminds us, “learning to communicate is learning to listen and to contemplate as well as speak. This is especially important for those engaged in the task of evangelization.” The effort to inculturate the Gospel in every aspect of contemporary life will be successful to the extent that it leads all persons — evangelizing and evangelized — to keep their “gaze fixed upon Jesus Christ,” experience his love, and contemplate the Beauty revealed in him. All communication of the Christian faith must, in method and in content, remain continually informed by its goal: the transforming encounter with God, which takes place above all in the Church’s liturgy and in the silence of adoration.

**Guideline for discernment**

With an eye to the dangers of the multiplication of words and messages in the area of social communications, our communication of the faith must remain attentive to the necessary interplay of word and silence. We must seek to lead the men and women of today to an experience of the silence in which God speaks, and in which we learn what it means to love. Benedict XVI explains:

> Out of such contemplation springs forth ... the urgent sense of mission, the compelling obligation ‘to communicate that which we have seen and heard’ so that all may be in communion with God (1 John 1:3). Silent contemplation immerses us in the source of that Love who directs us towards our neighbors so that we may feel their suffering and offer them the light of Christ, his message of life and his saving gift of the fullness of love.
Sources

Technology and the New Evangelization


3 Among many others, Nicholas Carr, The Shallows (Norton, 2010); Norman Doidge, The Brain that Changes Itself (Penguin, 2007); Stanislas Dehaene, Reading in the Brain (Penguin, 2009); Maryanne Wolf, Proust and the Squid (Harper, 2007).

4 These exciting discoveries have been recounted in passionate detail by Norman Doidge in his The Brain that Changes Itself. The writer, a psychiatrist and researcher at Columbia University in New York, reconstructs the history of the fundamental discoveries in neuroscience by presenting various “case studies” of his personal knowledge. Five years earlier, Jeffrey Schwartz and Sharon Begley told the same story in more technical language in The Mind and the Brain (HarperCollins, 2002).

5 Described in Schwartz & Begley, 217.

6 I dedicate more space to developing these themes in The Scent of Lemons, (London: Darton, Longman and Todd, 2012).

7 Benedict XVI, Message for the 45th World Communications Day, June 5, 2011.

8 Benedict XVI, Apostolic Exhortation Verbum Domini, 116.
The Use of Technology in the New Evangelization:
A Few Guidelines

1 Cf. Lineamenta for the 2012 Synod on the New Evangelization, “The New Evangelization for the Transmission of the Christian Faith,” 3-4, on how the new evangelization is necessarily “a process of discernment. Proclamation first requires moments of listening, understanding, and interpretation.”

2 Cf. Benedict XVI, Address to participants in the plenary assembly of the Pontifical Council for Culture, November 13, 2010: “In today’s culture of technology too, the Gospel is the guide and the permanent paradigm of inculturation, purifying, healing and elevating the best features of the new languages and the new forms of communication.”

3 Benedict XVI, Message for the 45th World Communications Day, June 5, 2011.

4 Benedict XVI, Address to participants in the plenary assembly of the Pontifical Council for Culture, November 13, 2010.

5 Ibid.

6 Benedict XVI, Message for the 45th World Communications Day.

7 Ibid.
Pope Benedict’s questions provide helpful criteria for discernment: “The new technologies allow people to meet each other beyond the confines of space and of their own culture.... This is a great opportunity, but it also requires greater attention to and awareness of possible risks.... Does the danger exist that we may be less present to those whom we encounter in our everyday life? Is there a risk of being more distracted because our attention is fragmented and absorbed in a world ‘other’ than the one in which we live? Do we have time to reflect critically on our choices and to foster human relationships which are truly deep and lasting? It is important always to remember that virtual contact cannot and must not take the place of direct human contact with people at every level of our lives” (ibid.).

Title of Benedict XVI’s Message for the 46th World Communications Day, May 20, 2012.

Ibid.

Benedict XVI, Apostolic Letter Porta Fidei, 13.

Benedict XVI, Message for the 46th World Communications-Day.
About the Authors

Jonah Lynch, F.S.C.B. (1978) has been a priest since 2006. He graduated in Physics from McGill University in Montreal, and then entered the seminary. He studied philosophy and theology at the Lateran University, and obtained a Master’s in Education at George Washington University. He writes on music and theology for the American edition of Communio. In Italy, he has published five books. An English edition of his essay on technology and human relations, The Scent of Lemons, is forthcoming from Darton, Longman, & Todd. He is the Vice-Rector of the Seminary of the Priestly Fraternity of the Missionaries of St. Charles Borromeo in Rome.

Michelle K. Borras, Ph.D., is director of the Catholic Information Service. She received a B.A. in English Literature from Harvard University; an S.T.L. from the Pontifical John Paul II Institute for Studies on Marriage and Family in Rome; and a Ph.D in theology from the Institute’s Washington, D.C. session, with a dissertation on Origen’s interpretation of the Paschal Mystery. Dr. Borras taught at the John Paul II Institute in Washington an adjunct professor during the 2010-2011 academic year, and has given seminars in Catholic literature, the patristic interpretation of Scripture, and the theology of Hans Urs von Balthasar at the internal school of the Missionary Sisters of St. Charles Borromeo in Rome. In addition to translating extensively, Dr. Borras has published articles in the areas of Catholic literature and theology.
About the Catholic Information Service

Since its founding, the Knights of Columbus has been involved in evangelization. In 1948, the Knights started the Catholic Information Service (CIS) to provide low-cost Catholic publications for the general public as well as for parishes, schools, retreat houses, military installations, correctional facilities, legislatures, the medical community, and for individuals who request them. For over 60 years, CIS has printed and distributed millions of booklets, and thousands of people have enrolled in its catechetical courses.

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“In today’s culture of technology too, the Gospel is the guide and the permanent paradigm of inculturation, purifying, healing and elevating the best features of the new forms of communication.”

— Pope Benedict XVI
A TEEN PERSPECTIVE ON SOCIAL MEDIA
By Anne Florence Brown, Christ Presbyterian Academy

We live in a technology-driven world. Gone are the days of snail mail and landlines with tangled cords. Teens are now surrounded on every side by the influences of the internet, social media, and smartphones. According to commonsensemedia.org, “Almost all teenagers in America today have used social media. Nine out of 10 (90%) 13 to 17 year olds have used some form of social media. Three out of four (75%) teenagers currently have a profile on a social networking site.”

With so many teens in our community enveloped in this world of technology, we must examine the effects of social media, not only for the sake of this generation but also for the next. Living through the screen can damage our hearts and magnify our sin.

But even though social media has its flaws, there is hope for redemption.

Two years ago, I was sitting on my bed with a computer in my lap. I was weighing two options on my Instagram settings: “Deactivate” or “Return to Profile”. Slowly, I dragged my mouse across the settings page and pressed a button that freed me. I have been without Instagram for two years and without Snapchat for one. Living without them has given me freedom because for years I suffered from the harms of social media.

Instagram was an effective trigger for my already struggling self-worth as it provided me with a tangible measure of how many friends I had and how many people liked my life. It was a tool I used to damage my self-esteem daily. The most dangerous part was I did not realize how much I was controlled by this social app. I felt immune to its addictions, its allure. But I found myself at the beach, spending the entire time “fixing my feed” with new pictures and filters. While waiting in the doctor’s office, I tried to come up with the perfect caption for a picture I was planning to take that weekend with a certain popular friend at a party. I imagined how cool I would look to my Instagram followers once I posted it. I lost sleep because I stayed up late every night before bed, refreshing my screen for hours on end.

Every scroll of my thumb brought a new judgment, comparison, or observation that was followed by a feeling of either self-righteousness or self-degradation.

When I finally spent a week “unplugging” from my phone, I realized that the withdrawals I experienced from disengaging from the app were a sign of the control it had over me. This control scared me and made me angry because I had willingly put myself in an unnecessary position to compare my insides to others’ outsides, to be controlled by my appearance and people’s opinions, and to hurt others and myself with my comments, posts, or digital footprint. This unnerved me because it was a dangerous trap that had been disguised by an attractive, socially acceptable, and necessary staple of popularity.

After I deleted my social media accounts, I began to notice how other teenagers my age were trapped in the same digital world that I was. I wanted to understand why this was happening. What exactly are we as a society risking with the constant attachment to our screens?
We are risking both practical and emotional problems by our screen habits. Social media and the internet are very recent inventions, which means studies are just now emerging about the physical and psychological effects they have on us. Studies have shown that looking down at a phone for an entire day has the same effect on the spine as carrying an eight-year-old or four adult sized bowling balls on your neck. “Neck muscles, in their proper position, are designed to support the weight of your head, about 10 to 12 pounds,” Dr. Bolash, a pain specialist at the Cleveland Clinic said. “Research shows that for every inch you drop your head forward, you double the load on those muscles. Looking down at your smartphone, with your chin to your chest, can put about 60 pounds of force on your neck (health.clevelandclinic.org).

Furthermore, studies show that when your phone receives a notification, a small dose of serotonin, the neurotransmitter responsible for happiness, shoots through the brain, causing a small high. Psychologically, “New research suggests that comparing yourself with others on Facebook is more likely to lead to feelings of depression than making social comparisons offline” (psychcentral.com).

These growing risks show that due to the internet’s short existence, we cannot foresee the amount of risks involved in something we have integrated so deeply into our lives. If this is true, should we not treat our national “epidemic” more seriously? These risks combine to show that we are raising generations addicted to potentially harmful devices.

Children are growing up without privacy as their parents digitally document every moment from birth on—sometime even before birth. Speaker, author and cyber expert Tyler Cohen Wood explains, “Children now have an entire life history, down to the pregnancy announcement before they were born, on social media. The ramifications of this can be far-reaching” (Care.com).

Teenagers own an all-access pass to bullying, sexting, and pornography because even the most strict parental controls can’t fully block every vulgar website, TV show, post, or profile on social media apps. Kids also observe parents obsessing over their own social media—texting during dinner, or checking twitter while driving. Children conclude that, like their parents, they need validation from a virtual world in order to be accepted. We are fostering a generation that lives through a rectangle in their hand and believes that they cannot live without it.

With all of this being said, the true problem here is a heart problem, not a device problem. The smartphone and its apps are not inherently evil. In fact, used correctly and in moderation, these are beneficial devices that cultivate education, connection, and community. In a world where people seldom journal, social media can act as a way to document our lives—as something to look back on years down the road. Social media can also produce confidence in young people as they share their thoughts, feel heard, and project themselves to others. Digitaltrends.com said “there’s universal agreement on one thing: [social media sites] promote both honesty and openness. It seems people really enjoy being themselves, and throwing that openness out there for all to see.”

I have experienced these successes firsthand. I have seen new sides of people through Snapchat that I never would have seen before, which grew our friendships. I have seen others longing to be more authentic in their profiles in order to combat shallow connections. Despite these significant
positives, people are often grateful for opportunities to “unplug”. Why is it that every time we leave our phones behind for a weekend, or a week, or a month, we feel set free for that time? We rave about how beneficial it was to our heart and soul, but then we go straight back to them without skipping a beat.

Our hearts are crying out for relief. As we spend day in and day out trying to control our image, we grab it and hold it in a fist, unwilling to let it go and give it to Jesus. Even those without any accounts, like myself, struggle with image control by posting nothing. Therefore, eliminating social media from life isn’t the perfect answer either.

Instead, we must each address our hearts and our approach to our phones. Jesus said in Revelation that he has come “to make all things new” (Rev 21:5). That includes our image and how we try to present it. So maybe we can take part in bringing redemption to the digital world together. We are called to be in this world, but not of it. Maybe that means we are called to be a people who bring redemption to a technology-driven world. Maybe it means putting our phones away, looking up, and being wholly present wherever we are. Maybe it means deleting our accounts all together. Maybe it means sharing the words of Jesus on our digital platform. Jesus said, “let your yes be yes and your no be no”, so maybe living out the gospel means communicating full truths on our profiles, not half-truths, or the best versions of ourselves.

As we go forward, learning to navigate our technological lives, let us be mindful of our heart problems, celebrate others who overcome, and encourage one another to be image bearers of Jesus by cultivating one of the greatest skills of our time: using social media with grace, confidence, moderation, and love. And as we do, may we remember that the “greatest of these is love.”
ONE DAY last summer, around noon, I called Athena, a 13-year-old who lives in Houston, Texas. She answered her phone—she’s had an iPhone since she was 11—sounding as if she’d just woken up. We chatted about her favorite songs and TV shows, and I asked her what she likes to do with her friends. “We go to the mall,” she said. “Do your parents drop you off?,” I asked, recalling my own middle-school days, in the 1980s, when I’d enjoy a few parent-free hours shopping with my friends. “No—I go with my family,” she replied. “We’ll go with my mom and brothers and walk a little behind them. I just have to tell my mom where we’re going. I have to check in every hour or every 30 minutes.”

Those mall trips are infrequent—about once a month. More often, Athena and her friends spend time together on their phones, unchaperoned. Unlike the teens of my generation, who might have spent an evening tying up the family landline with gossip, they talk on Snapchat, the smartphone app that allows users to send pictures and videos that quickly disappear. They make sure to keep up their Snapstreaks, which show how many days in a row they have Snapchatted with each other. Sometimes they save screenshots of particularly ridiculous pictures of friends. “It’s good blackmail,” Athena said. (Because she’s a minor, I’m not using her real name.) She told me she’d spent most of the summer hanging out alone in her room with her phone. That’s just the
way her generation is, she said. “We didn’t have a choice to know any life without iPads or iPhones. I think we like our phones more than we like actual people."

I’ve been researching generational differences for 25 years, starting when I was a 22-year-old doctoral student in psychology. Typically, the characteristics that come to define a generation appear gradually, and along a continuum. Beliefs and behaviors that were already rising simply continue to do so. Millennials, for instance, are a highly individualistic generation, but individualism had been increasing since the Baby Boomers turned on, tuned in, and dropped out. I had grown accustomed to line graphs of trends that looked like modest hills and valleys. Then I began studying Athena’s generation.

Around 2012, I noticed abrupt shifts in teen behaviors and emotional states. The gentle slopes of the line graphs became steep mountains and sheer cliffs, and many of the distinctive characteristics of the Millennial generation began to disappear. In all my analyses of generational data—some reaching back to the 1930s—I had never seen anything like it.

The allure of independence, so powerful to previous generations, holds less sway over today’s teens.

At first I presumed these might be blips, but the trends persisted, across several years and a series of national surveys. The changes weren’t just in degree, but in kind. The biggest difference between the Millennials and their predecessors was in how they viewed the world; teens today differ from the Millennials not just in their views but in how they spend their time. The experiences they have every day are radically different from those of the generation that came of age just a few years before them.

What happened in 2012 to cause such dramatic shifts in behavior? It was after the Great Recession, which officially lasted from 2007 to 2009 and had a starker effect on Millennials trying to find a place in a sputtering economy. But it was exactly the moment when the proportion of Americans who owned a smartphone surpassed 50 percent.

The more I pored over yearly surveys of teen attitudes and behaviors, and the more I talked with young people like Athena, the clearer it became that theirs is a generation shaped by the smartphone and by the concomitant rise of social media. I call them iGen. Born between 1995 and 2012, members of this generation are growing up with smartphones, have an Instagram account before they start high school, and do not remember a time before the internet. The Millennials grew up with the web as well, but it wasn’t ever-present in their lives, at hand at all times, day and night. iGen’s oldest members were early adolescents when the iPhone was introduced, in 2007, and high-school students when the iPad entered the scene, in 2010. A 2017 survey of more than 5,000 American teens found that three out of four owned an iPhone.

The advent of the smartphone and its cousin the tablet was followed quickly by hand-wringing about the deleterious effects of “screen time.” But the impact of these devices has not been fully appreciated, and goes far beyond the usual concerns about curtailed attention spans. The arrival of the smartphone has radically changed every aspect of teenagers’ lives, from the nature of their social interactions to their mental health. These changes have affected young people in every
corner of the nation and in every type of household. The trends appear among teens poor and rich; of every ethnic background; in cities, suburbs, and small towns. Where there are cell towers, there are teens living their lives on their smartphone.

To those of us who fondly recall a more analog adolescence, this may seem foreign and troubling. The aim of generational study, however, is not to succumb to nostalgia for the way things used to be; it’s to understand how they are now. Some generational changes are positive, some are negative, and many are both. More comfortable in their bedrooms than in a car or at a party, today’s teens are physically safer than teens have ever been. They’re markedly less likely to get into a car accident and, having less of a taste for alcohol than their predecessors, are less susceptible to drinking’s attendant ills.

Psychologically, however, they are more vulnerable than Millennials were: Rates of teen depression and suicide have skyrocketed since 2011. It’s not an exaggeration to describe iGen as being on the brink of the worst mental-health crisis in decades. Much of this deterioration can be traced to their phones.

Even when a seismic event—a war, a technological leap, a free concert in the mud—plays an outsized role in shaping a group of young people, no single factor ever defines a generation. Parenting styles continue to change, as do school curricula and culture, and these things matter. But the twin rise of the smartphone and social media has caused an earthquake of a magnitude we’ve not seen in a very long time, if ever. There is compelling evidence that the devices we’ve placed in young people’s hands are having profound effects on their lives—and making them seriously unhappy.

In the early 1970s, the photographer Bill Yates shot a series of portraits at the Sweetheart Roller Skating Rink in Tampa, Florida. In one, a shirtless teen stands with a large bottle of peppermint schnapps stuck in the waistband of his jeans. In another, a boy who looks no older than 12 poses with a cigarette in his mouth. The rink was a place where kids could get away from their parents and inhabit a world of their own, a world where they could drink, smoke, and make out in the backs of their cars. In stark black-and-white, the adolescent Boomers gaze at Yates’s camera with the self-confidence born of making your own choices—even if, perhaps especially if, your parents wouldn’t think they were the right ones.

Fifteen years later, during my own teenage years as a member of Generation X, smoking had lost some of its romance, but independence was definitely still in. My friends and I plotted to get our driver’s license as soon as we could, making DMV appointments for the day we turned 16 and using our newfound freedom to escape the confines of our suburban neighborhood. Asked by our parents, “When will you be home?,” we replied, “When do I have to be?”

But the allure of independence, so powerful to previous generations, holds less sway over today’s teens, who are less likely to leave the house without their parents. The shift is stunning: 12th-graders in 2015 were going out less often than eighth-graders did as recently as 2009.

Today’s teens are also less likely to date. The initial stage of courtship, which Gen Xers called “liking” (as in “Ooh, he likes you!”), kids now call “talking”—an ironic choice for a generation
that prefers texting to actual conversation. After two teens have “talked” for a while, they might start dating. But only about 56 percent of high-school seniors in 2015 went out on dates; for Boomers and Gen Xers, the number was about 85 percent.

The decline in dating tracks with a decline in sexual activity. The drop is the sharpest for ninth-graders, among whom the number of sexually active teens has been cut by almost 40 percent since 1991. The average teen now has had sex for the first time by the spring of 11th grade, a full year later than the average Gen Xer. Fewer teens having sex has contributed to what many see as one of the most positive youth trends in recent years: The teen birth rate hit an all-time low in 2016, down 67 percent since its modern peak, in 1991.

Even driving, a symbol of adolescent freedom inscribed in American popular culture, from Rebel Without a Cause to Ferris Bueller’s Day Off, has lost its appeal for today’s teens. Nearly all Boomer high-school students had their driver’s license by the spring of their senior year; more than one in four teens today still lack one at the end of high school. For some, Mom and Dad are such good chauffeurs that there’s no urgent need to drive. “My parents drove me everywhere and never complained, so I always had rides,” a 21-year-old student in San Diego told me. “I didn’t get my license until my mom told me I had to because she could not keep driving me to school.” She finally got her license six months after her 18th birthday. In conversation after conversation, teens described getting their license as something to be nagged into by their parents—a notion that would have been unthinkable to previous generations.

Independence isn’t free—you need some money in your pocket to pay for gas, or for that bottle of schnapps. In earlier numbers, kids worked in great numbers, eager to finance their freedom or prodded by their parents to learn the value of a dollar. But iGen teens aren’t working (or managing their own money) as much. In the late 1970s, 77 percent of high-school seniors worked for pay during the school year; by the mid-2010s, only 55 percent did. The number of eighth-graders who work for pay has been cut in half. These declines accelerated during the Great Recession, but teen employment has not bounced back, even though job availability has.
Of course, putting off the responsibilities of adulthood is not an iGen innovation. Gen Xers, in the 1990s, were the first to postpone the traditional markers of adulthood. Young Gen Xers were just about as likely to drive, drink alcohol, and date as young Boomers had been, and more likely to have sex and get pregnant as teens. But as they left their teenage years behind, Gen Xers married and started careers later than their Boomer predecessors had.

Gen X managed to stretch adolescence beyond all previous limits: Its members started becoming adults earlier and finished becoming adults later. Beginning with Millennials and continuing with iGen, adolescence is contracting again—but only because its onset is being delayed. Across a range of behaviors—drinking, dating, spending time unsupervised—18-year-olds now act more like 15-year-olds used to, and 15-year-olds more like 13-year-olds. Childhood now stretches well into high school.

Why are today’s teens waiting longer to take on both the responsibilities and the pleasures of adulthood? Shifts in the economy, and parenting, certainly play a role. In an information economy that rewards higher education more than early work history, parents may be inclined to encourage their kids to stay home and study rather than to get a part-time job. Teens, in turn, seem to be content with this homebody arrangement—not because they’re so studious, but because their social life is lived on their phone. They don’t need to leave home to spend time with their friends.

If today’s teens were a generation of grinds, we’d see that in the data. But eighth-, 10th-, and 12th-graders in the 2010s actually spend less time on homework than Gen X teens did in the early 1990s. (High-school seniors headed for four-year colleges spend about the same amount of time on homework as their predecessors did.) The time that seniors spend on activities such as student clubs and sports and exercise has changed little in recent years. Combined with the decline in working for pay, this means iGen teens have more leisure time than Gen X teens did, not less.

So what are they doing with all that time? They are on their phone, in their room, alone and often distressed.

One of the ironies of iGen life is that despite spending far more time under the same roof as their parents, today’s teens can hardly be said to be closer to their mothers and fathers than their predecessors were. “I’ve seen my friends with their families—they don’t talk to them,” Athena told me. “They just say ‘Okay, okay, whatever’ while they’re on their phones. They don’t pay attention to their family.” Like her peers, Athena is an expert at tuning out her parents so she can focus on her phone. She spent much of her summer keeping up with friends, but nearly all of it was over text or Snapchat. “I’ve been on my phone more than I’ve been with actual people,” she said. “My bed has, like, an imprint of my body.”
In this, too, she is typical. The number of teens who get together with their friends nearly every day dropped by more than 40 percent from 2000 to 2015; the decline has been especially steep recently. It’s not only a matter of fewer kids partying; fewer kids are spending time simply hanging out. That’s something most teens used to do: nerds and jocks, poor kids and rich kids, C students and A students. The roller rink, the basketball court, the town pool, the local necking spot—they’ve all been replaced by virtual spaces accessed through apps and the web.

You might expect that teens spend so much time in these new spaces because it makes them happy, but most data suggest that it does not. The Monitoring the Future survey, funded by the National Institute on Drug Abuse and designed to be nationally representative, has asked 12th-
graders more than 1,000 questions every year since 1975 and queried eighth- and 10th-graders since 1991. The survey asks teens how happy they are and also how much of their leisure time they spend on various activities, including nonscreen activities such as in-person social interaction and exercise, and, in recent years, screen activities such as using social media, texting, and browsing the web. The results could not be clearer: Teens who spend more time than average on screen activities are more likely to be unhappy, and those who spend more time than average on nonscreen activities are more likely to be happy.

There’s not a single exception. All screen activities are linked to less happiness, and all nonscreen activities are linked to more happiness. Eighth-graders who spend 10 or more hours a week on social media are 56 percent more likely to say they’re unhappy than those who devote less time to social media. Admittedly, 10 hours a week is a lot. But those who spend six to nine hours a week on social media are still 47 percent more likely to say they are unhappy than those who use social media even less. The opposite is true of in-person interactions. Those who spend an above-average amount of time with their friends in person are 20 percent less likely to say they’re unhappy than those who hang out for a below-average amount of time.

The more time teens spend looking at screens, the more likely they are to report symptoms of depression.

If you were going to give advice for a happy adolescence based on this survey, it would be straightforward: Put down the phone, turn off the laptop, and do something—anything—that does not involve a screen. Of course, these analyses don’t unequivocally prove that screen time causes unhappiness; it’s possible that unhappy teens spend more time online. But recent research suggests that screen time, in particular social-media use, does indeed cause unhappiness. One study asked college students with a Facebook page to complete short surveys on their phone over the course of two weeks. They’d get a text message with a link five times a day, and report on their mood and how much they’d used Facebook. The more they’d used Facebook, the unhappier they felt, but feeling unhappy did not subsequently lead to more Facebook use.

Social-networking sites like Facebook promise to connect us to friends. But the portrait of iGen teens emerging from the data is one of a lonely, dislocated generation. Teens who visit social-networking sites every day but see their friends in person less frequently are the most likely to agree with the statements “A lot of times I feel lonely,” “I often feel left out of things,” and “I often wish I had more good friends.” Teens’ feelings of loneliness spiked in 2013 and have remained high since.

This doesn’t always mean that, on an individual level, kids who spend more time online are lonelier than kids who spend less time online. Teens who spend more time on social media also spend more time with their friends in person, on average—highly social teens are more social in both venues, and less social teens are less so. But at the generational level, when teens spend more time on smartphones and less time on in-person social interactions, loneliness is more common.
So is depression. Once again, the effect of screen activities is unmistakable: The more time teens spend looking at screens, the more likely they are to report symptoms of depression. Eighth-graders who are heavy users of social media increase their risk of depression by 27 percent, while those who play sports, go to religious services, or even do homework more than the average teen cut their risk significantly.

Teens who spend three hours a day or more on electronic devices are 35 percent more likely to have a risk factor for suicide, such as making a suicide plan. (That’s much more than the risk related to, say, watching TV.) One piece of data that indirectly but stunningly captures kids’ growing isolation, for good and for bad: Since 2007, the homicide rate among teens has declined, but the suicide rate has increased. As teens have started spending less time together, they have become less likely to kill one another, and more likely to kill themselves. In 2011, for the first time in 24 years, the teen suicide rate was higher than the teen homicide rate.

Depression and suicide have many causes; too much technology is clearly not the only one. And the teen suicide rate was even higher in the 1990s, long before smartphones existed. Then again, about four times as many Americans now take antidepressants, which are often effective in treating severe depression, the type most strongly linked to suicide.
What’s the connection between smartphones and the apparent psychological distress this generation is experiencing? For all their power to link kids day and night, social media also exacerbate the age-old teen concern about being left out. Today’s teens may go to fewer parties and spend less time together in person, but when they do congregate, they document their hangouts relentlessly—on Snapchat, Instagram, Facebook. Those not invited to come along are keenly aware of it. Accordingly, the number of teens who feel left out has reached all-time highs across age groups. Like the increase in loneliness, the upswing in feeling left out has been swift and significant.

This trend has been especially steep among girls. Forty-eight percent more girls said they often felt left out in 2015 than in 2010, compared with 27 percent more boys. Girls use social media more often, giving them additional opportunities to feel excluded and lonely when they see their friends or classmates getting together without them. Social media levy a psychic tax on the teen doing the posting as well, as she anxiously awaits the affirmation of comments and likes. When Athena posts pictures to Instagram, she told me, “I’m nervous about what people think and are going to say. It sometimes bugs me when I don’t get a certain amount of likes on a picture.”

Girls have also borne the brunt of the rise in depressive symptoms among today’s teens. Boys’ depressive symptoms increased by 21 percent from 2012 to 2015, while girls’ increased by 50 percent—more than twice as much. The rise in suicide, too, is more pronounced among girls. Although the rate increased for both sexes, three times as many 12-to-14-year-old girls killed themselves in 2015 as in 2007, compared with twice as many boys. The suicide rate is still higher for boys, in part because they use more-lethal methods, but girls are beginning to close the gap.

These more dire consequences for teenage girls could also be rooted in the fact that they’re more likely to experience cyberbullying. Boys tend to bully one another physically, while girls are more likely to do so by undermining a victim’s social status or relationships. Social media give middle- and high-school girls a platform on which to carry out the style of aggression they favor, ostracizing and excluding other girls around the clock.

Social-media companies are of course aware of these problems, and to one degree or another have endeavored to prevent cyberbullying. But their various motivations are, to say the least, complex. A recently leaked Facebook document indicated that the company had been touting to advertisers its ability to determine teens’ emotional state based on their on-site behavior, and even to pinpoint “moments when young people need a confidence boost.” Facebook acknowledged that the document was real, but denied that it offers “tools to target people based on their emotional state.”

In July 2014, a 13-year-old girl in North Texas woke to the smell of something burning. Her phone had overheated and melted into the sheets. National news outlets picked up the story, stoking readers’ fears that their cellphone might spontaneously combust. To me, however, the flaming cellphone wasn’t the only surprising aspect of the story. Why, I wondered, would anyone sleep with her phone beside her in bed? It’s not as though you can surf the web while you’re sleeping. And who could slumber deeply inches from a buzzing phone?
Curious, I asked my undergraduate students at San Diego State University what they do with their phone while they sleep. Their answers were a profile in obsession. Nearly all slept with their phone, putting it under their pillow, on the mattress, or at the very least within arm’s reach of the bed. They checked social media right before they went to sleep, and reached for their phone as soon as they woke up in the morning (they had to—all of them used it as their alarm clock). Their phone was the last thing they saw before they went to sleep and the first thing they saw when they woke up. If they woke in the middle of the night, they often ended up looking at their phone. Some used the language of addiction. “I know I shouldn’t, but I just can’t help it,” one said about looking at her phone while in bed. Others saw their phone as an extension of their body—or even like a lover: “Having my phone closer to me while I’m sleeping is a comfort.”

It may be a comfort, but the smartphone is cutting into teens’ sleep: Many now sleep less than seven hours most nights. Sleep experts say that teens should get about nine hours of sleep a night; a teen who is getting less than seven hours a night is significantly sleep deprived. Fifty-seven percent more teens were sleep deprived in 2015 than in 1991. In just the four years from 2012 to 2015, 22 percent more teens failed to get seven hours of sleep.

The increase is suspiciously timed, once again starting around when most teens got a smartphone. Two national surveys show that teens who spend three or more hours a day on electronic devices are 28 percent more likely to get less than seven hours of sleep than those who spend fewer than three hours, and teens who visit social-media sites every day are 19 percent more likely to be sleep deprived. A meta-analysis of studies on electronic-device use among children found similar results: Children who use a media device right before bed are more likely to sleep less than they should, more likely to sleep poorly, and more than twice as likely to be sleepy during the day.

I’ve observed my toddler, barely old enough to walk, confidently swiping her way through an iPad.

Electronic devices and social media seem to have an especially strong ability to disrupt sleep. Teens who read books and magazines more often than the average are actually slightly less likely to be sleep deprived—either reading lulls them to sleep, or they can put the book down at bedtime. Watching TV for several hours a day is only weakly linked to sleeping less. But the allure of the smartphone is often too much to resist.

Sleep deprivation is linked to myriad issues, including compromised thinking and reasoning, susceptibility to illness, weight gain, and high blood pressure. It also affects mood: People who don’t sleep enough are prone to depression and anxiety. Again, it’s difficult to trace the precise paths of causation. Smartphones could be causing lack of sleep, which leads to depression, or the phones could be causing depression, which leads to lack of sleep. Or some other factor could be causing both depression and sleep deprivation to rise. But the smartphone, its blue light glowing in the dark, is likely playing a nefarious role.

The correlations between depression and smartphone use are strong enough to suggest that more parents should be telling their kids to put down their phone. As the technology writer Nick
Bilton has reported, it’s a policy some Silicon Valley executives follow. Even Steve Jobs limited his kids’ use of the devices he brought into the world.

What’s at stake isn’t just how kids experience adolescence. The constant presence of smartphones is likely to affect them well into adulthood. Among people who suffer an episode of depression, at least half become depressed again later in life. Adolescence is a key time for developing social skills; as teens spend less time with their friends face-to-face, they have fewer opportunities to practice them. In the next decade, we may see more adults who know just the right emoji for a situation, but not the right facial expression.

I realize that restricting technology might be an unrealistic demand to impose on a generation of kids so accustomed to being wired at all times. My three daughters were born in 2006, 2009, and 2012. They’re not yet old enough to display the traits of iGen teens, but I have already witnessed firsthand just how ingrained new media are in their young lives. I’ve observed my toddler, barely old enough to walk, confidently swiping her way through an iPad. I’ve experienced my 6-year-old asking for her own cellphone. I’ve overheard my 9-year-old discussing the latest app to sweep the fourth grade. Prying the phone out of our kids’ hands will be difficult, even more so than the quixotic efforts of my parents’ generation to get their kids to turn off MTV and get some fresh air. But more seems to be at stake in urging teens to use their phone responsibly, and there are benefits to be gained even if all we instill in our children is the importance of moderation. Significant effects on both mental health and sleep time appear after two or more hours a day on electronic devices. The average teen spends about two and a half hours a day on electronic devices. Some mild boundary-setting could keep kids from falling into harmful habits.

In my conversations with teens, I saw hopeful signs that kids themselves are beginning to link some of their troubles to their ever-present phone. Athena told me that when she does spend time with her friends in person, they are often looking at their device instead of at her. “I’m trying to talk to them about something, and they don’t actually look at my face,” she said. “They’re looking at their phone, or they’re looking at their Apple Watch.” “What does that feel like, when you’re trying to talk to somebody face-to-face and they’re not looking at you?,” I asked. “It kind of hurts,” she said. “It hurts. I know my parents’ generation didn’t do that. I could be talking about something super important to me, and they wouldn’t even be listening.”

Once, she told me, she was hanging out with a friend who was texting her boyfriend. “I was trying to talk to her about my family, and what was going on, and she was like, ‘Uh-huh, yeah, whatever.’ So I took her phone out of her hands and I threw it at my wall.”

I couldn’t help laughing. “You play volleyball,” I said. “Do you have a pretty good arm?” “Yep,” she replied.

Historically Speaking:
Amanda Foreman

Nancy Science
Often Born of Years of Labor

If Neccessity is the mother of invention, serendipity is the mother of progress. One recent example comes from an international scientific study of bacteria, led by researchers at the University of California, Berkeley. In their efforts to study the bacterium, *Pseudomonas aeruginosa*, the researchers are not the only ones using form of plastic, thus allowing the bacterium to eat it. As reported in the Proceedings of the National Academy of Sciences earlier this year, in the course of their research, the scientists accidentally created an organism that is even better at dissolving the plastic than the original. It's still early days, but we already have a new tool to solve one of humanity's man-made scourges of plastics pollution.

Developmental biology illustrates a truth seemingly serendipitous discovery called "serendipity" is usually the result of years of experimentation—and often a lucky break. A new book by two business professors at Wharton and a biology professor at Harvard, "Finding Biotech in the Life Sciences," argues that governments and venture capital companies should adopt a more fluid approach to rapid innovation and creativity, which can often lead to unexpected breakthroughs. As one of the authors, Philip Rea, argues, serendipity is not usually found in the lab but in the field.

"Getting answers to questions that are not even being asked is often just a lucky break. It depends on who has observed the accident, too. As Joseph del Valle, the first head of the Smithsonian Institution, said, 'The seeds of great discoveries are constantly floating around and may not even be noticed, but they only take root in minds well tuned to receive them.'"

Teenage Social-Media Trap

Adolescents increasingly measure and manage social success online, and it may be taking a toll on their mental health.

By Jennifer Bruffey Wallace

**TEENAGERS HAVE always worried about how they measure up. Am I popular? Attractive? Do I fit in?**

Social media now answers those questions in a very public and quantifiable way. It’s not just about the number of “likes” and online friends a young person has. The data on popularity can be even more granular: how many photos you’re tagged in, the level of activity and comments on your posts, how long it takes to accumulate those status markers, and even the “follow ratio,” that is, how many people you follow versus how many who follow you.

Sites like Instagram, Snapchat and Facebook offer much more than a virtual place to hang out. New research shows that they play a key role in how teens measure and manage social success; it also finds that the overuse of social media may bring added risks to an adolescent’s mental health.

For many teens, social media offers positive benefits, such as a deeper connection with friends and a low-stakes way to communicate with peers. For those on the social margins, online communities also can offer a sense of belonging and support.

But for others, it can be stressful to keep up with hundreds of online friends, maintain a perfectly curated digital profile and manage the onslaught of posts showing peers living seemingly better lives. “The hyper-vigilance that some adolescents feel forced to maintain online is anxiety-provoking and hijacks time away from more important things like home work and sleep,” says Catherine Steinert-Adair, a clinical psychologist in Chestnut Hill, Mass., and the author of "The Big Disconnect." Before social media, she adds, home was a place where you could be a more relaxed, authentic version of yourself. Now some teens never get that break.

A study led by Jacqueline Nel of the University of North Carolina at Chapel Hill, published in March in the Journal of the New Child & Adolescent Psychology, calls the quest for online popularity “digital status seeking.” The researchers followed 716 adolescents, ages 15 to 18, for one year. They found that adolescents who were more engaged in digital status seeking—frequent social-media users who employed status-seeking strategies and reported caring more about their online popularity—were more likely, a year later, to be engaged in risky behavior such as substance abuse and having an increased number of sexual partners. Ms. Nel theorizes that this is perhaps because they “are more willing to engage in behavior that will make them appear popular.”

Adolescent girls can be especially susceptible. In a longitudinal study in the UK, published in the magazine BMJ Public Health, researchers followed nearly 10,000 adolescents between the ages of 10 and 15 for five years. The study found that at age 10, 30% of girls and 7% of boys reported spending one to three hours a day on social media. By age 15, the figures increased to 43% of girls and 31% of boys. Girls who used social media for more than an hour a day at age 10 were found to have the highest risk for developing social and emotional problems at age 15.

The association may have to do with the tendency of girls to use social media to compare their lives to those of their peers, which can have a negative effect on self-esteem, the researchers say. The strong association between well-being and use of social media didn’t hold for boys, perhaps because they spend more time playing online games and less making social comparisons, says lead researcher Cara Booker of the University of Oxford.

Another recent study, published in the Journal of Research on Adolescence, looked at the effort that goes into cultivating online identities. In a series of focus groups, many of the study’s participants (27 females and 34 males, ages 12 to 18) talked about the need to appear “interesting and likable” online, but girls added the need to be “attractive.” They also were more focused on making change in their social capital, by posting content at peak hours for traffic, for example, and enlisting friends to comment on and “like” posts to boost their popularity. Several of the girls described the process as a lot of work, but none of the boys didn’t do it that way, nor did they expect close friends to “like” or comment on their posts.

Some adolescents even resort to paying for online validation. A pilot study of 100 Canadian teens, ages 13 to 17, presented this week at a conference in St. Catharines, Ontario, found that teens who spent more than $700 in one or more “deceptively like-seeking behaviors,” such as purchasing 500 “likes” for $6.99 through a website or using computer programs to give themselves a “digital nose job” before posting.

Lead researcher Tara Dumas of Humber University College in London, Ontario, calls the findings “concerning.” She adds, “We know from previous research that social validation and belonging is so important for adolescents, but when you are getting ‘likes’ by buying them or based on an image of you that’s not real, what is that doing to your self-esteem?”

“Too many young people, typically girls, confuse the attention they get on social media with their self-worth,” says Rachel Simmons, a leadership development specialist at Smith College and the author of "Enough Already: Why Our Kids Can’t Stop texting, e-mailing, and cyber-bullying and what we can do about it."

"What can parents do? Pulling back the curtain on social media—exposing the tactics that are used to get us hooked—can help teens think more critically about how they’re participating in a system that profits from their obsession with "likes," says Ms. Simmons.

Dr. Steiner-Adair advises parents to check in daily about what’s going on in their teen’s online world and to stay approachable. "Parents need to start taking as much interest in their teen’s online life as they do their real one," she says.

Ms. Wallace is a freelance writer in New York.

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**Turning Plants Into People**

Famously lucky meeting of personal prodigies

When Isaac Newton observed an apple fall from the tree, (the details are hazy, but there’s no evidence that he was actually struck by it), he was supposedly thinking about gravity's relationship to the motion of the planets. Still, it took Newton another 10 years of work before he published his theory of Universal Gravitation. And that's why the enthusiast was the catalyst for an agricultural revolution, leading to physicist James Clerk Maxwell's discovery of the electromagnetic theory of light, which was then applied to the development of the telephone and radio. This week is the 350th anniversary of the birth of Newton, who was born on Christmas Day in 1642.