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Cross-Pollinating the Mind: Reflections at the Crossroads of English and STEM  
Studies

Cindy Lutembacher and Alison Ligon

We are tempted to begin this essay with a defensive tone, for the mediated airplay of the need for STEM majors and STEM embodied professionals oftentimes seems akin to the beat of the works of John Philip Sousa. Even though the fact of the matter is that U.S. colleges and universities graduate two to three capable STEM majors for every U.S. STEM job (Krashen; Jordan Weissman), the contemporary culture in which we live, struggle, and thrive emphasizes the need for both the wonderful creativity of scientists and the desire for the (erroneously) perceived absolutism of the sciences.

What is also true is that we are two English professors who, revealed in confessional mode as we brainstormed for this essay, both adore science and math. One of us, through family heritage and expectation as well as her own zeal for science, was destined to become a physician and attended a science and technology magnet high school, and the other received a scholarship to pursue mathematics because she achieved the third highest score in her state on a standardized math test in high school. Somehow, we ended up—gratefully and passionately—in the Department of English, but our love for STEM has remained a stalwart devotion for both of us. Thus do we find ourselves at the intersection of STEM and English studies. (In this essay, we use “science” and “scientists” to include all the STEM fields and practitioners.) As important as are the STEM fields, is English likewise vital in this time and place? If English is not of value for its own sake (and we hasten to say that we believe it is) then how does the discipline of English studies nourish those in the fields of science, technology, engineering, and math?

### ***Literature, the Humanities, and STEM: Crossroads to Consider***

We begin our discussion of this question with the study of literature, for that inquiry is so much more than a dissection and parsing of literary works, as many presume the field to be. The study of literature must be a journey to the center of the mind and soul, as we dive headlong with our students into the voices of people from other times and places—voices whose mission was/is at least a kissing cousin to the necessity to speak timelessly of a specific time and place. The study of literature is “the timeless expressions of humanistic inquiry” whose expressions, therefore, become just as much the province of students and teachers in the humanities as they are questions that must be continuously posed by students and teachers in STEM fields. Scientists must be immersed in humanistic inquiry because of the rapidly changing needs of people who are directly impacted by research findings in STEM fields. Moreover, in STEM fields, the concerns that are addressed by scientific and technological interventions are ultimately human ones. For the sciences of all species—biology, chemistry, physics, technology, engineering, mathematics—as well as their subspecies, such as neuroscience, quantum mechanics, set theory, et cetera, each discipline requires its practitioners to deeply engage in much larger issues than the specifics of individual research projects.

For example, when a chemistry professor observes his/her students completing lab experiments, it is just as important for him/her to emphasize that students be mindful of laboratory protocols and research reporting standards, as it is critical to provide context for why these matters and the scientific content of the experiment are significant. Consequently, the context that the chemistry professor provides students frames and, in many instances, inspires his/her students to want to commit

themselves to the realization of scientific accuracy and inquisitiveness because their volitional acts will benefit the greater good of life on this planet.

Equally plausible is the claim that students' awareness of and desire to realize these elements of key scientific significance begin in an English classroom. This site for exploration and learning that is often dismissed as a humble space—by students and non-English faculty alike. However, we contend that the English classroom is a setting where all college students are first equipped with the language and behaviors that are sought in STEM classrooms, namely, critical thinking, reasoning, argumentation, affirmation, and refutation skills. Scientists must be able to imagine well beyond the impact of their research within their own fields; they must be able to envision the niche and potential that their work occupies in the human world. As George Bugliarello, Chancellor of Polytechnic University and former president of the Scientific Research Society, Sigma Xi, notes, “The crucial questions for our culture are, what is it, indeed, to be human, and how can we maintain and enhance our humanity as we develop ever more revolutionary scientific advances and our ever more powerful and pervasive societal organizations and processes and machines? To answer, we need to understand the indissoluble complex formed by us as biological organisms, by the society around us, and by the machines we have created. . . .”

That kind of understanding and imagination is no simple or easy task, for so many facets of “the human condition” factor into any inquiry. For example, perhaps a “bench scientist” is researching drugs that more effectively control blood pressure in Black people than those drugs whose research has primarily included White people. How much richer would the scientist's understanding of the research be had he/she (regardless of the scientist's race) engaged in delving into the world of Pecola Breedlove, a young Black girl who is coming of age and reckoning with the massive

pressures and oppressions of her world, as so painfully and magnificently elucidated in Toni Morrison's *The Bluest Eye*. Seeing the world through Pecola's eyes could open the door to an entirely new avenue of investigation, simply by feeling and bringing conscious struggle to one's own similar or analogous sorrows and by imagining the intersection of one's own research with Pecola's world.

With the study of literature, we listen to voices of those artists who duty it is to speak authentically in their own time and place. It is through the study of literature that students are introduced to questions about the human condition that are palpable. For the first time in many students' lives, the questions that they are forced to wrestle with as adult learners can help them develop in their personal and pre-professional lives. We are of the opinion that humanities courses, specifically English courses (like many courses in the pure sciences), provide students with a powerful opportunity and impetus to grapple with critical life-defining questions, for such overarching investigations are the purpose and meaning of humanities. As English faculty, we are poised to guide students as they encounter and learn to interrogate these ideas. Support for this notion is found in an observation that was made nearly forty years ago by Brooke Workman:

Humanities is based on the concept that life isn't really departmentalized. Human beings cannot escape the variety of their culture. But the schools of a culture often draw boundary lines for intense instruction, though there is considerable overlap. Certainly English teachers, more than instructors from any other discipline, understand the problems of boundaries and overlap. And in many ways, they are best prepared to initiate inter-disciplinary experiments (7)

Understanding the artificial nature of compartmentalizing human existence has led to a more integrated curriculum and education for college students. In the years since Workman offered this idea, it has become commonplace for college and university faculty of all disciplines to champion and lead interdisciplinary teaching and research experiments, despite the fact that a cavernous terrain once precluded these instructional and research unions. Most importantly, though, strides that have been made in the past four decades—to remove the barriers between the once seemingly disparate English and STEM fields of study—have positively impacted the way that students in each of these areas are taught (and how faculty in these areas interact). This unification may be in part due to the growth and development of humanities studies. We will not belabor the question of what humanities studies are, but we are curious about these assertions because they provide an interesting trajectory that allows us to map the ways in which faculty and students in English and STEM fields have been able to find common intellectual ground in recent decades.

This common ground certainly has found its place in pedagogy, as well. In an effort to understand more about what is best for undergraduates, especially lower-division students enrolled in core courses, Julie Weismann and Kenneth Boning in their essay “Five Features of Effective Core Courses” have found that what should be the focal points in all courses, regardless of disciplinary distinctions, are the student-focused learning outcomes. Weismann and Boning contend that “learning is optimized when students are actively engaged in learning in a collaborative environment. The pedagogy of the courses emphasizes an interactive, interdisciplinary mode that focuses on learning through inquiry and discovery” (151). This assertion, when broadly considered, suggests that some of the best qualities of teaching and learning—found in English and STEM classrooms—create in equal measure,

opportunities for students to be engaged in and by interactive learning experiences and collaborative exchanges with their peers and instructors. Teaching experiences that value interdisciplinary questioning and experimentation further enrich students' learning experiences. These qualities provide evidence for the need to build bridges between English and STEM courses.

In many STEM disciplines, the heart of instructional inquiry is the collaborative laboratory setting. For example, at our institution, biology, chemistry, and physics majors are informally divided into research teams to conduct laboratory experiments under the guidance of faculty. In addition, our college's Division of Science and Math utilizes Peer-Led Team Learning (PLTL) in many major courses. The PLTL model uses advanced students as leaders in weekly meetings with six to eight students in order to tackle research problems associated with the course material and to discuss issues germane to the focal points of the week's material. Studies conducted at our institution show this method to be profoundly beneficial to students and their engagement with and retention of scientific knowledge and inquiry. From these peer-led teaching opportunities, students are able to find value in exchanging ideas—both orally and writing—so that learning becomes a shared experience. When viewed this way, one may see that the English classroom has been a PLTL learning environment that teaches students that great personal and collective rewards stem from (no pun intended) their collaborative information exchanges.

Workman's contemporary Richard Kuhns sought to deconstruct " 'Humanities' as a Subject." In an essay bearing this title, Kuhns asserts that in the humanities, over time, "communication did not break down because the aesthetic was considered incompatible with the cognitive; but rather reasoning prospered in the sensibility it encouraged, and the extent of sensibility was enlarged by the application of careful

thought to literary excellence” (9). Following this rationale, then, literary excellence, it seems, results in and becomes a conduit through which enhanced communicative bonds—both literary and scientific—can be established. Regardless of how the humanities disciplines function (and are perceived to function by others who are not trained in these discipline areas), the promotion of a refined state of reasoning is the central aim of humanities disciplines—especially English studies. Hence, students’ studies in the STEM disciplines are profoundly complimented by students’ studies in English—specifically, English literature, theory, and composition courses. This symbiotic relationship then enables what Kuhns refers to as the promotion of greater reasoning and sensibility.

In addition to Kuhns’ claim that an individual’s appreciation for fields rooted in reasoning and sensibility can be enhanced through one’s studies in the humanities, one may also find that the fractious relationship that some have contended exists between English and STEM studies can be mended and, arguably, ameliorated through an examination of their shared (but often ignored or misunderstood) unions. Kuhns surmises that there were competing understandings of what humanities “looked” like versus the thought and reasoning processes that were enabled through the study of interrelated humanities disciplines. Furthermore, Kuhns sees no need for a disconnection to exist between the humanities and the sciences:

Scientific in its demands, rigorous in its methods, the literary text provides a created literary world in which the student can find answers to questions, can pose and test hypotheses, discover what is impossible as well as what makes claims of a high degree of probability. It is in this sense a world to be explored, known, charted, evaluated; the confrontation of a student and a text ought to be challenging. Indeed, the humanities course can be a scientific

and objective exercise, satisfying the demands of the rigorous mind. I say this as an answer to those, usually from the social sciences, though less frequently from the sciences, who say that humanities courses are intellectual tourism or dilettantism or simple development of sensibility, implying that the mind is left out of account. (13)

Kuhns observed that there is a practiced style of engagement and rigorous analytical inquiry that is part and parcel of humanistic inquiry, just as it is in scientific disciplines. Therefore, it seems reasonable that the joint quest—shared by English and STEM students and faculty—is to incorporate the writing skills acquired in English composition courses that may be used in diverse communicative settings like STEM courses.

### ***English Composition and STEM “Habits of Mind”***

The subfield of composition studies embraces interrelated aims, with the foci upon effective communication and critical thinking—or as we perceive critical thinking, deep questioning. Such inquiry requires its practitioners to reject easy answers to questions in order to more fully view our world from multiple perspectives and, thus, to raise more questions in a thoughtful, open-ended, but disciplined fashion. Such a cognitive posture also keeps students and teachers in both an uncomfortable and humble place because true critical thinking does not allow one to rest upon “Aha!” moments, as valuable as epiphanies may be. Instead, the critical thinking essential to composition studies relies more upon the “What if. . .?” frame of mind, which is exactly the kind of thinking required of research scientists and other STEM practitioners. Hence, incipient questions that are designed to equip students with these opportunities for reflective thought and engagement exist, it seems, as the crossroads of STEM and English inquiry.

Tina Grotzer of the Harvard Graduate School of Education specializes in science education and cognition. She cites five habits of mind that are vital to students and practitioners in math and science disciplines:

1. openness and appreciation for new ideas.
2. skepticism and appreciation for evidence, logic.
3. consideration of alternatives.
4. creative use of imagination.
5. curiosity, integrity, diligence and fairness.

Such habits are precisely what composition classes are designed to foster. In English 101 and 102 classes, we bring to the composition table a variety of contentious inquiries designed not only to engender discussion/debate and critical questioning, but also to require students to traverse disciplinary boundaries to see the interrelatedness of the world we inhabit. For instance, in certain sections of the first semester composition course, as well as in some sections of the introductory biology course, the subject of homosexuality and its possible biological origins is considered. This issue, while currently enjoying some measure of political victories, is still highly problematic in the United States, and offers deep investigation for students in an all-male HBCU. We find that students are particularly sensitive about homosexuality because of the stereotyping the media inflicts upon our college and because the issue is too often very divisive within a community that deeply needs unity in order to grapple with the perduring disease of racism. Students dive into the investigative swamp, examining everything from the meaning of the interstitial nuclei of the anterior hypothalamus to the efficacy of twin studies and possible explanations for their results. They plumb the depths of religion, the literature of the Bible and the Koran, and the historical/social precepts that informed the origins of religion.

With this particular concern—homosexuality—the intersections of biology, the social sciences, and the humanities are utterly salient, and the questions posed by students cross all borders. For example, if homosexuality is largely not a matter of personal choice, does the scientific explanation make it socially acceptable? Conversely, if homosexuality is largely a personal choice, why should it be considered unacceptable? What is the impact upon children raised in a home with parents of the same gender? What rights are currently denied homosexuals? In addition to such questions, students also peer more deeply into the region of their hearts for their own feelings and attitudes concerning sexuality; this personal navigation of often difficult emotional waters lends power and purpose to the questions explored in class. And, ultimately, students construct cogent arguments that synthesize their research and responses to the interrogation of the origins of homosexuality.

The search into such a topic requires students to understand that each person’s mind operates from a framework or window, and with sufficient information, self-searching, and the power of choice, an individual can choose to step outside that framework in order to envision anew a question or the entire world. Therefore, the vital context for the process of a person conducting such a re-framing is the necessity in an English composition class for a person to express his/her findings and thoughts. Following the investigation and question-raising, a student can only find a plateau of “completion” if he/she must ground his/her thoughts and provisional conclusions in a communicative product: writing.

Another example of a contentious issue that provides fertile territory for the deeper questioning that we call critical thinking is that of considering the economic systems of capitalism and socialism. This query functions beautifully to illustrate the way that we often accept the “givens”—the social structures in which we were (by

accident of birth) raised. For instance, students often bring with them the concept that competition and the Darwinian survival of the fittest are simply organic to human beings and, therefore, not amenable to change or choice. They are typically surprised to learn that other cultures approach economic systems from a different set of values and ideas; often the values of other cultures more closely resemble those of some of the students. Many of our students are raised in extended families or communities in which their church is central to the life of the community and of the individual, and they see more clearly the effect of, for example, sharing resources. This conflict—believing in the idea of competition as “natural,” yet seeing a collaborative effort as family members and church communities sacrifice for the good of all—is incredibly rich soil for development of all the “habits of mind” that are essential to students and professionals in the sciences. The point of this probing is primarily to unsettle the concept of a “given”—we want students to have such an open and questioning habit of mind that their creativity and problem solving are not limited by a lack of recognizing their own intellectual frames through which they envision the world. We want them to understand that there is *nothing* in the world that *cannot* be challenged, studied, turned upside down and inside out, and re-imagined.

We know that other disciplines in the humanities and sciences can similarly enrich and deepen such attitudes and “re-cognitions,” but, unlike composition courses, most are bound by the necessity that students encounter and retain discipline-specific content. For example, a course in twentieth century U.S. history will undoubtedly require students to learn and remember events leading to this nation’s entry into World War II or the essential provisions of the U.S. Banking Act of 1933, popularly known as the Glass-Steagall Act. Disputatious questions for students to ponder and study and debate would spin from that intellectual and “factual” plane

rather than from the almost limitless set of options that greet our contemporary lives every day. Naturally, skills developed through such a curriculum are also essential to students' careers, for they will be asked in their professions to investigate problems not of their own choosing.

But we contend that the freedom to pursue wide-ranging inquiries—and especially inquiries that are of the students' own choosing—is vital to the initial stages of development of the scientific habits of mind. Composition courses are directly and distinctly driven by the openness, creativity, and curiosity that pursuit of problematic questions produces; such mental positions are at the epicenter of the *purposes* of composition curricula. Information gathering is necessitated not by the discipline's particular "factual" edifice, but rather only by the actual dilemma to be investigated. Such focus upon the problem and the knowledge it requires rather than a set of pre-determined informational student outcomes is precisely the pathway to the creative, "what if" imagination essential to a scientific intellect.

This kind of inquiry bears much in common with professional scientific research. For example, even though a neuroscientist must have the arduously gained, deep, informational understanding of the brain and its biochemical correlates, his/her exploration of new drugs for the treatment of Alzheimer's disease will concentrate on the knowledge, questions, and possibilities particularly inherent in the *problem at hand*. In other words, all creativity, questioning, seeking of knowledge, collaboration, and other elements of the research study will be guided by the need to solve a problem and not by the artifice of required course content.

Furthermore, as noted above, the act of writing provides a necessary (albeit provisional) completion of the creative process involved in a problem-defined investigation. The intention and focus required by a well-honed argument or position

paper demand that a student utilize all his/her powers of openness to and skepticism about ideas, “consideration of alternatives,” and “creative use of imagination” (Grotzer). And as philosopher Georges Gusdorf noted almost fifty years ago, “Nothing is completely true for us as long as we cannot announce it to the world as to ourselves” (72). Writing is a way to “complete” an idea, even if that very idea is revisited and revised upon its next encounter.

Some may argue that in most institutions of higher learning, all students are expected to take English composition in some form or another as a core requirement. However, only English majors—and students majoring in other areas who seek the enriching benefit of extended studies in English—must meet such demands with nearly every paper that they write during their course of study. This continual reinforcement of the skills that are the hallmarks of critical thinking/questioning, searching/researching, and writing brings students to the level that the openness, appreciation, skepticism, consideration, creative use, curiosity, integrity, diligence, and fairness that Grotzer articulates do truly become “habits of mind.”

### ***English Studies and STEM Application: New Vistas to Explore***

Current scholarship reveals an interesting and affirming trend—that humanities and STEM disciplines have moved beyond a perceived adversarial relationship—since many professional and graduate programs seek to include students from the diverse disciplines. When one considers new trends in professional and graduate studies programs, the order of the day seems to reflect a desire of faculty and students representing diverse disciplines to reach common intellectual ground—regardless of previously ironclad disciplinary boundaries.

For example, pre-medical education is in essence “fast tracking” undergraduates engaged in humanities and STEM focused educations through early

identification and medical school admissions programs. The Icahn School of Medicine at Mount Sinai is one of the forerunners in medical education that has formed its highly regarded, successful program around attracting qualified students who major in humanities disciplines to pursue careers in clinical and research focused medicine. The FlexMed Program (an extension of the well-established Humanities and Medicine Early Assurance Program and the Science and Medicine Program) at Mount Sinai seeks applicants from all academic disciplines. Applicants are grouped into three categories, Humanities and Social Sciences, Computational Sciences and Engineering, and Biomedical Sciences. The FlexMed admissions web brochure notes that teaching clinical faculty “are interested in talented students from all areas of study....Once accepted, students will be free to pursue their area of study, unencumbered by the traditional science requirements and MCAT” (2).

One may find that such a refreshingly inclusive program is representative of reasons that undergraduate studies that have a scientific focus can be complimented by those that are generally humanities and specifically English focused. This is an especially promising time when faculty and students in STEM and English fields are finding that their fields of study can be viewed in a complimentary, non-adversarial manner. For this reason, it is rather telling that the language used in the aforementioned admissions view book (for The Icahn School of Medicine at Mount Sinai) alludes to such a complimentary union. It is written that students will proceed to their chosen areas of study “unencumbered” by the route of “traditional” science course preparation and standardized medical school admissions testing. This brazen phrasing alone suggests the uplifting recognition that young, talented students can enter their pre-professional medical training with certain skills and exposures that are arguably cultivated in other fields outside of scientific ones. This may also be

suggestive of the recognition that skills and qualities that are highly recognized and prized in young medical clinicians and researchers and clinicians can be cultivated in disciplines like English. This allusion is brief, but, nonetheless, suggestive of the bridges that are being built between STEM and humanities fields of study.

Furthermore, it appears that the admissions staff and teaching faculty at The Icahn School of Medicine at Mount Sinai understand the necessity of seeking young people who are full of promise and who understand that the rich, multi-textured existence of scientific inquiry can only be enhanced by students' "tempering" through humanities exposures. Such exposures can foster within the future health care providers, for instance, a sensitivity, awareness, and desire to approach decidedly complex scientific questions (medical interventions, clinical applications, and research inquires) through the portal of human reflection, engagement, and questioning. Such an approach enables the health care provider to adopt a posture that is questioning, focused, fair, compassionate, and empathetic. These qualities only serve as a natural compliment, a proverbial yin and yang relationship.

However, it is unclear whether programs like FlexMed will have a positive, far-reaching impact on the way that undergraduate STEM programs prepare their students for the rigors of graduate and professional study. At nearly every college and university in the United States of America, there is a continuous quest to find balance between general education studies courses and major fields of study. Again, despite the desire for balance between curricular and co-curricular offerings, the often-contemptuous relationship suggests that one course is "robbing" the other of precious time; a similar tension is often felt between individuals either teaching or enrolled in STEM and English courses. Nonetheless, these challenges must be overcome, for what is truly at stake is the opportunity to send into the professional world young

people who are intellectually well-rounded, critically engaged, and can communicate effectively orally and in writing.

Students outside of the pure sciences, who are focused on other questions of scientific and technical import, will find that as they prepare to engage in pre-professional pursuits, they must refine their written and oral communicative skills. Students who are in the applied sciences—especially those with technological and mathematical foci—must be judicious in their efforts to develop their writing and oral expression techniques. Like their peers in the pure sciences, applied science majors must—just as scientific researchers who intimately examine human concerns—appreciate the impact of their contributions to research. Whether an engineer is presenting her ideas for a hurricane-proof bridge to members of the city council of New Orleans, or a mathematician is collaborating with public health officials on the probability of higher levels of influenza in coming years, the ability to effectively exchange information and ideas reveals the necessity of having strong communicative skills in oral and written expression. Students who major in engineering and mathematics must grasp the significance and possibilities that their work presents to their fields of study and to populations around the world. These ideas, for English and STEM majors alike, must be understood as habits of mind.

These habits of mind, then, become an extension of the skills that we teach our students in composition and literature courses, namely, how to effectively utilize critical thinking, writing, and oral expression skills. We wish for them to think intently about the applicability of these important skills in other contexts, outside of our courses—in particular, we wish for them to learn to gauge the value of these skills in their chosen fields of study. During our class discussions, we often consider why the skills that students strive to acquire and refine in our English courses matter.

Often, these conversations with STEM majors stymie us as we seek to convince those students—who sometimes balk at the necessity of learning English composition and literature particulars—that the changing nature of their professions will necessitate them being conversant in a myriad of ways. English studies, we contend, provides all students, (especially those seeking to have careers in research and science) with a communicative resiliency that will enable them to endure unforeseen changes in their careers. We are then better prepared to convince these naysayers that such a strong foundation will enable them to make meaningful choices in how they will live their professional and personal lives. Ironically, we find that some of the students who are most receptive to these ideas and skills are STEM majors.

### ***Concluding Thoughts***

Some people may consider the fact that English Studies feels the need to justify its existence through methods such as the field's potential to enhance the education of STEM majors to be a sad commentary upon the state of the discipline or the state of our world—or the state of both. Even Kuhns concludes his essay by saying, “Perhaps the strongest indictment of this point of view is to be found in our need to defend the humanities as a subject” (16). However, we believe that such an attitude is precisely contradictory to the kind of thinking or “habits of mind” that we have explored here. The purpose or even existence of any discipline, idea, belief, set of social mores, “way of doing things,” curriculum, ad infinitum must always be open to scrutiny and critical questioning in order for growth to occur.

Moreover, English Studies has long been a field that refuses to remain bound to the contours of a guarded intellectual purview; language and communication are common to all cultures and people in every human endeavor. How could English Studies *avoid* entering into all realms of thought, all disciplines of learning?

It is possible that some of the flames of the seeming discord between STEM fields and the discipline of English Studies are fanned by institutions or entities with little understanding of the power and potential for the deep integration of the disciplines. Certainly, the mainstream media has actively engaged in promoting the separation between fields of inquiry, often to the disparagement of English Studies and the humanities.

But to fall into this maelstrom of discord is truly counter to the enterprise called humanity. We must continue to seek avenues to soften the perimeters of disciplines in order to envision our enterprise as something whole—compartmentalization and territoriality do not serve a view of humankind that can look into the Great What-If for responses and answers to the challenges that face our future. Bugliarello even claims that “[t]he interaction of these endeavors and instruments shapes a *new morality* (emphasis ours), which cannot be defined as the domain of a single discipline or set of disciplines.” The deep integration of disciplines is fundamental to all questions posed by humankind, else we will “perpetuate divisions and forego opportunities to the ultimate risk of our civilization” (Bugliarello).

May our departments of English ever seek both the necessary growth of self-challenge and the open handed invitation to just the kinds of morality that Chancellor Bugliarello offers.

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