

## Mathematics and the Liberal Arts Curriculum

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*“The search for consilience might seem at first to imprison creativity. The opposite is true. A united system of knowledge is the surest means of identifying the still unexplored domains of reality. It provides a clear map of what is known, and it frames the most productive questions for future inquiry. Historians of science often observe that asking the right question is more important than producing the right answer. The right answer to a trivial question is also trivial, but the right question, even when insoluble in exact form, is a guide to major discovery. And so it will ever be in the future excursions of science and imaginative flights of the arts.”*

Edward O. Wilson, *Consilience: The Unity of Knowledge*, 1998, 298.

As a professor of English and a former director of General Education at a liberal arts college, I want to begin to make the case for the centrality of mathematics in today’s college curriculum. What follows is more *apologia* than manifesto, however I do feel the issue intensely and have thought about it for several years.

In our faculty’s initial work with what we call Integrative Studies, our general education program, we physically moved the mathematics department to the building which housed the humanities, the social sciences, and business departments. We wanted to signal a change in the college’s attitude toward mathematics—namely that the significance of mathematics to all disciplines would be emphasized in the future. We can make physical gestures like this at a small college. A friend on the faculty at Northwestern wrote me one year they were wondering why they knew no one in the sciences. “We drove over to the science campus; it was exactly one mile from where the humanities were located.”

At our institution, mathematics had been essentially subservient to the natural sciences. Like many small colleges, biology essentially drives the sciences here and we had pre-med, pre-vet, pre-dentistry, and pre-osteopathy students. In addition, we had EMICT for a while, we always have several students who want to become physical therapists, and we have a modest but robust nursing program. We do produce graduate students in chemistry and physics each year, but not many. The irony of course is that, generally speaking, those furthest from using and teaching mathematics (here distinct from statistics) in the classroom were in charge of the math department. Needless to say mathematics languished in obscurity as a department which was a wholly owned and operated subsidiary of the natural sciences in general and in the hands of the Biology Department in particular.

The department was relocated and through hard work, redesigned, with attention paid to the tradition as well as ethno-mathematics and art/math combinations. Reza Sarhangi and Mehri Arfaei led the department during these early, difficult years. In addition, they designed and directed the Bridges Conference, now in its fourth year. During this time we have hosted many talented mathematicians through several academic years in addition to all those who come for the conference.

Bridges has been developed as the iconic conference for our Integrative Studies program and Brent Collins' "Genesis" was chosen as icon and logo for the conference and for the Integrative Studies program itself. We hope in the future to add two regional conferences: one featuring the art and craft of storytelling and another which examines curricular issues in general education.

The friendships from the Bridges Conference have been useful to the continued examination and revision of our curriculum here. In addition, this year we have had the incredible skill and work ethic of Slavik Jablan, editor of *Visual Mathematics* and a visiting lecturer from Belgrade, Yugoslavia. Although we regret losing Reza Sarhangi to Towson University, we hope to alternate sites for Bridges with Towson. Before he left, Reza installed one of Brent Collins' sculptures, "Pax Mundi," outside the mathematics department and laboratory. A second piece by Brent, titled "Genesis," will be installed in time for the opening of the fourth Bridges Conference: 2001. Future developments call for us to establish at least two domestic sites for the conference with plans for the conference to be held in Lisbon, Portugal in two years. The long-term future will perhaps find the conference in Teheran, Iran.

While the administration was committed to the idea of building mathematics as a central feature of the institution seven years ago, things do change. Math has been moved back to its original home in Mossman Hall. It is now adjacent to the new Beech Science Hall and Mabee Laboratory. Jealousies emerge within the faculty and pledges are forgotten. We have yet to determine a way fully to integrate mathematics across the disciplines. Some of us understand that requiring one or two math courses is not the answer to undergraduate education in the United States. Somehow some math sensibility or intuition needs to be democratized.

Inevitably, new and younger teachers arrive and recall, as a reflex, their own university math requirements. For many, the multi-versity defines the best thinking about curricula that exists. Often because they are big and resource-laden, they become our model and ideal. Silly but true. We are currently trapped between an imitation-university solution and finding something that not only fits us but that takes full advantage of our size and traditional strengths.

We continue to struggle with the role of mathematics in our curriculum. The answer is surely not better prepared calculus students. We currently use a three-part narrative to organize our full program. Each course illustrates either the story of matter, the story of culture or the story of mystery. While these categories may suggest the body/mind/spirit triad currently popular, they have the advantage of seeming less restrictive and, from a scientific point of view, less anthropocentric. Obviously, the questions raised by mathematics indicate some of the challenges in finding where and how to work with math here. Is it discovery or invention? Should we emphasize theory or application? Should we train student intuition or teach students how to plug values into given formulae? Should we simply ignore statistics or give it non-mathematics standing in our struggle with math in the curriculum? Davis and Hersh, at Brown University when they wrote *Descartes' Dream*, conclude that math is, properly understood, one of the humanities and should be treated as such. Is math a creative art or something else?

The first year student at the college may choose two or three narrative structures, each of which we believe is fundamental to undergraduate education. One requirement of each course design is that it contain either cross-disciplinary or trans-disciplinary features. A result of this is that we have been able to eliminate all "Introduction to..." courses which are often thinly disguised invitations into the black holes of major fields. Once inside a black hole, the undergraduate may never return to broadly based studies again.

The story of matter is pursued in *Atom and Cosmos*, a course which introduces particle physics as well as cosmology. The joining of these fields over the last three decades has enabled this course to encompass the smallest physical structures and the largest. **Planet Earth**, aided by a generous NSF grant, involves

not only eco-systems, but also human interaction with “natural” systems. This has been taught by a biologist and a social scientist. Specific bio-regions are examined with a focus on the local bio-region and its water supply.

Another course examines the nature of life and the challenge in identifying just what life is. **From Alchemy to Chemistry** traces the evolution of modern chemistry from its alchemical origins. Several courses examine the Human Genome Project. **The History of Science** responds to Gerald Holton (a former philosopher of science professor at Harvard University), who has issued a call for deeper and richer historical and philosophical contexts for contemporary science.

The story of culture begins with a two-semester sequence called **Ancient Civilizations and Modern Civilizations**. In **Ancient Civilizations**, paleontological and archaeological origins are considered prior to the emergence of our species. We are also currently working to present some of the Santa Fe Institute’s attempts to connect mathematical modeling with the appearance and decline of civilizations. Although we have been often burned in our search for the “iron laws of history,” we cheat our students if we keep this age old challenge from them. We do warn of the problems and failures which litter the paths of those who would make of history a science.

**Modern Civilizations** offers both historical and social science principles in its examination of contemporary cultures. Ancient and modern language courses, **Mathematics and Art**, **Art as Therapy**, **Eco-Systems and Public Policy**, **World Literature and Cinema** (with a different geopolitical region emphasized each semester), **Dancer and Dance**, **Myth and Their Makers**, **Truth and Beauty: Chaos and Fractals**, **Beyond Race and Racism**, **New Frontiers in American Education**, and **Gendering** round out our current story of culture.

A two-semester **Creativity** sequence introduces the trans-disciplinary approach to mystery. Here, speculation about the nature and source(s) of creativity are examined. Collaborative approaches to creative problem solving are emphasized with some of the structure and content based on *Odyssey of the Mind* competitions. So far we have had sections of **Creativity** taught by musicians, poets, dramatists, chemists, and one business professor. Small group sessions during the second semester have involved virtually every academic department at the college as well as several members of the staff. The mystery and necessity of creativity affects almost everyone.

Other trans-disciplinary courses include **Computer, Brain, and Society**, which moves beyond current Boolean structures to quantum models and the most recent investigations of brain processes. The challenge of producing hard Artificial Intelligence continues to elude our grasp, but it goads us to deeper and deeper questions about the nature of thought, itself. We have just begun the creation and exploration of a cyber community with our current laptop initiative at the college. An IBM Thinkpad is a requirement for each entering freshman class. The laptops are upgraded every two years.

**Mind, Body, Cosmos** examines the recent advances in mind-body research from psycho-neuro-immunology to bio-feedback; from the uses of imaging in cancer research to the Spindrift Institute’s studies of the efficacy of prayer in plant growth and human disease. One of the distinct advantages of working within the context of a private, Christian, liberal arts institution is that we can raise questions about spirituality, prayer, and the nature of the Godforce without raising too many eyebrows.

Courses in **The Judeo-Christian Tradition**, **Comparative Religions**, **Buddhism**, and **Epistemology: Ways of Knowing** continue our current investigation of mystery in spiritual and philosophical forms. While this quick review may beg more questions than it answers, it is important to recall that we are obviously not demanding mastery of any given field. We have discovered that the exploration of a deep question often reaches those students who had not been terribly intrigued by education.

We all love a mystery. Interestingly, the 4.0 students often struggle because they have been educated in a cookbook system which rewards memory and repetition rather than curiosity. One of the several issues we ask faculty members to present is the unanswered questions in their respective fields. Nothing has done more damage to higher education than has the idea that the book of the universe has already been written and read. Good questions are far more valuable to our students than are the incomplete answers faculty members have been provided by most graduate programs.

Deep Ecology, for example, has emerged in response to the superficial, reductive notions of ecology. The answers to the problems which confront the planet will appear only when the unification of physical forces is achieved and we have both a deeper and a wider comprehension of who and what we and the planet are. Only then will Einstein's "new manner of thinking" become a reality. We should be cheered that the walls are coming down—walls that have separated peoples, species, hemispheres, academic fields, researchers, and dimensions. We do not yet understand how to unify our knowledge base. Most are not even sure what, if anything, this idea refers to. A few years ago we did not have the insight or courage to ask the question in higher education. The Bridges Conference is one more way to ask questions about the issues which separate and unite the disciplines.

I do believe that physicist John Wheeler is correct when he says, "Some day a door will surely open and expose the glittering central mechanism of the world in its beauty and simplicity." Until that day arrives, we must continue to knock on the several doors available to us. One of the obstacles to Wheeler's apocalyptic (unveiling) moment exists in field separation.

Physicist Stephen Hawking exemplifies this failure of comprehension in his attack on a major branch of philosophy in his conclusion to *A Brief History of Time*. Hawking writes:

"Philosophers reduced the scope of their inquiries so much that Wittgenstein, the most famous philosopher of this century said, 'the sole remaining task for philosophy is the analysis of language.' What a comedown from the great tradition of philosophy from Aristotle and Kant."

Rather than a "comedown," Wittgenstein, Heidegger, Saussure, Peirce, Quine, Derrida, Bakhtin, and others have provided the possibility that the "glittering, central mechanism" mentioned by Wheeler will be revealed in an identity established between matter and human signs (natural language and mathematics). The inability of scientists to understand this quest and the inability of philosophers to follow the Titanic efforts to unite gravity and the other three forces merely confirm the nature of the academic and intellectual prisons we currently occupy.

In a paper reviewing the new sciences, a student, Jenny Muret-Bates, focuses on this century's efforts to discover a grand unified theory (GUT) and a theory of everything (TOE). She concludes:

"Another clue to the understanding of 'everything' lies in the nature of language. The beauty and effectiveness of mathematics in expressing the principles of classical and quantum physics have been well noted. As yet, no one can explain this effectiveness, but some insight may be gained by studying spoken language.

...Again, as with science and religion, electricity and magnetism, it is likely that the metaphor of language and logic of mathematics are dual parts of the same reality.

...Only when we examine all aspects of truth—scientific, religious, mythological, and linguistic—can we truly begin to touch the eternal, to explain the mysterious, to get to know ourselves...and God.”

Although more comprehensive in her understanding than is Hawking, the young student and the aging physicist’s conclusions are not dissimilar. Hawking writes:

“However, if we do discover a complete theory, it should in time be understandable...by everyone, not just a few scientists. Then we shall all...be able to take part in the discussion of the question of why it is that we and the universe exist. If we find the answer to that, it would be the ultimate triumph of human reason—for then we would know the mind of God.”

Don’t be fooled by the references to God; there is no narrow sectarianism in either Muret-Bate’s or in Hawking’s idea of equivalence in knowing the mind of God and in knowing reality.

We do hope that our work at Southwestern College will enable students and faculty to have a voice in this discussion as well as a role in the great quest for unification at the beginning of a new millennium. The professionals have had their way with this issue far too long. It’s time for some dedicated amateurs to be invited to play. Mathematics is at the center of this dialogue. If you have ideas about other roads to integration let us know. The President’s name and e-mail is provided below, as is the Dean of the Faculty and the Director of Integrative Studies. We all have a stake in unification if it exists *and* if it can be discovered.

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## **Corey Cerovsek: A World Class Violinist and Mathematician**

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Violinist Corey Cerovsek's first contact with Southwestern College came even before the inception of the Bridges Conference. A guest artist with the Wichita Symphony Orchestra, Cerovsek made the short trip to Winfield to give a recital at the college. As is often the case with recitals at Southwestern, faculty and students were able to interact with Cerovsek, talking with him about his life and interests. That he had completed doctoral work in music and mathematics caught the attention of Reza Sarhangi, who had been planning the first Bridges Conference. Reza invited Corey to the conference and Corey has been a Bridges "regular" ever since.

We are very thankful for Corey's involvement in Bridges. He has brought his music, his sense of humor, and his knowledge of the interconnectedness of mathematics and music to our community. It has helped make the Bridges Conference what it is today.

A Canadian native, Cerovsek began violin studies at five years of age and graduated from Toronto's Royal Conservatory of Music with a gold medal for the highest marks in strings at 12. Then he was accepted by Josef Gingold as a student and enrolled at Indiana University, where he completed his doctoral course work in mathematics and music at age 18.

He has performed extensively in North America with the orchestras of Philadelphia, San Francisco, Cincinnati, St. Louis, Indianapolis, Buffalo, Baltimore, Colorado, Detroit, Milwaukee, Atlanta, Phoenix, San Diego, Denver, Kansas City, Utah and the New World Symphony, and internationally with the Israel Philharmonic, Iceland Symphony, Prague Symphony, National Symphony Orchestra (Ireland), Hong Kong Philharmonic, Residentie Orkest of the Hague, Berlin Symphony, Sydney and Melbourne Symphonies (Australia), Montreal Symphony Orchestra, Winnipeg Symphony, Vancouver Symphony, Bournemouth Symphony, Vienna Chamber Orchestra, Toronto Symphony and National Arts Centre Orchestra.

Twice, Cerovsek has been featured on NBC's "Tonight Show." He has also made appearances on the "David Frost Show" in England, on the PBS special "Music Encounters," and on CBS's "Sunday Morning." He has recorded "Corey Cerovsek Plays Wieniawski," made with pianist Katja Cerovsek, and "Mozart Adagios" and "Russian Soul" with the Moscow Chamber Orchestra, all on the Delos label.