

Part Three: The Metaphysical Problem

5. Aristotle University: Intellectualism and Scientism

The only way of expressing emotion in the form of art is by finding an objective correlative; in other words a set of objects, a situation, a chain of events, which shall be the formula of that particular emotion. Such that when the external facts, which must terminate in sensory experience, are given, the emotion is immediately evoked. . .

The ordinary person puts these feelings to sleep, or trims down his feelings to fit the business world. The artist keeps them alive.

T. S. Eliot, "Hamlet and His Problems"

"Traditional" theory is always in danger of being incorporated into the programming of the social whole as a simple tool for the optimization of its performance; this is because its desire for a unitary and totalizing truth lends itself to the unitary and totalizing practice of the system's managers.

Jean-François Lyotard

Metaphors embody and configure both the abiding and the changing preoccupations of an age.

Barbara M. Stafford, Body Criticism: Imaging the Unseen in Enlightenment Art and Medicine, 1993.

Aristotle University is a private institution, named after the famous Greek philosopher (384–322 BCE). In explaining their choice of the name, its founders claimed that Aristotle had influenced Western intellectual history more than any other thinker and therefore symbolizes greatness in the tradition of liberal arts. The university has a proud history of academic excellence in this tradition, sufficient to compete with Ivy League schools. In order to keep pace competitively with these other institutions, the administration continues to add new departments, and there is an increasing emphasis on specialties and applied professions within each department. Over the last 50 years, its science programs have been expanding with support from military-related research grants and the National Science Foundation (NSF).ⁱ

A literary club, which began on campus a century ago, has developed its own traditions over the years. Early on, its members built a clubhouse to commemorate literature and to celebrate the legacy of Greek thought. Long a university landmark, this clubhouse, with its spacious living room, elegant kitchen, and large stone fireplace, is designed to facilitate conversation and discussion. But not all the discussions are as comfortable as the surroundings. The members of the club heartily disapprove of the university's connection with the military and its reliance on government grants, for example, and here they express themselves unreservedly on this and other topics.

One of these traditions is the practice of nicknaming a colleague after a particular thinker who that colleague considers important. For example, if a club member were to quote continuously from the work of Anaximander of Miletus (611-547 BCE), he or she would be called by his name, or more likely "Anaxi," for short.ⁱⁱ In the old days, members were regularly given Greek names in this way – Pythagoras or Democritus, Heraclites or even Leucippus. Today more modern names are common -- Descartes, Hegel, or Kant, Rousseau, Whitehead, Wittgenstein, etc. So, in this half-teasing, witty manner, club members have been used to re-name each other. Sometimes the practice even extends to non-members. In order to preserve anonymity, we will use these nicknames to tell this story.

A major debate has arisen in the club -- as it had in the literary world in general -- over questions pertaining to literary theory. Normally friendly, discussion has become particularly divisive over the question of whether language can be said to represent reality. Not only literary professors are involved; they have also vigorously engaged the faculty of other departments in broad issues of science and ethics. Some club members argue

that claims for *any* relation between *language* and *reality* must be abandoned. Other members totally disagree. Recently one Club member, taking one of the most radical positions, has kept insisting that nothing exists outside the “text.” “In fact, the whole world is text,” he says. “Everything is culturally constructed and collectively authored. Texts are self-subverting.” And so, he was named after the French Deconstructionist, Jacques Derrida.

The club is split in half, more or less. Outsiders begin taking sides, as well. One group is called “Just Discourse,” the other “Unjust Discourse.” However, members keep mixing up these titles: who belongs to which group depends on the side you are on.

This argument has simmered for years now. One side argues that no language can explain "reality," neither words nor sentences could ever serve as the foundation of knowledge. Indeed, some say that there is no rational foundation for knowledge. These assert: "No correspondence can be made between language and nonverbal reality. Language is not transparent to reality. And the language of science, just like any language, cannot assume that it represents the truth about what is 'out there' in nature. All assumptions carried by language are arbitrary; there is no common ground at Aristotle U. for explaining reality.”ⁱⁱⁱ

One club member, Helen Kristeva – whose extraordinary beauty is said to warrant comparison with her namesake, Helen of Troy -- claims that scientists are not teaching the whole story. She does see the importance of materiality in the human body but proposes that there is a “maternal regulation” that prefigures the “paternal law.” The laws of language operate at the level of matter.^{iv}

But there is quite a diversity of opinion in this club, and its members should not be stereotyped. Feminists differ among themselves. Some, such

as Helen Kristeva, say, “Science teaches students how to control the world.” This assertion is taken as a challenge and not well received by scientists. One, in an off-the-cuff remark, maintained that “scientists teach students how to be totalitarian, how to think about nature by manipulation and control.” So it is clear how the situation could become emotional.^v

Other professors on campus do not take this debate so seriously. They say that the language of literary theorists is esoteric and when a club member talks excitedly about “*dianoia*,” “What is that?” they ask. For the literary theorists, the term describes the fundamental theme of discourse going on in their university. In the taxonomy of Aristotle, *dianoia* includes the theoretical *epistêmê*, knowledge or understanding, and the more practical *technê*, but some non-club professors say, “Who cares!” As one physicist puts it, distancing himself from the whole debate, “That’s not *my* language.” Club members respond, “Your language is more esoteric than ours.”

Dianoia, they explain to those who will listen, refers to the meaning communicated in a body of work, such as an art form -- a superb painting, a noble play, or a majestic novel -- by the total pattern of its symbols. Every university can be seen as a work of art, they say, with its external facts and internal themes. Aristotle University expresses a *dianoia* partly through the core curriculum, where great imagery and symbols represent all that “we do together.” In another metaphor, they say that the “core” is an archetype of “our joint work” on campus.^{vi} So there you are. The fight threatens to become so bad that administrators are wondering if professors will lose their civility. Among club members, some still have fun bantering together, but they are now more edgy.

The Club calls the highly respected A.U. president “Aristophanes,” and on account of his brilliance and playfulness, the name has stuck.

Aristophanes is said to study everything -- from agriculture to zoology -- and his writing dazzles, full of great wit, but he has never darkened the door of the Club. Now club members hope that he may be drawn in to help them solve this problem of "language vs. reality." Perhaps he could change the tone of debate, adding insight and humor. Aristophanes appears to be sympathetic but is also very smart. He is amazed at how Socrates -- the so-named Chair of the Literary Club -- brings such diverse faculty members to talk together about large ideas, such as Justice, Science, and Culture.

Socrates is not his real name, of course, but everyone says that the Club chair speaks and looks like the historical Socrates: balding head, a great beard wiggling down into a rounded triangle beneath his chin, creases at the outside edges of his eyes that suggest a constant smile. Like his forerunner, this Socrates truly believes "that a life without examination is not worth living." Most people, Socrates chides, never have their minds opened by discourse at all, never know if their ideas make sense. This Club Socrates exhibits bravery and personal fortitude, and for these too, he is properly named. The president of A.U. very much admires what he has done to preserve the integrity of academe. But Aristophanes also teases him and other Club members, sometimes so wittily that it baffles their comprehension.

The President speaks to Club members about philosophers like Heraclitus of Ephesus (500 B.C.), author of *On Nature* and known as "the dark one" for his mystical character and the obscurity of his thought. While the Pythagoreans had emphasized harmony, Heraclites said that life was maintained by a tension of opposites, fighting a continuous battle in which neither side could win a final victory. Structure and flux, for example, were constantly in opposition. Cratylus, a follower of Heraclites, had said, "You

cannot step twice into the same river”; the water, in other words, will be different the second time, and if we call the river the same, it is because we see its *form* as reality.

Aristophanes is astute and so is not worried about the Club debate. Rather, he asks members how "we" might expand their semi-private debate to a fully public one with the entire faculty on campus. “How could other faculty members be included in the remarkable deliberation begun by your illustrious members?” is how he puts it. Club leaders are pleased, but this way of laying on praise so thick makes them uncertain of his motives. That their president is brilliant, they willingly allow, but he is also conservative and, because of his bent for comedy, unpredictable. Aristophanes believes firmly in the conservation of traditional values, and he attacks whatever problem arises with consummate intelligence often exceeding their understanding. He is undoubtedly eloquent, but known also for his towering humor and tomfoolery. In all his astuteness, he was capable of “making fun of reality,” and so the faculty at A.U. never knows exactly where he stands on certain matters. Some Club members therefore are suspicious, thinking he might see the Club’s debate as "Lunacy."

But Aristophanes responds to the Club’s debate positively and talks about promoting it on campus. He asks a clerk in his office to transfer his services to the Club, keeping minutes on how things proceed there. To Club members, the President offers his clerk to record potential new topics for dialogue as they are under discussion and generally to act as their factotum and assistant. “He is so unfamiliar with the world of ideas that he will be neutral in his note taking,” Aristophanes says in recommending him. “This debate is carrying a catalyzing fire into the edifice of thought. We need someone accustomed to habit and routine to help ground and document this

work.” To the clerk, he explains as best he can that the job entails something more than mere record keeping: he will in fact be helping with the foundation of a new “program of academic self-studies.”

Not long after he arrives, noting his typical bewildered, troubled expression, Club members nickname this clerk “Strepsiades.” They don’t yet know him well, but soon learn that he is energetic and even crude at times, desperate to sort out the difficulties of his personal life, especially with his unruly son Horacious, who, at a tender age, is already a gambler and uncontrollable spendthrift. It is Horacious and his growing debts, above all, that keep Strepsiades from sleeping at night. He’s made anxious by the specter of litigation his son’s foibles have raised. Married above his station, Strepsiades does not seem to be all that poor, however, especially given his work level, and Club members think him a little mad, but also crazy like a fox. Although not known for his intellectual prowess in this bastion of thinkers, he’d like to be.

So Strepsiades has sent Horacious to Aristotle U. hoping his son might learn something there to control his gambling; or if that is impossible, to acquire the eloquence and know-how to argue effectively in court. Strepsiades had gotten a job on campus, originally in the president’s office, in part to be able to keep an eye on his son. In addition, Strepsiades hopes that, by being on campus himself, he will learn a thing or two about the sort of discourse that will make his creditors turn tail and run, and without forking out huge legal fees. Some Club professors are not convinced about having Strepsiades in their midst, however. They doubt his credentials. One of them, who had his son in class, heard Horacious say one day, “I’d rather be at the track or the beach than going to this *lousy* school.” Among themselves, many Club members say Strepsiades and his son are fools. But

Aristophanes reminds them that Albert Einstein had once been a troubled student and a clerk, and was thought to be a fool. “Einstein was a simple man working as a post office clerk, but then look what happened to him,” the president encourages them, “He changed our world of thinking. He might have been a little crazy on social issues, but he brought world-altering ideas to all of us, and distinction to Princeton.” The disaffected members of the Literary Club gave up their argument against Strepsiades, happy as they were to see their ideas being moved out into the larger campus, ideas that might capture the minds of other faculty members of the university.

With permission from Socrates, the president brings Strepsiades to a Club meeting to listen to the dialogues. Aristophanes explains to everyone that a new debate on “the nature of things,” the reality question, would be starting on campus, which would require some lofty thought for faculty who are not acquainted with the literature on the subject. Excited by his words and the intellectual surroundings, for one hallucinatory moment, Strepsiades sees Socrates suspended in the air in a basket, under a balloon of all their thoughts.

At this meeting, in order to make him feel more welcome, Socrates asks Strepsiades what he thinks about “the nature of things.” While working in the president’s office, Strepsiades has been squirreling away any big words he hears, looking them up in his pocket dictionary, for just such an occasion. Everyone on campus seems so literate, he was afraid he might be caught speechless someday, or worse, with a mere colloquialism or curse. He says now that he wants to learn how to “confute” the laws of nature. When they hear this, Club members are variously pleased, puzzled, and piqued. What could he mean by this comment?

Those in the profession fields are *puzzled* because they think he might try to invalidate all arguments they will make. The most cultured are *pleased* because they think he is referring in jest positively to the ambiguity of words, as in poetry. The most scientifically minded are *piqued* because they expect precision in words, not liking ambiguity at all.

So Strepsiades passes muster "by the skin of my teeth," as he later tells his son. Horacious, just returning from another evening of betting on racehorses with his friends -- a bunch of young swells all living high off their parents -- was unimpressed. "I can't begin to pay these tabs!" Strepsiades shouts, grabbing them from Horacious, who was waving them provocatively under his nose. "And what about the court fees we are already incurring from the old ones? Not to mention all the interest and principal!"

Suddenly Strepsiades deflates, reeling with the vision of pending lawsuits and creditors scrambling after him in court. But he soon recovers his optimism with his fond hope that the two of them can acquire enough eloquence from being around all those illustrious, brainy professors in time to stave off bankruptcy, especially now that those laws have gotten so much tougher. Soon he will be spending most of his time recording their conversations. And before long, he might even be able to start thinking like them. Then his creditors will be in deep trouble. Let *them* find out then what it is like to eat, drink and stay up at night grappling with those monsters, the addition and subtraction tables!

A couple of day's later, the President addresses a faculty assembly on the theme of "The nature of things." "As a way of initiating our campus-wide discussion on language and reality, I hope that faculty members will work with a literary trope, the metaphor. The metaphoric principle could be

the basis for solving this problem,” he tells those assembled. “We need to experience the metaphor.”

“Experience the Metaphor?” asks Professor George Lakoff.^{vii}

The President continues. "When Robert Herrick addresses his mistress, calling her "a tulip," he uses a metaphor; and Robert Burns in writing "My love is like a red, red rose," uses a simile, a metaphor introduced by the word “like” or “as.” John Bunyan wrote *Pilgrim’s Progress* in the form of an allegory, an extended metaphor-narrative. All these literary works carry feelings in ways that build our common experience.^{viii}

“Metaphors are the building blocks of our language, but their origin is older than language. Metaphors have been with us since the beginning of the world itself. The question I want us to explore, therefore, is whether the metaphoric principle is the basis of nature itself; whether it can actually be said to *produce* our reality, and if so, in what ways?”

In the back row, a disciple of Socrates growls with a grin to his neighbor, “Aristophanes is a pig,” The neighbor, who admires Aristophanes, scowls back, “No, he’s a diamond.” Neither one is conscious that they are speaking to the president’s point.

“We can begin our exploration by considering how, when unlike things are brought together, a new reality is created that looks like the reality we are familiar with. It is my belief,” Aristophanes goes on to assert, “that because of their ability to join together two completely different things and create something entirely new, metaphors are at the root of knowledge and build our reality. They are in the nature of things. Indeed, metaphors create the words that define reality in each and every discipline you study, whatever that may be. And so I am interested to know what *you* think?”

Everyone is aware that Aristophanes loves parliamentary sessions where members speak up, as they do in England, similar to a prime minister who, even while delivering a speech, remains open to challenge. Bursting to respond, Socrates obliges him: “Do you *really* believe that metaphors create the reality in all our subject matter? I’d say that’s preposterous!”

“I know how utterly foreign this idea will sound to most of you, but for the time being, I’d request that you suspend disbelief,” the president answers with a smile. “Again, I want to propose that we all study in what ways the metaphor might belong to the nature of things.”

“No way,” shouts a scientist far back in the audience in utter refusal. Unperturbed, Aristophanes’ eyes twinkle: “This figure of speech is *in nature outside us as well in our language*, a creator of reality, the very maker of things,” he insists. “Even after billions of years, this figure today still explains many things about life, not least how our language works. But there is more to the metaphoric principle than that. The metaphor began its work in nature as the *synthesis of unlike things*. Do you follow me?”

Not a word is spoken. In the silence, a few members of the audience nod sympathetically, but most remain baffled.^{ix} “I propose to you that what has been considered a lowly rhetorical figure of speech actually is at work producing our reality, no less. But stay with me. So that you can understand better, I want to talk about dead metaphors. “Look: We speak and live by dead metaphors. For example, the word *understand* is a dead metaphor. It once explained the act of looking under a table to determine its solidity and then evolved to take on the more abstract sense of “getting under an idea in the mind,” thus to assess and grasp something difficult to assess. Our words move from an external meaning (under-stand) to an inner meaning. And look at the word ‘grasp.’ It refers to the act of holding something in your

hand, from the Latin: *prehend*, but it has evolved as a metaphor to mean ‘grasp an idea.’ Do you understand?”

A few heads are still nodding. “So a word that once referred to our perception of the external physical world evolved over time to assume a new meaning that defines an internal mental operation. The word “grasp” now refers just as much to what happens *inside our mind* as it does to an action outside *in our hand*. The word also added the Latin prefix “com” or “with,” “to comprehend,” or grasp more fully with the mind.”

Socrates, who prefers questions to assertions, does not like the tenor of this talk, not one bit. But Aristophanes goes on making assertions about “the nature of things” that bring questions now from his audience. He asks them to go back with him to the beginning of time.

“The history of the universe is a tale about the *synthesis of unlike physical things*. We call the world outside us *physical*. Our whole universe -- planet earth and our bodies – is outside, but we know them only in our mind. And that is the question we would ask in a grant proposal I will speak about later. Are we inside or outside?”

“I am proposing that nature develops by the metaphoric principle of synthesis. Particles are synthesized into atoms and atoms into molecules. Simple molecules synthesize into complex molecules, and then into cells. Unlike things combine in nature similar to the way they combine in our minds. So, this simple literary device leads us back to the nature of things. Aristophanes looks around. Some professors seem excited while others look quizzical; a few are drifting off. In the front row, Socrates scarcely conceals a yawn. He goes on: “We use nature’s own synthetic principle to create language and reality. “Natural history is a mixture of apparently opposite things. But what is seen as external matter, on the one

hand, is being acted on – analyzed and synthesized in various ways – inside the minds of scientists. External Nature is synthesizing while we are doing the same internally. Our mind keeps evolving as *nature inside nature*.” It is in the nature of things.” “Pay attention!” Aristophanes suddenly shouts to wake up the sleepers. “What I’m telling you is vital!” “Water derives from the synthesis of hydrogen and oxygen, a combination of unlike atomic elements. This is what I call the “metaphoric principle” in nature. Let me put this another way: two unlike elements produce a ‘higher’ element called water. I call it higher because the new compound created retains the basic elements of hydrogen and oxygen in its new nature. That water is real; I assume you would all agree. So, nature is based on the principle of the metaphor, a synthesis of different things. You might call this outlook metaphysics, but that would not be altogether accurate, because it is the subject of physics.

“Come on!” cries Socrates. “Aristotle would not approve of these distorted attempts at reasoning.”

“Oh yes he would! While he was a classifier of things, he was also very empirical,” Aristophanes quickly rebuts, then expands on his point. “The whole of natural history, the story that we tell to explain nature, is based on this same metaphoric principle of a synthesis of unlike things. So, language leads us to examine the nature of things beyond physics, as well as within the laws of physics. And there is a fundamental likeness between the compounding process of poetry and the synthesizing of oxygen and hydrogen into the compound *water*.

“When the poet writes “The ship plows the sea,’ this metaphor brings ‘the plow,’ an agricultural tool, into conjunction with ‘a boat’ a marine vehicle, to create a new image in the mind. These two different components

combine to form a different sense of reality. ‘Grasping’ an idea is a higher level of activity than ‘grasping a banana’ because the former does not exclude the latter.

“Oh,” Strepsiades exclaims out of the blue, “I never thought of that!”

“Yes,” the President says with a smile. “The same metaphoric principle synthesizes ideas inside the mind just as water is synthesized outside the mind.”

“This is not discourse; it’s a monologue!” Socrates protests. “We need more examples.”

“Examples are available all around us,” Aristophanes replies. “Look: photosynthesis is a conversion of water and carbon dioxide into oxygen and glucose. It too takes place according to the ‘metaphoric principle.’ Plants obtain energy from the sun and create useful chemicals and by doing so they synthesize -- just as we do in using language. This is reality. We would not be alive to speak without plants doing their work for us by the metaphoric principle.”

He continues with further examples in chemistry. Then, as Socrates’ cheeks redden and he grows more restless, to quell an angry look, Aristophanes says: “Even Aristotle was fascinated by metaphors; in fact, in his *Poetics* he wrote, ‘The greatest thing by far is to be a master of metaphor.’

“Yes,” a Club member sitting to the speaker’s right interrupts, “but there is a problem. Aristotle divided the uses of speech into logic, poetry, and rhetoric. The metaphor could be used to illustrate a point or persuade a crowd, but it was only an ornament of language to charm people. It did not apply to geometry, physics, or any other science.” “That’s right, Aristophanes readily agrees. “In Aristotle’s day the metaphor had no larger

function than its use as a rhetorical device. Until the modern era, it had only a literary or dramatic role in language. But I return to my original suggestion, that we research the big question that has your club so divided: What is the connection between language and reality?"

"Aha!" Club members say, relieved, "The president is still a friend."

His task as note taker in its preliminary phase, Strepsiades accidentally writes "fiend" for "friend."

Aristophanes proceeds: "But in the eighteenth century, Giambattista Vico challenged the isolation of the metaphor. And philosophers like Friedrich Nietzsche said the metaphor is a way of 'experiencing facts.' "Experiencing what facts?" exclaims Prof. Lakoff again, "The metaphor gives life to facts," Aristophanes elaborates. "The metaphor exists *prior to the terms for reality*. Can we say before human history? It shapes the subject of history." "Okay!" Strepsiades interjects, becoming more animated like a shill in the audience, even though he cannot grasp a thing that is being said.

"These modern scholars thought differently than did Aristotle and those following him," Aristophanes says, "and we stand on their shoulders. They wrote about the 'precognitive nature of revelation through metaphor.'"

This does not go down well with A.U. scientists, who are thinking as quickly as a treed cat. One shouts, "The metaphor in *your* sense would be like 'the substructure of reality.' Nature would then be a function of 'consciousness.'" Another shouts, "No, consciousness would be a function of nature." A third intervenes: "Impossible! That's a contradiction." Other faculty members mutter, "Aristophanes must be spoofing," while still others see the seriousness in what he says. They all admire the president's intelligence but everyone is cautious and watchful of him.

Now Aristophanes makes a stunning new assertion about the “structure of knowledge” on campus. He says that in Aristotle's time philosophy encompassed all the facets of intellectual inquiry. Philosophy was an extension of reasoning, called "science," which today carries a different meaning than the scientific method. It could be practical, poetical or theoretical.

“Let me take the poetical feature of Aristotelian science for a moment. I would say that Aristotle University is like an orchestra. The arts and humanities are like great cellos and basses that have lost their sound behind the sciences and the professions, the trumpets and woodwinds of the orchestra. But they should return to the first rank with them. Aristotle University should mix the sound of science with the sound of the human spirit. This university will then have a richer tone again, gain more character, and represent more reality,” Aristophanes concluded.

“I agree!” Professor Emerson stands up enthusiastically to declare his support for this notion that poetry and the arts should join the sciences in the university “orchestra.” “They will better express the sound of nature together than they do apart.”

But others, primarily the scientists, are not pleased: "Such changes would concern those who allocate money -- government, foundations, corporations. That could affect the flow of capital to this campus."

“Well, “I think those grants and gifts will not stop; in fact, they should increase,” Aristophanes disagrees. “This grant will be modest, and our proposal would be to show how all disciplines are metaphors of reality.” “What!” says Socrates, “This is Unjust Discourse!” But a minority of faculty in the Literary Club says, “No, it is *Just* Discourse.” Aristophanes chuckles quietly, then continues: “New disciplines are created, and hence new fields

of reality, by new combinations of words. The creation of new subjects raises the level of thought. For example, the Greek word ‘bios’ or ‘life,’ was combined with ‘logos’ -- which refers to language as well as the capacity to reason -- to designate a new area of study, *biology*, the ‘story and study of life.’ Biologists classify every living thing and thereby everything is given a new meaning. As a result, students of biology are able to see a different reality through biological categories.”^x

There is enough support by the end of the President’s talk to start a university study on the nature of things. Strepsiades is officially assigned to take notes. Three weeks later, fifty professors from different departments have drafted an idea, at which time the President opens another meeting of the faculty: “Before we write a grant proposal, we need special lectures on this subject of metaphors to help us see our nature inside and out.” Strepsiades, proud of his new position and wanting to make a good impression, is uncertain nonetheless whether *he* is inside or out, as Aristophanes goes on to emphasize, “We will hold lectures on how metaphors shape reality inside and out.”^{xi}

Aristophanes calls on experts to lecture. He hopes that faculty members from all departments will be persuaded to suspend disbelief, think “outside the box,” in his words, and consider how their disciplines might be rooted in the metaphor principle. After all, academic disciplines themselves-- and not merely bio-logy -- are evidence for him of this principle at work, having been at one time or another created by the synthesis of unlike words and ideas: socio-logy, the study of society and social systems; anthropo-logy, the study of humankind, which comes from the Greek word “anthropos” that means “human being;” theo-logy, the study of gods and religion; and so on: musico-logy, geo-logy, cosmo-logy, astro-logy, psycho-

logy, etc. He hopes to be able to convince them that, just as the combination of different words signaled the creation of new fields of thought, thereby expanding our sense of reality, so too in the natural world, syntheses of disparate elements produce new realities.

Club members are not sure where they are headed but the President announces his plan. The lectures will be a prelude to the NSF proposal.

Before Writing a Grant Proposal

President Aristophanes asks faculty to think imaginatively about a grant proposal. "These lectures will take us to a new place. Our question is: How is one discipline represented in another discipline?"

"You are *crazy*," says Professor Rousseau, named after the 18th century French philosopher. "Each person is separate and different and so is every discipline. Each discipline should be treated as equal; each should have one vote on what happens here. This is *democracy*."

But Aristophanes stays cool.

"Think with me. Each department may be separate and different, but their subjects of study are symbol systems, not precisely and literally "separate." We will ask our first lecturer: 'How is the subject of physics inside the subject of music?' Could elements of the universe be holding music in this room? I knew when I entered this room that Mendelssohn's Piano Sonata is playing on our local radio station. The Sonata is in the air, but we can't hear it."

Silence. Rousseau mutters, "So what?"

"So, how might one thing be inside another without our knowing it? How is music present in the air? We can define the air as oxygen, but we cannot hear the sound of music. So, now, how is the subject of music inside the subject of physics?"

Silence. A grumble. Someone murmurs, “Either he’s crazy, or he’s a genius.” The grumbling does not deter Aristophanes: “ “Furthermore, how can choreography be at play inside chemistry? Do molecules dance? Are they a work of art? Is nature created just by chance, or could it be like a dance? Is there an intelligent design inside the molecule? Or is nature created by both chance and design?”

“Come on! Get your head out of the clouds!” shouts Professor Voltaire, as candid as his namesake. “You are thinking like Pangloss, not in the realm of reality at all. The world is not that simple! You can’t simply mush the study of all these academic fields together.”

President Aristophanes does not budge. Faculty leaders plan a series of “lecture-experiences”. They want faculty members to think about questions raised by Aristophanes before writing a grant proposal. Socrates and other literary Club leaders ask the professors they call “O’Rorty” and “St. Saussure” to start the project. Aristophanes asks them to design lectures for the whole campus, hoping to get a broad range of faculty to support the grant proposal. He talks at length about keeping lecturers to the theme of how different subjects combine and become interrelated, one inside the other so to speak.

Strepsiades works to keep pace with the professors’ discussion, but images of his son betting on horses continually sidetrack him. And hadn’t he seen Horacious only yesterday afternoon hanging around some of that dubious Unjust Discourse bunch from the Club?

Professors O’Rorty and St. Saussure respond that faculty members could start by studying the mutuality of physics and music, but they must first find a physicist and a musicologist sufficiently open-minded to undertake a discussion of this topic he had raised. Aristophanes says: “Yes, those

involved in the experiment should be willing to entertain the idea that the character of reason is changing." Many professors are present when musicologist Frank Kennedy and physicist Kevin Bedell begin their conversation.

Discourse I: Teaching Physics with Music

Professor Kennedy: "Let me start with a question to my colleague,

Professor Bedell: Do you think that music is in the physical world of nature?"

Professor Bedell: "There could be music within nature. Each natural element has a vibration, a rhythm of sorts, and everything in the space-time matrix has frequencies. This is an ancient idea in Greek thought going back to Pythagoras who told his followers that a stone is 'frozen music.'"

Prof. Kennedy: "Can we think then of these different vibrations as types of music? Could nature hold some World Symphony – to borrow a phrase from Antonin Dvorak? I am serious. Could atomic vibrations be part of a "deep song" in nature? Is it possible that composers hear supreme natural chords by an inner ear? Mozart, for one, said that he heard the music for his symphonies before he wrote them down."

Prof. Bedell: "I cannot say. Physicists see the universe in terms of vibrations; we work with the pitch and pattern of wavelengths. And the greatest physicists I know of were interested in music: Einstein played the violin throughout his life; Max Planck was a gifted pianist, composer and singer.^{xiii} Composers could hear higher frequencies than are normally heard. Mozart might have orchestrated what he heard intuitively into a musical score, but we have no way to prove it."

Prof. Kennedy: When we hear the sound of an orchestra, we think of percussion instruments providing the rhythm, but *every tone* that comes

from a musical instrument has its frequencies. If drumbeats were speeded up faster and faster, they would blur into what we hear as a musical tone. We hear the separate beats of the drum, but each instrument has similar separate beats that become tones. Our ears are conditioned to tones but we have never studied such "universal tones" as might be linked to music. Could music become a subject of physics?"

Prof. Bedell: "It would need an empirical base to do so."

Prof. Kennedy: "But our ears cannot pick up these vibrations."

Prof. Bedell: "That's right. We cannot hear gravity."

Prof. Kennedy: The slowest rate of vibration that listeners can hear as music, to my knowledge, is a little lower than the lowest note on the piano, which pulses at 27.5 beats a second. The highest piano note pulses at 4,186 times a second. The frequency range of the human ear is greater -- from around 20 to 20,000 cycles per second; still we do not know how higher frequencies sound. But I must ask you. Is there a rhythm -- I mean a regular pattern of beats -- in an atom?

Prof. Bedell: When we look for one second at the yellow wing of a butterfly, the dye molecules in our retinas vibrate approximately 500 trillion times. There are more waves in that second than all the ocean waves that has beaten on this planet's shores for the past 10 million years. With X rays, the rate of vibration speeds up to a thousand times, with gamma rays, a million. The vibratory rates of subatomic particles are still higher. You want to know if this could this be a musical 'score' beyond our senses? I have no idea."

Struggling to keep up with the gist of the arguments, Stepsiades is now plagued by visions of his son watching horses speed like light around a course, and waves of debt inundating them both.

Prof. Kennedy: “The rates of vibration of all energy in an electromagnetic spectrum show more than seventy octaves. All the ‘tones’ in this spectrum have harmonic overtones, with similarities at octave intervals. Could physicists propose that we study this question in a grant to the National Science Foundation?”

Prof. Bedell: “I would not even try. You might think about the Periodic Table of Elements in chemistry. This is where all chemical elements are listed in their order of atomic weight. It breaks down into seven octaves, which have properties that tend to repeat themselves, as in musical octaves. You could postulate a tendency toward harmony at certain vibratory levels.

“Two oscillators pulsating in the same field in almost identical rhythm will lock into one another in a way that eventually results in the different vibrations becoming synchronous. We call this ‘mutual phase locking,’ or ‘entrainment.’ It is so ubiquitous that we hardly notice it. It may tell us how the tendencies of the universe begin to vibrate in harmony.”

Prof. Kennedy: “Can you say more about this?”

Prof. Bedell: “Physicists at CERN, in Geneva, Switzerland, say that there’s a ‘loose end in the data’ left over on the microwave radiation from the early universe. They call it the ‘bass of a song.’ Across the sky, maps of the cosmic microwave background radiation show fluctuations large and small, like the high and low harmonics in the beat of a drum. The size of most of these fluctuations match expectations, but the largest scales are like ‘the rumbling bass of a song.’”^{xiii}

Prof. Kennedy: “Interesting. Both theologians and astronomers talk about music in the universe. We might find one of each to lecture on campus. A

Sufi in the Islamic tradition also spoke profoundly about it. I'll quote him; see what you think:

The life absolute from which has sprung all that is felt, seen, and perceived, and into which all again merges in time, is a silent, motionless, and eternal life, which among the Sufis is called *zat*. Every motion that springs forth from this silent life is a vibration and a creator of vibrations. Within one vibration are created many vibrations. As motion causes motion, so the silent life becomes active in a certain part and creates every moment more and more activity, losing thereby the peace of the original silent life. It is the grade of activity of these vibrations that accounts for the various planes of existence. These planes are imagined to differ from one another, but in reality they cannot be entirely detached and made separate from one another. The activity of vibrations makes them grosser, and thus the earth is born of the heavens.

The mineral, vegetable, animal, and human kingdoms are the gradual changes in the vibrations, and the vibrations of each plane differ from one another in their weight, breadth, length, color, effect, sound, and rhythm. . . .

There are two aspects of vibration, fine and gross, both containing varied degrees; some are perceived by the soul, some by the mind, and some by the eyes. What the soul perceives are the vibrations of the feelings. . . .^{xiv}

“How do you think we could study this outlook in science?”

Prof. Bedell: “I have *no* idea.”

Prof. Kennedy: “The Jesuit anthropologist Pierre Teilhard de Chardin in *The Phenomenon of Man* speaks of the unfolding of the cosmos in stages up to what he calls the *noosphere* in the present. Can his ideas be studied?”

Prof. Bedell: “Physicists who I know personally would not take up the question. Most do not and would not think in these terms.”

Prof. Kennedy: “David Tame, a music critic, describes what he felt once listening to a concert of Bach's Brandenburg Concertos. At the concert, some ‘presence’ saturated the air from the first note, he writes, a ‘timeless moment.’ His body came ‘alive with light’ and ‘his heart was a fire’ consuming him, a ‘living filigree lattice-work of mathematical precision.’ It was as if he could touch the light, and tears ran down from his eyes. What is happening here?^{xv}

Stepsiades’ writing hand starts to tremble. The horses still racing in his vision are assuming the colors of horses in paintings by Franz Marc -- blue, green and red. He has never heard music talked about in this way before, and ears humming, he shakes his head. “It’s not just about what’s happening, but what’s the point of all this?” he wonders.

Prof. Bedell: “He had an emotion, which has nothing to do with physics.”

Prof. Kennedy: “But you said this is a vibratory universe. *Something* must be vibrating, and he is in the universe.”

Prof. Bedell: “Well, it’s *not* the subject of physics.”

Prof. Kennedy: “As I said earlier, perhaps some theologians or religious organizations would be interested.

“In Catholic, Protestant and Jewish traditions, certain music is held to be sacred. Pope Benedict XVI says that the Christian faith can never be separated from the ‘the soil of human events’; we are part of a musical universe. In the Christian tradition, what about Gregorian chants, for example? Whereas in India, music is considered a ‘subtle divine thread’ that believers say links the Jeevatman or individual soul with the Parmatman or Supreme Soul, the source of primeval creation. The Lord Shiva in his cosmic dance produced different types of sounds. According to this Indian view, the origin of the 7 basic notes can be traced back to Shiva.

I think the idea would interest religious people, and maybe some wealthy ones.”

Prof. Bedell: “The general idea is not uninteresting to me, but it has no relationship whatsoever to physics.”

Prof. Kennedy: “Again, according to Indian myth, 7 keynotes form the units of music all over the world. These express 7 levels of human consciousness from which springs the stream of life. In one direction, it is called music, in another dance, in a third, painting, and a fourth, poetry. Music has the subtlest of vibrations. It forms the ‘life-current in each and every cell of the body.’ The *Nada*, or sound current, which is omnipresent and eternal, follows rhythms, curves and waves, and flows through all our lives.”^{xvi}

Prof. Bedell: “Well, this is definitely part of ‘myth,’ not science. Perhaps neuroscientists will research for the location of music in the brain.”

Prof. Kennedy: “The Suzuki Music Academy works along the lines you suggest, but my question is a qualitatively different one: What does a composer hear? Wolfgang Mozart said he could hear the sound of a whole symphony before he scored anything on paper. Are these sounds coming from a non-physical plane?”

Prof. Bedell: “What makes you think Mozart heard a whole symphony?”

Prof. Kennedy: “I’ll quote now from a letter I have with me by Mozart, writing about how he hears a whole orchestral piece in advance ‘all at once’:

When I am, as it were, completely myself, entirely alone, and of good cheer — say, traveling in a carriage, or walking after a good meal, or during the night when I cannot sleep; it is on such occasions that my ideas flow best and most abundantly. *Whence* and *how* they come, I know not; nor can I force them. Those ideas that please me I retain in memory, and am accustomed, as I have been told, to hum them to myself. If I continue in this way, it soon occurs to me how I

may turn this or that morsel in account, so as to make a good dish of it, that is to say, agreeably to the rules of counterpoint, to the peculiarities of the various instruments, etc.

All this fires my soul, and, provided I am not disturbed, my subject enlarges itself, becomes methodised and defined, and the whole, though it be long, stands almost complete and finished in my mind, so that I can survey it, like a fine picture or a beautiful statue, at a glance. Nor do I hear in my imagination the parts *successively*, but I hear them, as it were, all at once (*gleich alles zusammen*). All this inventing, this producing, takes place in a pleasing lively dream. Still the actual hearing of the *tout ensemble* is after all the best. What has been thus produced I do not easily forget, and this is perhaps the best gift I have my Divine Maker to thank for.^{xvii}

“How could we write a grant to study this phenomenon?”

Prof. Bedell: “Perhaps it would fit in a study of theoretical physics, such as String Theory. Based on this theory different particle types are replaced by a single building block, a ‘string.’ The string is free to vibrate, and its different modes of vibration represent different particle types. These different modes are viewed as a variety of masses or spins: one mode of vibration or ‘note’ makes the string appear as an electron, another as a photon. There is a mode that also describes the ‘graviton,’ the particle carrying the force of gravity. But the study of this mode is a specialized field.”

Prof. Kennedy: “It does sound interesting. Give us more details.”

Prof. Bedell: “The revolutions and spin of electrons vibrate. These vibrations generate waves shaped in accord with harmonic principles of frequency, length, and amplitude, the same that govern music. The higher the frequencies become, the more complex become the shapes. Vibrating atoms cause biomolecules to vibrate. A concentration of vibrating molecules, together with catalysts, temperature and pressure produce larger

vibrations. When the intensity goes beyond a critical point in the cycle, the process may take a new course.”

Prof. Kennedy: “Just a little change in how fast or slow atoms vibrate by frequency in a molecule can completely change our perception of what a particular substance or mass is. For example, we know the more slowly vibrating molecules of H₂O as ice, a solid. As the frequency of vibration increases, we know them as water, a liquid; faster still, as steam; faster yet, as a Hydrogen and Oxygen gas. As their frequency increases, the more invisible they (i.e., the vibrating molecules) become. They may even vanish, as steam does, but they are just changing form.”

More and more overwhelmed by the professorial discourse and his efforts to record as much as possible, Stepsiades mumbles to himself: “Why this is no place to learn how to get out of debt! It’s nothing but a School of Thoughtery!”

Prof. Kennedy: “I see. Then, how do crystals affect the transmission of vibrations to our senses?”

Prof. Bedell: “A grant proposal might start with the study of resonance. Crystals can take electricity and change it to a different physical vibration or conversely, take a vibration and change it to electricity. This was what enabled the development of radio and television. Crystals transform the vibrations of electricity into yet more rapid vibrations of radio/TV waves, which travel through the air. And crystals also change them back to electricity, so we can hear or see something that is in a far away place. Each receiving crystal is ‘tuned’ to a specific frequency, which matches a transmitting crystal. By changing a receiving crystal, you ‘change channels.’ Before the invention of synthesized tuners, you had to have a

different crystal for every different channel or frequency you wanted to tune in to....”

“Everything vibrates at different levels,” Professor Kennedy interrupts. “Our bodies vibrate; our cells vibrate, and organs have their ‘vibration levels.’ Scientific understanding of these vibration levels combined with advanced technology could alter the organ vibrations in our bodies. This could advance medicine and provide doctors with a new way to treat diseases.”

Prof. Bedell: “And it might be part of a viable grant proposal. From the field of music, what do you know that might be include in such a proposal?”

Prof. Kennedy: “The frequency of the musical note ‘A’ for tuning instruments is 440 cycles per second, but there are an infinite number of ‘octaves’ of ‘A,’ above and below 440hz. The next higher octave of ‘A’ is exactly double the one used for tuning, i.e., 880 cycles per second, and the next ‘A’ lower is 220 cycles per second, exactly half. These vibrations continue doubling above and below the 440hz level at the same rate infinitely, even beyond sound.”

Professor Bedell smiles: “We could create a new field and call it ‘phonic physics.’”

Looking up from his notes, instead of the two professors, Strepsiades sees two head-shaped clouds whose mouths open and shut, foreheads wrinkling. ““Curiouser and curiouser,” Strepsiades thinks, a little awed, “In this "School of Thoughtery, anything is possible.”

Prof. Kennedy: “The note ‘A’ is still an ‘A,’ whether it is played in the highest octave or the lowest, but when the frequency increases and goes beyond the range of hearing, it comes within the range of sight. Our eyes

see it. Then the same law that dictates the repeating notes of different octaves holds true as colors. Colors are to vision as notes in the octave are to music. So in some sense, each color is comparable to a note, and each note comparable to a color. Some people see colors with music and hear music with colors. This phenomenon of spontaneously synthesizing modes of perception is called *synaesthesia*.”

Prof. Bedell: “How does this relate to our grant proposal?”

Prof. Campbell: “Our eyes cannot see x-rays, but we now have x-ray machines that take pictures on film which we can see with visible light. The question is: How could physics begin researching vibrations? President Aristophanes would like to know.”

Prof. Bedell: “We could start with ultrasound. Ultrasound pictures show structures inside the body. The Doppler sonogram produces images of problems such as clots in blood vessels or weaknesses in artery walls. We could propose to make use of the NSF MetaCenter to synthesize computational research on this matter, a political strategy. This will link us to NSF and make our proposal more viable. We could use money in an NSF proposal to hire technicians and thereby advance studies in vibratory fields. The XMM (X-ray Multi Mirror) explores the universe for x-rays emitted by celestial sources, such as exploding stars and pulsars. Astronomers need empirical evidence of black holes. We would ask for NSF money to obtain information using different devices for light measurement.”

Prof. Kennedy: “Which devices?”

Prof. Bedell: “We specify in a grant proposal that we want a signal that varies with the amount of light incident on a detector. We ask for an uncalibrated photodiode. Photodiodes respond to light energy. Radiometers measure the amount of light power on a detector. The contribution of light

at each wavelength is weighted by what is called the ‘photopic luminous efficiency function.’ You can measure the speed of light through a polymer fibre optic cable using the timing capabilities of a fast, PC-based oscilloscope....”

Prof. Kennedy: “You are beyond me. We need a special committee to work on this. An NSF grant will take a lot of work.”

“Foto-die-odes” and “foto-pick-leuminus-??-funkshun,” Strepsiades painstakingly writes, scratching his nose. “This ‘School of Thoughtery’ isn’t ever going to help get me out of debt,” he thinks, beginning to despair.

After sending his notes to Socrates and the faculty senate, Strepsiades asks the President: “Do I have to listen to any more of this head-in-the-sky stuff?” “Only one more round,” Aristophanes assures him.

On Choreography and Biology

After he has spent some time attempting to decipher Strepsiades’ notes, Socrates asks members of the Literary Club: “Is Aristophanes serious? I don’t trust him.” There is further debate among Club members over the President’s real intentions, but he moves on to the next topic of discussion: the mutual involvement of biology and choreography. Professor St. Saussure asks Professor Chomsky, a highly literate member of the faculty who occasionally writes about politics, to think about the lecture-experiment. Chomsky says, “This will be an experiment in language that begins with signs. The sign is relational. We can assume that the identity of the elemental units of language and signification can be subject to rigorous analysis. The acquisition of language is explained by facts about an individual's psychology and ultimately by facts about the individual's brain.”

“‘Relay-shun-all’ and ‘Sig-nifi-cashun !’ Dear God,” says Strepsiades, “Either these guys are nuts or they’re gonna drive me that way! And then how will I ever get out of debt?”

Chomsky asks two professors on campus to lecture: Professor William Petri, a biologist, and Professor VerEecke, a choreographer. They will co-teach a module for students on the link between art and science. As Chomsky talks to them, his brilliant mind is working: “Could you discuss the ‘dance of the bees,’ or the ‘mating dance’ of birds? Aristotle wants to look at how one subject is inside the other.”

Prof. Petri cannot conceal his amusement, but Chomsky is serious and says, "A study of how bees dance could be linked with the brain’s capacity for language." Chomsky arranges a meeting between Petri and VerEecke to discuss how bees “dance” in the search for nectar in flower fields.

Aristophanes hears about the plan and asks that the lectures include the idea of metaphor. Prof. VerEecke says that dance is a metaphor “in which *we tell one story through another one*. The bees do something similar” “Dancers,” he says, “follow the natural rhythmic impulses of their body. Good choreography builds from the rhythmic nature of the body.”

The two faculty members design lectures on " bee dances.”

Prof. VerEecke, who is unfamiliar with bees, reads about their form of dance. "I think that students in this experiment should try dancing like bees. Bees are social, and their dance is a social event in which they ‘respond’ to each other and make gestures toward ‘future behavior. They point to something beyond themselves – as metaphors do.”

Trying hard to cover his mirth. Strepsiades almost falls off his chair laughing, Dancing like bees: this is more like it!

Strepsiades sends his introductory notes on this discourse to the Literary Club where members are divided in their response. The “Just Discourse” group finds this “shocking,” while ‘Unjust Discourse’ members find it “bold.” But still, no one can decide whether Aristophanes is serious about a grant proposal to NSF. Thinking to conciliate Aristophanes, Socrates talks to the Club about grammar in relation to Nature and the gender of bees. Is Nature an "it," a "he," or a "she?" What natural objects should be referred to as a "he" or a "she?" This ignites a gender debate that does not quit until long past midnight.

Unable to get a wink of sleep, Strepsiades sneaks into the Club and stays with the diehards to the bitter end, although he is mystified by the gender of things like stones and the moon. Looking out the window at the moon, which is full, he sees Socrates floating across it in a balloon gondola. In this mad moment, he says out loud, more convinced than ever, not caring who hears: “They’re all just talking heads, the whole lot of them.”

“Biology-and-choreography” has never been taught as an integrated subject at this university. Aristophanes labels the class “bio-choreography.” The choreographer and biologist will invite faculty and students to the lectures.

Discourse II: Teaching Biology with Choreography

Professor Petri starts the lectures on bee behavior: “The gender of bees is important. Scientists first thought that the ruler of the beehive was male and called him ‘king of the bees,’ but then they discovered the ruler is a queen who controls the sex of her offspring. When an egg passes from her ovary to her oviduct, she determines whether the egg is fertilized with sperm from the spermatheca, a receptacle in her body where they are stored. A fertilized egg then develops into a female honeybee, either a worker or

another queen; an unfertilized egg becomes a male honeybee, or drone. That's gender justice as I see it," he says glancing playfully at Socrates.

Next, Prof. Petri shows the audience films of bees in action, or "dancing": exploring a meadow, when they find food, they come back to the hive to teach others how to locate it. They communicate or "speak" to each other about the "prize" they have found in what Prof. Petri calls a "waggle dance":

A bee that has found a honey-rich flowerbed flies back to the hive and informs her co-workers about it. She performs a kind of dance, wagging her body, and buzzing her wings noisily. The tempo of the dance indicates how far away the food is: if it is 1000 feet away, she will 'run' in the middle of the dance for two seconds, if 2000 feet, she runs for three seconds. What is remarkable is her way of indicating the direction. By the pattern of the dance, the bee 'tells' the others, that the flowerbed lies, say, 20 degrees to the right of an imaginary line drawn towards the direction of the sun. In order to indicate this, she dances at 20 degrees to the right of this imaginary vertical line. The other bees are able to decode her communication and fly to the source.^{xviii}

Prof. VerEeke speaks up: "Can we say that this dance is unconscious? My field of dance improvisation depends upon the unconscious rhythms of the body."

"I wonder whether the word 'unconscious' should be applied to this situation," Prof. Petri answers. "The individual bee, whose brain is the size of a grass seed, does not recognize that it is reproducing a codified map of direction and distance for others to follow. The dance is created by 'adaptive mutations,' a robotic behavior," he says. "This dance is done with intricate mathematical perfection. My question is, rather, how it could have evolved with such perfectly codified instructions!"

"I see the bee dance as a work of beauty," Prof. VerEecke says,

“I do too,” Prof. Petri responds, but he is thinking about the "mathematics" of the dance. He connects “beauty” in relation to the movements of bees with the work of Paul Adrien Maurice Dirac, a mathematician who found that a theory with mathematical beauty which fits experimental data would more likely be correct than an ugly one. “Dirac's link between art and the logic of mathematics taught me secrets about the 'dance of the electron,'” Prof. Petri says. Then in an explanation of Dirac's equation for the "electron dance,” he compares it to the bee dance.^{xix} “According to Dirac, the spin of an electron can take either of two values, $+1/2$ or $-1/2$, "up" or "down," he points out, “and Dirac's artistic and mathematical mind saw this opposing movement. The bees’ dance carries similar features.”^{xx}

In the middle of the audience, Prof. Kennedy stands up suddenly to say that the direction of their discourse connects with his discussion on music. “May I speak?” he asks.

“Yes, go ahead,” says Prof. Petri.

“In the late 1700's,” Prof. Kennedy begins, “musicians and composers created dice games that allowed anyone to create different melodies by randomly putting together musical fragments from an array of choices. The most famous game is attributed to one composed by Mozart. I’d like to tell you how it works.”

“Go ahead!” Prof. VerEecke enthuses.

“It is all based on chance and mathematics. For each of the 16 bars of a Viennese minuet, the Musical Dice Game offers 2 choices for the eighth and sixteenth bars, and 11 choices for each of the other 14 bars. Participants used a pair of dice to select randomly among the alternatives for each bar; a player could then generate a wide variety of different melodies by chance. The choices for each bar were designed in such a way that, no matter which

combination of bars they ended up with, the result was a pleasing melody to satisfy all the harmonic and compositional requirements of a Viennese minuet in those days.

Strepsiades tries to record the technical talk but he is befuddled, while at home Horacious is becoming increasingly insolent, attacking him whenever Strespsiades deploras his long nights at the tracks. Members of the Literary Club's Unjust Discourse crowd have taken Horacious under their wing, teaching him specious reasoning, how to succeed using clever-sounding, deceptive explanations. "You had better learn enough eloquence to defend yourself in court, whatever it takes. I won't pay for any more your lawsuits," Strepsiades threatens.

"Fascinating," says Prof. Petri.

Now students are really engaged; some raise their hands. They are not convinced that the dance is just mathematics and "robotic behavior." At one time the dance had to have been a true creative breakthrough for the bees; only today does it look robotic to our way of thinking. "Could the bees' dance have once been 'creative group' behavior?" one of Prof. VerEecke's students asks. "Could we use the word 'creative' for robots? How could one random mutation take place in a *single* bee and cause a *social* dance? Would two bees have to have simultaneous mutations to engage in this dance? If one bee alone has obtained the information through its genes, could this bee have taught it to other bees? Could this behavior be learned?"^{xxi}

"To understand the answer to these questions, you should study *mimetics*," Professor Petri advises. "Mimetics is a science that studies the replication and spread of *memes*, which are information patterns capable of being copied to another individual's memory."^{xxii}

"If everything is copied or replicated, how could bee behavior be creative?" the student fires back.

“Numerous writers have adopted “natural selection” to understand the continuous change in cultural behaviors. Perhaps the most popular informal use of the term describes memes as 'viruses of the mind.' Parallels to both biological and computer virus varieties have been drawn from geneticists.”

Strepsiadēs mutters, “I may not know much about it, but this doesn’t sound like biology.” Sick at all this useless blather, he sighs at the return of the thoughtery, but summarizes as best he can.

Prof. VerEecke notices that a handful of students look bored, but the bee story has stung chemistry majors wide-awake. Prof. Petri is delighted by the excitement being generated by the discussion, but when a graduate student in biochemistry wants to speak, he is reluctant to call on her for fear that the discussion will veer too much into technicalities and divert the purpose of the mini-course. The class has time limits, after all. “Thank you,” he says, “but if class members want to delve more deeply into this subject, they’ll have to apply to our graduate program!” Instead, he turns to a psychology major who has been waving his hand energetically:

“I’d like to re-visit one of Prof. VerEecke’s earlier questions: are the bees conscious or unconscious?”

Prof. Petri replies, "And I did address this earlier, but I cannot answer your question definitively because ‘consciousness’ is not a prime subject for research in biology. “

Students grumble.

Professor Petri: “Bees give out faint low-frequency sounds when they dance. They move by a series of step motors emitting sounds like those of a live forager. In a grant proposal, we could explore how sounds and vibrations are involved in ‘dance language.’^{xxiii}

Aristophanes is present and closes the meeting on time at the end of his remarks.

The next day, it is Professor VerEecke's turn to speak: "The dance is a form of extended metaphor, an allegory," he begins. Metaphors can be verbal and written or visual like this dance. To understand a metaphor, you must have a code. So the task of an allegorist is to translate one story into another by code. *In their dance, the bees are translating stories.*"

"Wow!" students exclaim, leaning forward.

"*The bees' dance is an allegory,*" Prof. VerEecke continues, "a long metaphor with a code that signals bees into another story outside the hive. This 'outside' realm is different from their inner one. They tell each other a story of where treasure may be found in the garden beyond, 'straight ahead and a little to the right.'" "I see this principle of allegory as *part and parcel of the natural world*. This is how insects and animals survive and Nature evolves! The dance code is translated by other bees in order to discover the nectar."

Strepsades senses something new happening and ends all his sentences with exclamation marks!

"One context of meaning for bees *in the hive* stands for another context *in the meadow*. The dance is a sign for others to read, a social communication, as we have said. It is a sign language, yes, and sign language is a prelude or seed that produces human language. The future is contained in the past; or as Aristotle said, the seed contains the oak tree, even though he could not understand evolution as we know it today."

Some students applaud. Prof. Vereecke continues:

"In the art of dance different stories are brought together, which in turn requires cooperation. Did you notice that the bees were working with each other?" He reads from a book by Martin Buber on how a story can be told:

A rabbi, whose grandfather had been a disciple of the Baal Shem, was asked to tell a story. "A story," he said, "must be told in such a way that it constitutes help in itself." And he told: "My grandfather was lame. Once they asked him to tell a story about his teacher. And he related how the holy Baal Shem used to hop and dance while he prayed. My grandfather rose as he spoke, and he was so swept away by his story that he himself began to hop and dance to show how the master had done. From that hour on he was cured of his lameness. That's the way to tell a story!"^{xxiv}

At the end of the class President Aristophanes asks the biochemist and the choreographer to assess their progress: "How is the class doing?" he asks.

They tell him that in their discussion about the nature of things, the class is going well. "Students are challenging the idea of robotic behavior and asking such penetrating questions as 'how is nature creative?'" Prof. Bedell says. "I am encouraged to see that they are thinking independently." Prof. VerEecke speaks about how excited students are to study a specific example of the way that Nature is based on the metaphoric principle. The two professors talk with Aristophanes about the grant, and Aristophanes declares that the time is ripe to write it.

A group of professors meet with students to elicit their reactions to the class. A few of them say that the concept of robots and formulas did not bring them far enough into the subject. The *object* of this scientific inquiry -- bee behavior -- is different from its *subject*, which is the bees themselves dancing. To really penetrate into the subject they should be closer to bees as

they are dancing -- and not just try to *enact* a bee dance. They are thinking of the way St. Francis of Assisi knew and related to birds. “St. Francis talked with the birds,” one of them says. They are speaking poetically, and afterwards several science professors complain that this experiment has “already gone too far.”

Nonetheless, the faculty senate decides to apply to the National Science Foundation. They said, "If this grant is accepted, it could make history."

Crossing the Great Divide

The grant application calls for university and public discourse over a two-year period. The lecture modules will be public. “Each department has its abstruse language. Our faculty must translate our usual jargon into plain talk,” President Aristophanes urges. Everyone at Aristotle U. senses the challenge of plain speaking. And there will be no copyrights or patents in this experiment.

So, a grant proposal is written with teaching modules like the ones practiced in the A.U. experiments. Professors discuss their modules with NSF staff, as they make appropriate “personal contacts.” Parts of the plan they had begun to explore – through joint studies of physics-and-music, chemistry-and-choreography -- are selective examples of how they would proceed. Below is brief outline of a 500-page proposal to the NSF. (The whole proposal would be too technical to describe in greater detail as it is written to meet the expectations of government scientists.) The NSF would provide funds on an annual basis and review the contract based on how well the project proceeds. The funds necessary for the project will be low.

The Changing Universe
A Proposal to the National Science Foundation

First Year: *The Nature of Things* (One videotaped lecture/discussion per month on each topic)

Month: What is the nature of?

- January: A particle? (Astrophysicist and anthropologist talk)
- February: An atom? (Physicist and historian talk)
- March: A molecule? (Chemist and choreographer talk)
- April: The earth? (Geologist and dramaturgist talk)
- September: A living cell? (Microbiologist and sociologist talk)
- October: A plant? (Botanist and linguist talk)
- November: An animal? (Zoologist and metaphysician talk)
- December: An anthropoid? (Archaeologist and architect talk)

Second Year: *Linking subjects in the Arts and Sciences*

Month: What is the nature of?

- January: Culture? (Anthropologist and biologist)
- February: Dance? (Aesthician and natural historian)
- March: Language? (Linguist and botanist)
- April: Music? (Musicologist and physicist)
- September: Poetry? (Poet and physicist)
- October: Theater? (Dramatist and biochemist)
- November: Painting? (Art historian and astronomer)
- December: Sculpture? (Philosopher and architect)

At the end of the first year, written lectures are prepared for publication. All lectures are videotaped.

Third Year: *On the Nature of Things*

Month What is the Nature of?

- January: What is Sacred? (Theologian and sociologist)
- February: What is a Sound? (Physicist and composer)
- March: What is the Self? (Psychologist and sociobiologist)

April: What is Vibration? (Physicist and musicologist)
 October: What is Energy? (Physicist and choreographer)
 November: What is Power? (Biochemist and anthropologist)

Fourth Year: *What is the similarity between subjects? (Metaphor)*

January: Atoms and song (physicist/musicologist)
 February: Molecules and dance (chemist/choreographer)
 March: Cells and poems (biologist/poet)
 April: Plants and sculpture (botanist/architect)
 May: Animals and theater (zoologist/dramaturgist)

Special Lectures

October: The method of the sciences and humanities
 November: The evolving university culture

Videotapes and lectures and commentaries will be made available to the public. Panel discussions are prepared for publication.

Fifth Year:

January: Book manuscripts will be completed based on lectures.
 February: Private funding will be sought for interdisciplinary research in a *Center for Academic Studies*.

Outcomes for the University

Lecturers will be given the option to publish articles and books. A common book would be published to describe what happened. Faculty will create a program in academic self-studies that will communicate with other campuses about this program as a model.^{xxv}

Some professors say this plan is bold and awesome, while others claim it is arrogant and full of hubris. It is a tall tale, a joke, some say; still others, that it is an allegory with Aristophanes behind the whole thing. “That’s right!” exclaims Socrates, “This is all due to that slippery president.”

The Program's Significance

President Aristophanes says that this new Project should lead to a richer tone in teaching skills and should become the basis for evaluating the core curriculum; it should build up the humanities and bring them back into a position of importance. A.U. will not diminish its strength in science, but select scientists will engage in experimental talks with others on their subjects.

Then he heads to the Literary Club to discuss the work of Aristotle and its relation to the university name. "Aristotle was not Plato," he tells Club members. "For him, poetry was not in bondage to philosophy; in fact, it also had a capacity and power that was greater than history, the mere retelling of past events. Plato virtually banished humor, but Aristotle did not. And, a propos humor, Aristotle said that it is the only test of gravity, and gravity of humor: "for a subject which will not bear raillery is suspicious, and a jest which will not bear serious examination is false wit."

Satisfied that Aristophanes no longer needs him, Strepsiades has returned home, where sitting down to a supper of boiled beans, he imagines the whole A.U. faculty suspended mid-air in a giant basket, blabbering away, their jaws creaking like puppets. "They belong up in the loft, all right," he mutters, "of a loony bin." He hears an angelic chorus singing him towards "an unforeseen destiny, a terrible downfall." "Not good, not good," Strepsiades shakes his head. "It's enough to drive anybody bonkers!" His thoughts then turn to his son learning all this *thoughtery*. Just at that moment, Horacious, throws open the back door, bounding in with his friend Pylades, son of one of the Club's members. "Where have you two been gallivanting?" Strepsiades thunders. "The racetrack?"

"No, we've been at the Club listening to Socrates," Horacious' friend answers.

“Yeah, and I’m starting to think the old codger may be onto something,” Horacious looks sheepish.

“What do you mean? He’s brilliant,” Pylades punches his arm, “you said so yourself.”

“Brilliant, the man’s nuts!” Strepsiades splutters.

“*He’s* the rational one; *you’re* nuts,” Horacious fumes. “He knows all about the seriousness of Reason, a subject about which you are utterly ignorant. You know,” he grins nastily. “I’d say Socrates is immortal.”

“No, Socrates is *immoral*, you nincompoop,” Strepsiades snaps back at him.

“But the difference between *immortal* and *immoral* is only a matter of a single letter,” Horacious quickly retorts. Strepsiades is furious at his son’s insolence, but Horacious has grown bigger and stronger than he. In a sudden burst of outrage, Horacious beats his father, then justifies his actions, in front of his friend, to Strepsiades’ face: “It is lawful to beat children when they misbehave.’ Didn’t you always tell me that when *you* used to beat *me*? Well, now you’re in your second childhood, it’s your turn to get beaten!”

Afterwards, a humiliated Strepsiades cries: “How dare you turn your specious arguments on me!” He appeals to the courts to defend him, but they say he deserves this punishment for trying to cheat his creditors while paying off his profligate son’s debts. Couldn’t he have done a better job of raising him than that? Strepsiades is now in a blind fury and vows revenge on the School of Thoughtery that has taught Horacious nothing but bad reasoning. “They’ll pay, I swear they’ll pay!” his shouts ring through the neighborhood.

Strepsiades is in a state of despair. The courts are all out to get him, chorusing in unison that he should be condemned for not paying his debts.

His son has won, and even beaten him into humiliation. Enraged, crazy, and loaded with feelings of revenge, late at night Strepsiades sneaks into the most prestigious edifice on campus, sacred to those who have done the most to further corrupt his son. At 2:00 am, with a blowtorch, he sets the Clubhouse aflame. This School of Thoughtery should be eliminated, utterly reduced to ashes.

The whole campus is lit up by the blaze; faculty and students are awakened by the sound of fire engines roaring and careening in from all directions at once. Everyone is stunned. Who could possibly have done this? How could it happen?

By the next day, word spreads that the perpetrator of this villainous deed was Strepsiades, the lowly clerk and recorder. Emotions boil up at the news, rage at their helm, chiefly among disaffected Club members. "It is that numbskull the President chose to take notes on his dubious project," they fume. "Kill Strepsiades!" somebody yells from the crowd.

A mob rushes off to find Strepsiades. They want at the very least to bring him to court. One says, "Hang him," but others say, "By cool reason, let's send this boob to prison forever."

Club members are shaken. The fine-looking, gracious Clubhouse, where they had undoubtedly wrangled, while attempting to keep their minds elevated, is now a stack of rubbish. The police discover Strepsiades hiding in his broom closet and put him in jail. The state attorney says, "Yes. Sickening! Strepsiades will have to pay for every penny of this. How much money does he have?"

Club members march to the house of Aristophanes debating along the way. They had asked Socrates to join them but he opted to go to the marketplace instead to talk about Justice with some of the townspeople. "I

think Aristophanes planned this whole thing right from the start,” one member says. “To him it is all pure drama, a damn comedy.” Another rejoins, “No, a tragedy.”

“Remember how in the *Poetics* Aristotle said that Comedy began long ago with the *komos*, the spectacle in which festive males sang and danced, cavorting around the image of a large phallus?” one says. “Yes, and remember that Aristotle said tragedy is about the downfall of a good person through some fatal misjudgment, which in the end produces suffering with insight,” answers another. “How could we have become embroiled in this?” cries yet another. Their rage has started to abate, giving way to thought.

The argument continuing, one member says finally: “All our talk is absurd, confuting.” Then someone else, recalling what had started them down this road, exclaims, “Language cannot explain reality! What difference will Aristophanes’ explanation of these events make to us?” So the crowd, quieting as they go, moves on to the President’s house.

They find his front door open and him in his living room, standing at a wall-size, sliding glass door opening onto a grand natural scene, as though he has been waiting for them. His backyard encompasses acres of Western and Oriental gardens: magnificent grasses and ornamental plants, vegetables and flowers, boulders and Zen rocks, trees domestic and exotic, and beyond them all fields and forest. Knocking politely on a sofa back table, they walk quietly inside to ask him for an explanation.

In response to their enquiry, Aristophanes is silent. And he remains silent, looking out the picture window at a noble blue sky, rocks mottled gray, stretches of garden and grassland. A dull sheen lights the gardens and fields that recede as far as the eye can see. Not far from his back door, a patch of dark brown earth leads to a yellow lilac garden and a tent, in whose

shade, chickens cluck and scratch. His eyes sweep over whispery speckles on trees, countless numbers of them, to a melancholy grove of pollard birches. Toward the south, past farmhouses and under billowing clouds, he sees a shadowy outline of the town, imagining he can just make out the marketplace where he suspects that, at this very moment, Socrates is lecturing.

The group remains quiet, even respectful. They stand, a bit awkwardly, for a while longer but no answer is forthcoming from this giant of intellect and humor. Aristophanes is in no mood to talk. Maybe he is sad about what happened. Maybe he is lost in meditation. So they return to the campus. For months, nothing happens.

Finally, the National Science Foundation announces publicly that it is accepting the A.U. grant proposal. The faculty will now have all the money they need for honorariums, travel expanses and hotel costs to host nationally known speakers, and they will be sending annual reports detailing their progress to the NSF. One critic says approvingly, “This is a new experiment in sensible thought.”

Socrates does not know what to make of the NSF decision. He goes alone to Aristophanes’ home to ask him questions about the meaning of the events as they have transpired: “Is this some drama you planned, as some have thought, anticipating the outcome all along? Is this Justice?”

But still Aristophanes is laconic. Turning from the window and the fecund outdoor scene, he says to Socrates. “I think it is all in the nature of things.”

ⁱ “...NSF.” This story is told in the spirit of Aristophanes’ play *The Clouds*, which was written in part to reveal the corrupt state of education in Athens. The playwright Aristophanes mocks Socrates and highlights the consequences of secularism in the Greek thought of their day. By the time the play was produced, Zeus is dead, replaced by an impersonal universe created by the Presocratics. In this impersonal world, there was for Aristophanes no perceivable moral order but only base physis (i.e. nature.) Our story line follows the play in certain respects. Aristophanes implies that this is a valueless universe, lacking purpose and meaning. An idle person in ancient times was said to walk on air. Aristophanes portrays Socrates suspended in the air to satirize his “thoughtery,” the word Aristophanes uses to describe the activity Socrates and his students are engaged in. *Thoughtery* is high in the air, ungrounded, and therefore useless.

In *The Clouds*, Strepsiades is an eccentric old man deep in debt, caused by his son Pheidippides – the Horacious of our story – who has an obsession with horse racing. Desperate, Strepsiades sends his son to the School of Thoughtery (or *Thinkery*) to learn. At his first appearance on stage in the play, Socrates descends from the sky in a basket. The incidents of foolishness in this story – such as puzzling over the gender of nouns – also occur in Aristophanes’ play, and at the end of the comedy, Strepsiades, thoroughly disgusted with the effect of Socrates’ teaching, sets fire to Socrates’ Thoughtery-School.

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- ii “...Anaxi for short.” Anaximander held that the “first principle” in philosophy referred to an undefined, unlimited substance without qualities, out of which the primary opposites became differentiated.
- iii “...for explaining reality.” On the debate about reality, see Richard Rorty, Philosophy and the Mirror of Nature (Princeton: Princeton University Press, 1979).
- iv “...operate at the level of matter.” On maternal regulation, see Julia Kristeva, Revolution in Poetic Language, Trans. by Margaret Waller, New York: Columbia University Press, 1984; Powers of Horror, Trans. by Leon Roudiez, New York: Columbia University Press, 1982.
- v “...become emotional.” On science and epistemology, see: Linda Alcoff and Elizabeth Potter, (eds.) Feminist Epistemologies, (New York: Routledge, 1993). Donna Haraway, Primate Visions (New York: Routledge, 1989).
- vi “...on campus.” For terms like *dianoia* see: F. E. Peters, Greek Philosophical Terms: A Historical Lexicon (NYU, 1967)
- vii “...Lakoff.” George Lakoff, a linguist and Mark Johnson, a philosopher, say that metaphors not only make thoughts more interesting but they actually structure our perceptions and understanding. George Lakoff and Mark Johnson, Metaphors We Live By (Chicago: University of Chicago Press, 2003.)
- viii “...common experience.” An allegory is an "extended metaphor" kin to the fable and the parable. Aesop's animal fables are simple allegories to teach the listener a lesson. "The Fox and the Grapes" is not just a story about a fox; it has a message about how people are likely to be critical of things

they cannot have. But the details of such narration also engage the imagination and imagery that are part of emotional learning. Long allegories like Pilgrim's Progress and Moby Dick engage personal feelings by readers' identifying with the key figures.

^{ix} "...remain baffled." Members of the Sante Fe Institute would support Aristophanes' view. The Director of the Institute, W. Brian Arthur says: "Nonscientists tend to think that science works by deduction. But actually science works mainly by metaphor. And what's happening is that the kinds of metaphor people have in mind are changing . . . Instead of relying on the Newtonian metaphor of clockwork predictability, complexity seems to be based on metaphors more closely akin to the growth of a plant from a tiny seed, or the unfolding of a computer program from a few lines of code, or perhaps even the organic, self-organized flocking of simpleminded birds." (Waldrop, p. 327 and 329; see also p. 149) Mitchell M. Waldrop, Complexity: the emerging science at the edge of order and chaos. New York, Simon and Schuster, 1992. Noted by Anthony Judge, "Human Values," <http://www.laetusinpraesens.org/docs/values93.php>

^x "...biological categories." The late Stephen Jay Gould was part of a debate in the natural sciences on metaphors, between "functional evolutionism" and "experimental empiricism." He saw these as well-coined terms that are metaphors. "Evolutionism," he said, "is an elaboration of the metaphor of organism; and empiricism is an elaboration of the metaphor of mechanism; thinkers from both schools, he said, deny the origins of their arguments as represented in language.

^{xi}. “...inside and out.” On organic/mechanical metaphors see Richard Harvey Brown, Society as Text (Chicago: The University of Chicago Press, 1987.)

^{xii} “...composer and singer.” Max Planck and Albert Einstein were violinists and could have thought along these lines, as do other great musicians, composers and conductors today. See Joseph Eger, Einstein’s Violin (NY: Tarcher, 2005).

^{xiii} “...the rumbling bass of a song.” This reference is drawn from “The Music of the Universe,” News Articles, CERN Bulletin, Issue No. 48/2004, November 2004.

^{xiv}. “...vibrations of the feelings.” Hazrat Inayat Khan, The Music of Life (New Lebanon, N. Y.: Omega Press, 1983), pp. 7-9. Khan continues, “This means that everything has its sound and its form. . . . What we call life and death are both a recognized existence within a certain degree of vibrations. For instance when a person says, “This leaf is dead,” what has made it dead is the change of vibrations. It has no longer the same vibrations that it had when it was a tree. Yet it has not lost its vibrations; it still has them. Thus according to the vibrations it is not dead; it has only changed into a different rhythm of vibrations. If that leaf were dead then herbs would not have any effect upon a man when he takes them as medicine. . . . The difference in the vibrations of dead and living bodies is a difference of their speed; it is a difference of rhythm.”

^{xv}. ...”What is happening here?” David Tame, The Secret Power of Music (Rochester, VT: Destiny Books, 1984), p. 20. The entire quote is as follows: “My body seemed to come alive with light; my heart was a fire, which flared forth to consume the dross of my soul. My perceptions were opened as though they had always before been firmly closed. Never had I heard music

in that way! What previously I had often listened to as abstract sounds were now Sound— a tangible, living filigree lattice-work of mathematical precision which I could almost reach out and touch, and which I could virtually see as it flowed from the leading violin. Every note hung suspended in the air, timeless and immaculate beyond all powers of verbal description. My body froze into a coma-like rigidity as I hung my consciousness upon each next chord. For several long minutes I lost all awareness of myself. The sheer beauty of it all was quite indescribable. From the first bar, silent tears ran from my staring, unblinking eyes.”

^{xvi} “...all our lives.” Russill Paul, The Yoga of Sound: Healing and Enlightenment through the Sacred Practice of Mantra (NY: New World Library, 2004). Nada Vidya or Nadopasana is the worship of Nada, which is not mere sound but musical sound.

^{xvii}. “...my Divine Maker to thank for.” Mozart goes on to say that once the total image is received, he commits it to paper quickly without change. What makes the music "Mozartish," he says, "and different from the works of other composers, is probably owing to the same cause which renders my nose so large or so aquiline, or, in short, makes it Mozart's, and different from those of other people. For I really do not study or aim at any originality." "A Letter," in Life of Mozart, by Edward Holmes, quoted in Brewster Ghiselin, The Creative Process (New York: Mentor, 1952), pp. 44-45. Edward Holmes' The Life of Mozart was published in 1845 as the first authentic narrative of the life of Mozart to appear in English. It was also the first biography after the composer's death to be based on his letters.

^{xviii}. “...fly to the source.” This is a summation drawn from different sources. Karl von Frisch, The Dance Language and Orientation of Bees (Cambridge,

MA: Belknap Press, 1967). Mary Maxwell, Human Evolution (N.Y.: Columbia University Press, 1984). Barbara Shipman, a mathematician at the University of Rochester, posits a theory about the dance that is related to quantum mechanics. Adam Frank, "Quantum Honeybees," Discover, Vol.18 No. 11, Nov. 1997.

^{xix}. "... to the bee dance." Dirac's equation was celebrated for satisfying requirements of the special theory of relativity -- while at the same time explaining the "spin" of the electron. R. Corby Hovis and Helge Kragh, "P. A. M. Dirac and the Beauty of Physics," in Scientific American, May, 1993. Biographers say that his work placed him among the great 20th-century scientists.

^{xx} "...similar features. Physicist Paul Davies argues that the basic stuff of the universe is not inert but carries ability to "self-organize." Paul Davies, The Cosmic Blueprint (NY: Simon and Schuster, 1989) p. 169.

^{xxi}. "... behavior be learned?" For many centuries, naturalists have observed that honeybees tell their nest-mates about discoveries they make beyond the hive but scientists are moving closer to understanding this system of communication today. See Wolfgang Kirchner and William Towne, "The Sensory Basis of the Honeybee's Dance Language," Scientific American, June, 1994.

^{xxii} "...another individual's memory." The term "meme" was coined by Richard Dawkins and became popular with the publication of his book The Selfish Gene in (1976). Daniel Dennett promoted the idea in his Consciousness Explained (1991) and in Darwin's Dangerous Idea (1995). Dawkins had used the term to refer to any cultural entity, for example a song, an idea or a religion, which might be considered a "replicator." He

proposed that cultural entities could be viewed as replicators, that is, replicating through exposure to humans that have evolved to be efficient copiers of information and behavior. The memes are not always copied perfectly and might be refined, combined or otherwise modified with other ideas, resulting in new memes. Stephen K. Sanderson, The Evolution of Human Sociality: A Darwinian Conflict Perspective (Rowman and Littlefield, 2001). F. Heylighen, "Selfish Memes and the Evolution of Cooperation," Journal of Ideas, Vol. 2, #4, 1992. pp. 77-84.

^{xxiii}. "...in 'dance language.'" H. M. Temin and W. Engels, "Moveable genetic elements and evolution," in Evolutionary Theory: Paths into the Future (ed. J.W. Pollard), (N.Y.: Wiley, 1984) pp. 173-201. H. Jaworska and A. Lima-de-Faria, "Amplification of ribosomal DNA" in *Acheta*. VII. "Transfer DNA-RNA assemblies from the nucleus to the cytoplasm," Hereditas 74, pp. 187-204; see also: M. Stroun, P. Anker, P. Maurice, P.B. Gahan, "Circulating Nucleic Acids in Higher Organisms", Int. Rev. Cytol. 51, pp. 1-48. Temin and Engels, 1984. G. M. Rubin and A.C. Spradling, "Genetic transformation of *Drosophila* with transposable element vectors", Science, 1982, 218, pp. 348-353.

^{xxiv}. "... to tell a story." Martin Buber, Tales of the Hasidim (N.Y., 1947) pp. v-vi. Quoted in: Wendy O'Flaherty, Other People's Myths (N.Y.: Macmillan Publishing Co., 1988), p. 1.

^{xxv}. "...as a model." There is no book to my knowledge that joins theories on physical-and-cultural evolution in the manner suggested in this series of lectures, no book that records the evolution of the song, the poem, painting, sculpture, theater, and dance, keeping in mind this larger context of natural history. Faculty will conduct cross-disciplinary discussions on subjects such

as "the sacred sound," and on the "electromagnetic vibrations of modern dance." On the use of the metaphor, see: Gaston Saint-Pierre and Debbie Boater, The Metamorphic Technique: Principles and Practice (York Beach, Maine: Samuel Wisser, 1983).