Illinois Wesleyan University
Digital Commons @ IWU

Honorees for Teaching Excellence

The Kemp Foundation's Teaching Excellence Award Ceremony

Spring 1983

Creative Mechanists: Putting Things in Order (text and audio)

J. Robert Hippensteele
Illinois Wesleyan University

Follow this and additional works at: https://digitalcommons.iwu.edu/teaching_excellence

Part of the Biology Commons, and the Higher Education Commons

Recommended Citation
Hippensteele, J. Robert, "Creative Mechanists: Putting Things in Order (text and audio)" (1983). *Honorees for Teaching Excellence*. 14.
https://digitalcommons.iwu.edu/teaching_excellence/14

This Article is protected by copyright and/or related rights. It has been brought to you by Digital Commons @ IWU with permission from the rights-holder(s). You are free to use this material in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s) directly, unless additional rights are indicated by a Creative Commons license in the record and/ or on the work itself. This material has been accepted for inclusion by University Archivist & Special Collections Librarian at Illinois Wesleyan University. For more information, please contact digitalcommons@iwu.edu.
©Copyright is owned by the author of this document.

Creative Mechanists: Putting Things in Order 1983

J. Robert Hippensteele

Thank you President Eckley, President Dooley, members of Century Club Club and guests, fellow faculty members and friends:

The title I have chosen states the theme that I will follow as I comment on a few of the things important to me. We may find ourselves straying at times from that theme, but I will try to bring us back before we have been gone too long. The idea that I would like us to explore together is that many of the things we do, no matter how differently we do them, share an important feature. I suggest that most of us are in the business of putting images, be they auditory, visual, or conceptual images, into some order or pattern that is valuable to ourselves and to others because it is meaningful, pleasing, or both. Further I suggest that within each of our areas of endeavor, we can be creative as we put images in order; as we create a composition of images (if I may borrow from the creative arts).

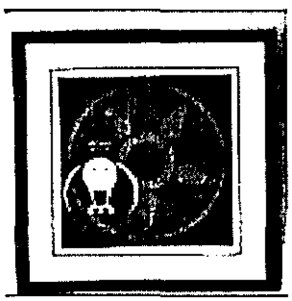
I thank Rick Drexler for his performance and for his willingness to play for us, in the style of Thelonious Monk, the Oscar Hammerstein-Jerome Kern ballad "All the Things You Are." Monk is a jazz pianist and arranger whom I have long respected. I requested this particular ballad partly because I like the romantic message, but I wanted also the opportunity to argue that the statements in the ballad can be extended beyond its romantic implications. Hammerstein and Kern may have collaborated to produce this ballad with nothing more in mind (with the possible exception of earning a living) than romantic love, even young romantic love. They focus on the desire of the lover to believe that he or she feels a love that is based on a full and realistic knowledge of the other, not merely on some fragile characteristic like physical beauty, starry-eyed attentiveness, or even easy communication.

But, thinking beyond the romantic, don't we need always to seek fuller knowledge about, and appreciation of, whole persons? Be they parents, children, siblings, friends, or acquaintances, we shun (or ought to) either the hero worship or the judgment that can flow from narrowly viewing selected characteristics of the person—often the very characteristics that define that person's individualism. My own children can attest to my recognizing their ability. They would phrase it differently, however: "Daddy, you expect too much." They would also tell you I never suggested that they were perfect, not even outstanding (although in some ways each one is). But I have tried to treat them as individuals with strengths and weaknesses—thus respected, criticized at times, but never condemned. Never have I called any child dumb or bad—only wrong at times. As I respect my own children, so do I respect my students. Thus I treat them similarly.

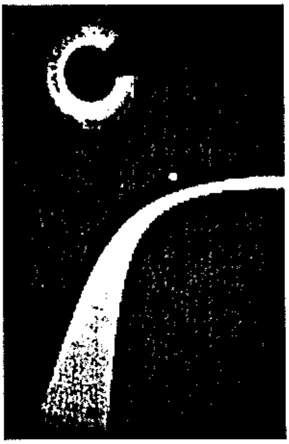
What we are talking about here is putting many facts about a person together in some combination, or order, so as to comprehend more fully who that person is. Of course the perspective from which I see a person is unlike any other perspective. Thus my comprehension of that person will be biased. But comprehensive or holistic knowledge of persons helps us to predict how they will respond to particular situations. The advantages to such holism are recognized by many people. And I'm thinking especially of those involved in the delivery of health care. Paramedical professionals (here the prefix "para" means around or alongside, not below) including nurses, physician assistants, and physical therapists have, for some time now, argued the advantages of holistic medicine. And now, at least in some specialties, physicians are recognizing the value of learning more about their patients than just their obvious physical symptoms. Indeed, the practices of some physicians are approaching the warmth and concern of the old family physician who was often invited to stay for dinner after completing a house call. (Perhaps the ballad "All the Things You Are" might have made a good theme song for the television program, *St. Elsewhere.*)

Do I exceed poetic license—not even being a poet—when I suggest that the ideas in a romantic ballad written by Hammerstein and Kern could apply so generally? Let's turn back now, to the creativity of those two artists and of Thelonious Monk and, indeed, of Rick Drexler. At points during the performance we heard, clearly, a sequence of sound images in the same order as that created originally by Jerome Kern. Thus we recognized the melody because we have often heard that particular sequence. And many of us also associate with the melody the words put to it by Oscar Hammerstein II. But Rick added more information, mimicking—at my request—the style of Thelonious Monk. He played additional notes, in particular sequences and particular combinations, in order to alter the texture of the music, and thus, the mood of the listener (the perspective from which the ballad is heard—the images seen). So we hear a composition—sound images in a certain order formed by sequences and combinations of notes. Our individual responses to the composition stem from its basic statement, its texture, and our individual experiences.

Such arranging of images may be even more obvious in the efforts of creators of the visual arts. The choreographer produces kinetic arrangements of images that change with time, the painter or sculptor static arrangements. Charles Harper is a contemporary Midwest artist who creates imagery by arranging the simplest of lines into a particular order. Here we see a photograph of a Harper lithograph called "HEXIT." You may find Harper to be a bit commercial but I like his work well enough to have hung this piece on my living room wall. Note that all lines are of the simplest geometric form—you see only straight lines, circles, arcs, or dots (And of course a dot is the shortest line that can be drawn). All of these lines can be drawn easily if you have a straight edge and a draftsman's compass. Each can be represented by a simple mathematical equation. Does this sound uncreative? Even boring? I find Harper's work fascinating. He uses texture, especially color, to create a part of the message. The colors used by Harper are subtly independent mixtures of pigments of his own design. (This makes matting and framing a Harper piece quite difficult.) In this piece we see a hex sign like many I have seen on barns in the Pennsylvania Dutch regions during drives north from Baltimore while I was a child. But we also see a barn owl who has just left a perch in the hayloft intent on doing its part toward maintaining the balance of nature. Harper suggests that there is a "hex" on mice scurrying through a nearby field tonight. Their number will have been diminished before this owl returns to roost. Subtle colors label the barn, especially the exit through which the owl has flown, as the source of a "hex." Thus the name "HEXIT." Brighter colors draw our attention to the owl through whom the hex is effected. Our impression, then, comes not only from the order or arrangement of the line images, the melody of the ballad—if you will, but also from the perspective provided by the texture of the combined color images.



As we continue to consider the process of putting things in order let's move from the creative work of artists to that of scientists. To make that transition I would like to look at an example of artistic efforts by someone whose major work is in the sciences. For this there would be an almost limitless myriad of examples of successful efforts. Still, I have decided to be self-indulgent and present a visual composition by one who makes no claim to be an artist—me. The credit (or blame) for this decision falls mainly on me, but also on those friends and colleagues whose artistic opinion I value and who have told me they "like" this piece. Here we see the St. Louis Arch, the so-called "Gateway to the West." Natural light from a setting sun behind us reflects from the moon and, for just a few more minutes, from the arch whose flowing lines thus still seem to point toward the moon. Soon the artificial light from the lamp atop the lamppost will replace the sun as the major illumination where we stand. Composing this picture required waiting for the sun to position itself for maximal reflection of its rays from the arch to the camera, and for the intensity of the mercury arc of the lamp to become bright but not brilliant. Positioning the images was not easy. With one leg wrapped around the lamppost and with my body contorted to position the images where I wanted them on the film plane, and to steady the camera for the slow shutter speed, I heard the footsteps of an approaching passerby. Fortunately, a friend was with me and nearby, for her laugh belied her attempt to deny that she knew me and it probably eased the anxiety of the passerby, who did ask if I was all right. Here is another example of a composition in which the expression of a message goes beyond the simple ordering of the images. Their context stems, in part, from the texture. For effect, this shot was underexposed, darkening the sky and enhancing the contrast between the natural and the artificial light. (Actually, I was quite fortunate that one of the two exposures I tried gave the effect I sought, for I depend greatly on trial-and-error in my photographic efforts.)



Up to this point we have been considering the creative efforts which can put visual or auditory images into a particular order that has value because it is expressive, or pleasing, or both. But for many of us, just the ordering of ideas or conceptual images is a form of creativity. In his book *When Bad Things Happen To Good People*, Rabbi Harold S. Kushner states that: "A creative scientist or historian does not make up facts but orders facts; he sees connections between them rather than seeing them as random data. A creative writer does not make up new words but arranges familiar words in patterns which say something fresh to us."

Among the many who strive to put ideas, or facts, into a meaningful order, some are scientists. Today scientists tend to be mechanists. They tend to believe that if all of the "laws" of the universe were known we could explain everything, even life. In other words, all things that exist and all things that happen can— but not with our present knowledge—be explained in terms of physical and chemical forces and interactions. This distinguishes mechanists from the vitalists who believe that living things contain some undefinable stuff—a vapor, or a spirit—that imbues life into nonliving materials. Rene Descartes was a vitalist. He believed that the stuff comprising the soul of the human emanated from the pineal gland (near the brain's center). But we now know the pineal gland to be the source of melatonin, a hormone important, at least in some nonhuman species, in the control of the springtime activity that produces still another generation. Could Descartes have been asserting that one of the soul's major responsibilities is to control sexual desire? Vitalists can easily be credited with creativity, (pun intended), as can those in the creative arts and humanities. However, I submit that a good mechanist must also be creative.

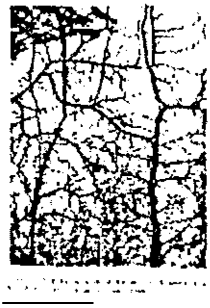
The creative scientist designs experiments to determine relationships between facts not previously recognized. But these must be recognized as efforts to learn about something that already exists, thus to "discover" something. From our discoveries we gain information that helps us to guess other relationships; that is to predict. Then we devise tests to see if our predictions were correct. But scientists can be overly zealous in their belief in the general applicability of relationships they discover. In his 1953 publication, *Politia Medici*, Jerome Head, himself a Midwestern physician, comments: "Science, then, is the method of obtaining knowledge and knowledge is the recognition of patterns of experience which permit prediction. Prediction permits intelligent action." Later, Head continues in this vein: "There is an almost ineradicable tendency to say that things happen as they do because they are governed by certain laws of cause and effect. Actually they merely happen as they do, and the law is constructed from observation of events. The events are not determined by the law. 'Why' turns out to be merely a refinement of what and how. It is, as they are, the result of pure description,—not merely a recognition of patterns and sequences which permit prediction."

E. O. Wilson takes it a step further, perhaps a step too far, when he claims that man is not a reasonable creature, that man is controlled mainly by genetically determined instinct. And Carol Tavris points out in her recent book, *Anger: The Misunderstood Emotion*, that we have come a long way from Plato's claim that reason (thus, our ego) can control our worst impulses. But Freud and his followers bet gloomily on the id, on the importance of instinct. And in contrast to Plato's attempts to show that man is better than the beast, Darwin and others have shown that man is just another species of beast. Tavris suggests that new ideas will "take" only if they fall on "fertile" ground and that the theories of Freud and Darwin are palatable because the social and economic conditions of the 19th and 20th centuries have buffeted human self-confidence, making us more receptive to psychoanalysis and to the concept of evolution.

Do we create ideas or do we merely observe nature and events? Do we instinctively guess what is to come? Do we act mainly by instinct? In the scientific community, how do we develop individual ideas? How do we determine a reasonable order in which those ideas relate to each other?

Let's look for a few minutes at a portion of the development of our present understanding of one scientific concept—one of special interest to me and one on which I work when I do research—namely, the functional design of the cardiovascular system in mammals.

Today we know that blood is pumped from the right side of the heart into the pulmonary circulation. Arteries carry the blood to the lungs and veins return it to the heart, this time to the left side. From there it is pumped into the systemic circuit which carries the blood through tissues throughout the body and back to the right side of the heart to complete its cycle. In both circuits blood flows from arteries to veins through microscopic vessels with walls so thin that gases and nutrients readily diffuse across them. Thus as blood flows past the lungs oxygen diffuses from air (in the many small cavities of the lungs) into the plasma, and carbon dioxide diffuses in the opposite direction, from plasma to air. The blood is then transported on through the plumbing of the system and it enters microscopic vessels near active cells. Hence oxygen from the blood enters the cells where it is used in the chemical reactions that produce energy for the cells. And the carbon dioxide released during those chemical reactions leaves the cells and enters the blood to be transported back to the lungs. Control of blood flow through the microscopic vessels (we call this the microcirculation) is of great importance to the survival of the cells. And this is an area of intensely active study. My own research investigates the control of the microcirculation provided by the levels of oxygen and carbon dioxide in fluids surrounding the microvessels. Let's look at a photograph showing the microvascular network leading from a small artery to a small vein. An artery and a vein lying both parallel and close to each other, extend vertically through the field on the right hand side. The artery is the thinner, somewhat lighter vessel. We see how complex a microvascular network can be. In each tissue we find characteristic vascular patterns. This photograph happens to be characteristic of a specific portion of the cheek pouch of a hamster, a very thin muscular tissue. For a simpler representation we can look at a line drawing of a small portion of the microcirculation, this portion feeding just a few skeletal muscle fibers. Notice that blood leaving the artery can flow to the adjacent vein or into another vein through any of a number of pathways.



But, how did we come to the point of understanding, to the extent that we do, the architecture and control of the circulatory system? The evolution of our understanding required extensive time and effort. With the very onset of thinking, humans must have wondered what life is—and how living things work. Probably our Stone Age and Bronze Age ancestors had little or no systematic knowledge of life processes. But they bled from their battle wounds and knew blood to be warm and fluid. And they knew that its flow from large wounds corresponded with the beating of the heart that they felt within the chest. Allusions to that relationship show up in artifacts from early Chinese, Hindu, and Egyptian cultures.

Aristotle, pupil of Plato and tutor of Alexander the Great, introduced the first systematic work in biology. Believing that effective study could be aided by orderly arrangement of material, Aristotle devised an organized classification for animals in which form was related to function. He observed that the first thing to show life in a developing animal is the heart (Remember that no microscopes and no microbiological techniques were available to him). He went on to observe that the heart supplies vital spirits to the body by the boiling from within it of nutritive spirits with air that flows into the heart through the arteries (Can't you feel that boiling in your chest?). And Aristotle thought that the lungs merely cool the blood. For many centuries hence, only slow advances were made in our formalized understanding of animal function, in general, and of the circulation of blood, in particular.

History indicates that the first person to begin a comprehensive exposition of how animals work did so during the second century, A.D. Galen was a brilliant Greek physician from Pergamon, physician to the Roman emperor Marcus Aurelius. But Galen was not an experimentalist. He was an observer, a thinker, and an arbitrary enunciator. Not until the 17th century did we learn, under the tutelage of William Harvey, to do careful physiological experiments. We can briefly summarize the four major points describing animal function enunciated by Galen. These formed the Galenic dogma that persisted to control thinking for many centuries: 1. Body function proceeds from a "coction" of food in the stomach where it is prepared, by ducts, for absorption from the intestines and transfer to the liver. (The ducts in the intestine are now known to secrete chemicals, not absorb nutrients.) 2. There (in the liver) it (the coction) is converted to blood containing "nutritive spirits" necessary to nourish the cells to which it is transported by veins; 3. Some of the nutritive spirits pass through pores in the septum of the heart (there are no holes through the septum of the normal healthy adult heart) and are combined in the left chamber with air coming from the lungs (ostensibly through the pulmonary arteries) to form "vital spirits." (Galen was obviously a vitalist.) In the process heat is produced causing boiling over of the vital spirits into systemic arteries, and through them, to all parts of the body. (For political reasons Galen could not have rejected Aristotle's widely accepted views.); 4. Finally, some of the vital spirits pass into the brain where they are converted into "animal spirits" which flow out through nerves to cause motion throughout the body. Amazingly, each of these points can, in an obtuse way, be related to present beliefs. Each is partly true. However, this humoral theory of the Greeks led to the practice of blood-letting in order to control the balance of the various humors. Disease states were believed to be imbalances in the relative presence of each of the humors.

You might have noticed that Galenic dogma gave no hint that vessels form a completed loop through which blood is circulated. But references from various historical niches suggest that, throughout the history from antiquity into the 17th century, there were occasional fleeting notions about the circular motion of blood. Still, few ventured to question the prevailing "scientific" dogma because it so closely adhered to the contemporary religious dogma and to the teachings of the Church. Indeed, it was dangerous to do so. As a case in point, consider Miguel Serveto (Servetus) who suggested, in the mid 1500's, a completed pulmonary circulation transporting blood to, through, and back from the lungs. It is true that in the same publication with his pulmonary theory, Servetus made some theological arguments concerning the Trinity. Knowing full well that the Roman Catholic Church would not abide his ideas, he left Paris to be with the Christian reformer, John Calvin, so that his ideas might fall on more fertile grounds. But Calvin tried him for heresy, condemned him, and had him burned at the stake along with all copies of his book. But three copies survived. They provide a good exposition on the pulmonary circuit of the cardiovascular system. Yet we have no indication that Servetus' work was widely read or that it had any significant effect on contemporary thought.

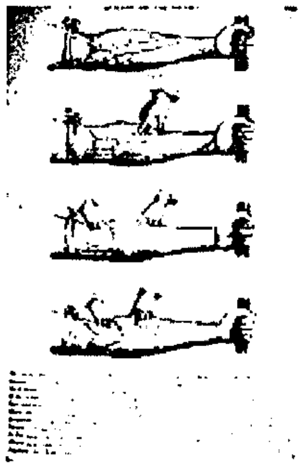
The man credited most with formally delineating the circulation of blood was the irascible founder of modern physiology, William Harvey. Harvey was more theorist than experimentalist. But a brilliant theorist he was. Near the turn of the 17th century the young Englishman was in Padua to study under the great medical teacher, Girolamo Fabrizzi. With his mentor he puzzled over the function of the valves in the veins. (The valves are located where we can see enlargements along the veins in a forearm when flow through those veins has been blocked by a tourniquet, or other constriction, on the upper arm.) Together, the two men dissected many of the structures and conjectured about how they might affect blood flow. This work helped Harvey to develop his concept of a complete circulation of the blood. The first formal exposition of the circulation suggesting that the vessels form a complete loop, out from the heart and back thereto, is found in notes from Harvey's first "visceral lecture" delivered in 1616 during the very month when Shakespeare died. Harvey had returned to London where he was a newly appointed Lumleian Lecturer at the Royal College of Physicians. His lectures there represent an important turning point in our understanding of animal function. At risk of excommunication from the church, Harvey described some simple observations which had led to his conclusions. But we should remember that many who preceded him had set the stage for Harvey's ideas, had produced the fertile grounds on which his ideas would fall.

First Harvey presented an estimate of the total blood volume in the body. (Suggesting from his anatomical observations that about 10% of the body weight is blood, he presented values that only slightly exceeded our present best guesses.) He then computed the volume of blood pumped per minute, multiplying estimates of the amount pumped during each contraction by the number of heart beats (felt in the chest) per minute. He indicated that in only a short time (actually several minutes) the heart pumps a volume of blood several times the total blood volume in the body. Thus, he concluded, the blood being pumped must be returned to the heart, the same blood passing through the heart several times each few minutes. He also demonstrated that the blood is returned through the veins and that the valves play an important role in that return. To do so he made a simple observation. Referring to the diagram (slide #9):

> But that this truth may be made the more apparent, let an arm be tied up above the elbow as if for phlebotomy (AA). At intervals in the course of the veins, especially in labouring people and those whose veins are large, certain knots or elevations (B, C, D, E, F) will be perceived, and this not only at the places where a branch is received (E, F), but also where none enters (C, D): these knots or risings are all formed by valves, which thus show themselves externally. And now if you press the blood from the space above one of the valves, from H to O, and keep the point of a finger upon the vein inferiorly, you will see no influx of blood from above; the portion of the vein between the point of the finger and the valve O will be obliterated; yet will the vessel continue sufficiently distended above that valve (O, G). The blood being thus pressed out, and the vein emptied, if you now apply a finger of the other hand upon the distended part of the vein above the valve O, and press downwards, you will find that you cannot force the blood through or beyond the valve; but the greater effort you use, you will only see the portion of vein that is between the finger and the valve become more distended, that portion of the vein which is below the valve remaining all the while empty (H, O).

As Harvey delivered this lecture, all present could see the evidence by following the procedure on their own arms. Thus they had been carrying this evidence with them all along, but had not observed it.

Also among Harvey's achievements was his enunciation of the most effective approach to studying natural science. That approach has been labeled the "scientific method." There are four components of the methodology which Harvey thought to be essential. Briefly they are: 1. a careful and accurate observation and description of a phenomenon; 2. a tentative explanation of the phenomenon (a hypothesis); 3. a controlled testing of the hypothesis; 4. conclusions drawn from data obtained during the tests.



When I first heard of the constraints of scientific methodology I knew I could never be a scientist. (I don't even like to use a cookbook though I do enjoy cooking and eating.) Fortunately I had forgotten about the scientific method by the end of my third undergraduate year, the point at which I first decided to pursue my developing interest in the sciences. Later I found that, as my exposure to the sciences and to those in the forefront of research in the sciences increased, I became increasingly aware of the fact that most advances result from investigations best described as "trials and errors." Granted, of course, that the trials are not random but are the result of careful thought and contemplation. This, by the way, is the approach I most enjoy when cooking, when creating photographs, and when investigating science. And I am in good company. In the words of Claude Bernard, one of the most brilliant investigators of animal function:

> "Scientific investigations and experimental ideas may have their birth in almost involuntary chance observations which present themselves either spontaneously or in an experiment made with a different purpose."

One of the requirements, then, of the successful creative life scientist is an ability to realize when you have come upon something important, something that increases our knowledge of the order of living systems, or of the relationships between the parts of a living system. Or perhaps your discovery merely alters our perception of relationships between facts already known, thus affecting the texture of that part of science.

A sonnet by Jerome Head appears in your program. Head captures there some of the difficulties encountered when a person tries to study life, interpret observations about life, or otherwise tries to discover a meaningful order among facts or ideas. It seems fitting to close with his words:

All being is a fountain's shifting plume
Whose scattering mist falls back into the bowl
Which, being always full, has always room.
The fountain lives by changing, but the whole
Containing change is changeless; measures rise
And equal measures equally return
For naught is born of nothing, nothing dies
And ne'er a drop o'erflows the brimming urn
Whose surface ruffled by the falling drops
Turns back the shafts of man's too curious eyes
And shows himself reflected. Knowing stops
Sharp at the surface, and howe'er man tries
To peer into the deepness of the bowl
'Tis his own self he sees and his own soul.

(Jerome Head, Sonnets in Exegesis of Heraclitus and Empedocles, Evanston, 1955)

I have enjoyed sharing these thoughts with you. Thank you for your attention.