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DIONYSUS, THE TOUCH OF GOLD, AND THE EARS OF MIDAS: PRESIDENTIAL ADDRESS, THE CLAY MINERALS SOCIETY, 1985

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Distinguished guests, ladies and gentlemen: The topic of this 1985 Presidential Address has been frustratingly close to me in my 28 years with Georgia Kaolin Research. That topic is innovation, specifically, new product development, and the title is "Dionysus, the Touch of Gold, and the Ears of Midas." Dionysus was the Greek god of wine or intoxication. Among other things, he has become noted for the Dionysian principle of surging vitality. This surge in vitality is promoted by the ingestion of intoxicants and is symbolic of the creative energy necessary to achieve invention—and invention is the first stage of innovation.

Dionysus bestowed upon King Midas the power to convert whatever he touched to gold. To convert an invention to a profitable enterprise, the second stage of innovation, commonly requires this golden touch of Midas. In amusing contrast, King Midas was given the ears of an ass by Apollo for declaring Pan's pipe more musical that Apollo's lyre. "Ears of Midas" has become a phrase applied to unsophisticated critics. Some of the critics of the innovative process, both in research and business arenas, including myself, have occasionally had the ears of Midas.

Much of the kaolin in Georgia was formed during the Cretaceous period nearly 70 million years ago. In the last 28 years I have both praised and cursed that time in geologic history. When I left academia for industry, I held the notion that a quest for new knowledge was a universally accepted practice for the technical investigator. Such naiveté gave way reluctantly to the realization that in the industrial world of managers preoccupied with bottom lines, efforts to achieve understanding are frequently viewed as innocence, and pragmatism is invariably truth. The bottom line of this realization is that paths to innovation are profoundly influenced by managerial philosophy, a problem that I will say more about below.

Innovation is the dream of industry. The most successful industry is generally the most innovative. Paths to innovation are painfully slow and incremental. As indicated above, innovation is a two-stage process—first invention, then commercialization. Usually the creative individual prone to invention is not predisposed to expedite commercialization. My remaining comments will be directed largely toward creativity and the invention stage.

Prevalent is the stereotypical notion that creative people are weird or crazy. Donald McKinnon, Department of Psychology at the University of California, has shown (Rice, 1984) that there is no correlation between creativity and psychopathology—though the conglomerate that I work for may very well consider me to be an exception as I fly in the face of many of their business school approaches. Schools for creative management contend that creativity is a latent talent in all of us which can be cultivated.

Creativity is not essential for all technical industry to succeed. Reductionist methods or vertical thought processes can be utilized successfully in youthful industries. This is particularly true where there is an abundance of potential directions in which to explore. Serendipity, which can be described as "dumb luck," is an occasional spin-off of these reductionists efforts. As industries mature, value that can be derived from these straightforward methods becomes depleted. Facilitated by lateral thought processes, creativity becomes essential for mature industries to regain vitality.

Edward de Bono, a systems behaviorist at the University of Cambridge, relates a story (1967) which I think is a superb example of lateral thinking. Many years ago when a man could be thrown in jail for owing even a small amount of money, a certain merchant, among many, found himself in this plight. One day the merchant and his young and beautiful daughter were standing in front of their store aside a pebble-strewn path. At that moment, the moneylender came by to tell the merchant that he would be thrown in jail immediately if he did not repay his debt. When the merchant said that he could not, the moneylender, at first, was angry, but on second thought, and with a sly glance at the beautiful daughter, offered a sporting proposition.

The moneylender said he would pick up two pebbles from the path, one black and one white, and place them in a bag. The daughter would draw one pebble. If she drew the black pebble, she would have to marry the moneylender who was old and ugly, but her father would not have to go to jail. If she drew the white pebble, she would not have to marry the moneylender and her father still would not have to go to jail. Reluctantly, the merchant and his daughter agreed to this proposition.

The moneylender stooped over and picked up two pebbles, then placed them in a bag. The daughter, not only beautiful, was sharp-eyed and saw that he had indeed picked up two pebbles, but both were black. She quickly reviewed in her mind possible courses of action. She could refuse to draw a pebble, but her father would still have to go to jail. She could draw both black pebbles showing the moneylender for the cheat that he was, but her father would still have to go to jail. Lastly, she could draw one pebble, necessarily black, be a martyr, and marry the moneylender. This seemed to be the only obvious way to save her father from jail, and it exhausted the possibilities coming from vertical thinking.

Among her many talents, the daughter could also think laterally. She drew one pebble from the bag making sure that no one saw it. And then, making it appear accidental, she deftly dropped the pebble to the path. It was lost among the other pebbles and no one could tell which color it was. Then she said to the moneylender, "Never mind, if you look in the bag you will know the color of the pebble that I dropped."

I would like to hire a girl like that.

Lewis Thomas, research pathologist and chancellor of the Sloan-Kettering Cancer Center, pointed out (1979) that cloning of humans is on most lists of things to worry about from science. Other items on the lists are behavior control, genetic engineering, computer poetry, unrestrained growth of plastic flowers, and transplanted heads! As incomplete as this list is, it makes me cogitate on what people might worry about most from clay mineral science. Certainly a few particulate minerals have been shown to promote pneumoconiosis. I hear that clay minerals have been impugned as potentially involved in a natural process of genetic engineering and that clay minerals have been studied extensively for use in the storage of nuclear waste.

Indeed, it is fair to say that just like those scientists in other disciplines, clay mineral scientists are rascals. Be that as it may, those phenomena that become worries and problems in science profoundly impinge upon creativity—the old standby, disruption and the necessity to correct, and not the least, the arousal of that rather mysterious force that makes us try to understand.

In an effort to explain the creative process, Janusian thinking has been invoked recently by a professor of psychiatry at the University of Connecticut, Albert Rothenberg (1979). This cognitive process is named after Janus, the Roman god of beginnings, who is represented with one head and two bearded faces set back to back. In Janusian thinking, two or more opposite concepts are conceived. Seemingly defiant of logic, these opposing ideas are reconstructed into a single, viable, working entity. It is a highly sophisticated form of lateral thinking.

Elaborated by Rothenberg, an excellent example of Janusian thinking was provided by Einstein in his work on the general theory of relativity. Einstein conceived that an observer in free fall has no gravitational field in his immediate vicinity. If the falling observer releases an object, that object remains at rest relative to him. The falling observer then is justified in considering his state as one of rest. Einstein concluded that the falling observer is in motion and at rest at the same time. This hypothesis was seemingly illogical, but it permitted Einstein to transcend vertical thinking and to encompass Newton's classical theory of gravitation into a broad principle of relativity.

As explained by Rothenberg, Janusian thinking helps to elucidate the sense of surprise in creativity. Always surprising is that the opposite of a previously held idea is true, but even more surprising is that opposing ideas can be true simultaneously. Perhaps we should consider trying this approach the next time we have differences of opinion with our spouses. If the approach fails, blame it on Rothenberg!

Having established at least a crude basis for what creativity entails, I would like to take a brief excursion into a problem in the United States that has been ongoing for roughly 15 years—and through this agency lead into other aspects of creativity and invention. The problem can be described as an innovation recession. Indicators of this recession, the amount of our gross national product budgeted to research and development, the number of patents issued, and productivity trends have all been pointing downward.

A litany of reasons has been cited to account for this recession, some of which are short-term corporate planning, the acquisition trend in lieu of internal growth, lack of capital, and lack of technologists in upper management. All these reasons are undoubtedly influential, but as a personal bias I believe that the most basic reason is related to managerial philosophy. If a company is to develop novel products, the management of that company must be fully committed to the innovative process.

Innovation is an outrageous process. As opposed to generally followed procedures, which are for the most part imitative, innovation involves higher cost and higher risk and, most ominously, necessitates change. All of this is antithetical to the more comfortable and conventional, short-term, financial approach to busi-

ness. Just as from the point of view of the oyster, the pearl is a disease, so management tends to view the innovative process as a disease. And with carefully conceived therapy, they frequently try to cure the patient.

According to Vannevar Bush, the best way to manage research is to realize that you can't (Luberoff, 1985). Although this statement may possess a touch of hyperbole, many experts in the management of research and innovation believe that Bush's observation is fraught with wisdom. Furthermore, they contend that the rising flood of systematic management in industry comes at the expense of creativity. If creativity for innovation is to be managed at all, it must be done in an atmosphere that is non-authoritarian, and free from anxiety and tightly scheduled activities.

Ernest Breton, a former research fellow of Du Pont and founder of INNOVATIS, described three management procedures for the cultivation of creativity (1975). These include a method of assigning tasks, an allowance for information gathering, and a patience for incubation. If an investigator is assigned the task of developing a better fountain pen, that is probably the only direction in which he will work. But if he is asked to explore better ways of making marks, he may come up with the felt tip or the ballpoint.

With respect to information gathering, it is a maxim that the greater the knowledge and the greater the variety of patterns of knowledge, the greater the probability to solve problems. Historically, eclectic combination of patterns of knowledge has been the fundamental basis for major inventions. Gutenberg provided a classic example when he combined two patterns of technology, the wine press and the authenticating seal, to develop the printing press.

The management of incubation is more abstract. It must be understood that indefinite periods of time are required to scan memory and to recombine patterns of knowledge. This subjective thinking—intuition—works from a much broader base than does objective thinking. Intuition is guided by inhand knowledge gathered over time and stored in remote, difficult-to-reach niches of the brain. This information potentially can be extracted under special conditions to enable us to give birth to those rare moments of creative illumination.

All of the reasons that I have cited to account for the innovation recession have excluded a parameter intimately related to managerial philosophy. This parameter is basic research. Although most of my experience has been with short-term, targeted, industrial research, I have had enough experience with basic research to be sympathetic to its importance. I reserve a conspicuous and passionate place in my mind for the exhilaration that comes from the discovery of new knowledge—knowledge that presumably has been cerebrated for the first time. It arouses the libido and the desire to create—to create other new patterns of knowledge that are elegantly exciting whether those patterns are lonely and esoteric or broadly applicable. Certainly some of you have cerebrated new knowledge in preparation for this meeting, or perhaps even during this meeting, but I will not be presumptuous about what this has done to your libido.

This splendid system of mind arousal is related to the Dionysian principle of surging vitality, which I alluded to above and which is beautifully developed by Rollo May (1975) in his book, *The Courage to Create.* Although Dionysus was the Greek god of intoxication, disappointingly, ingestion of alcohol does not give rise to elegantly creative results. This observation seems to be conventional wisdom, but I have collected my own, rather impressive, experimental evidence to substantiate this claim. In all fairness, however, I should mention a notable exception, Samuel Taylor Coleridge, who conceived the vision of the Kubla Khan during an opium-induced reverie.

Parallel, yet different, because of non-drug orientation is the surge in vitality that comes from intensity of effort. As described by May, we cannot will creativity, but we can give ourselves to the intensity of involvement. The most profound aspects of awareness become activated to the extent that we are committed. Indeed, there are now Rorschach responses (May, 1975) which indicate that people can observe more precisely when they have intense, emotional resolve.

In a related vein, psychological research is being carried out at the University of Colorado on the relationship between creativity and the twilight state of mind (Budzynski, 1977). This is the brief, somnolent state that occurs just before we go to sleep, when theta brain waves are generated. Creative insights commonly occur during these subconscious states of mind. There is some evidence that during these subconscious states the left side of the brain, which is usually dominant and controls logical thought, is bypassed, and the right side of the brain, which is emotional and intuitive, takes over.

Perhaps then we should not take lightly that Brahms, Kipling, Goethe, Longfellow, Niels Bohr, to name only a few, claim to have had some of their most creative insights during dreams. Even René Descartes, by his own account (Harman and Rheingold, 1976) claims to have conceived creative insights during dreams that enabled him to conceptualize modern rationalism. Though I do not intend to wax poetic, this relationship between dreams and creative insights does seem to offer the opportunity for poetic liberty—particularly when one considers that modern rationalism is the ideological framework for modern science. Whereas a small cadre of psychiatrists are beginning to consider dreams as nothing more than random, neurological noise, I think it is still safe to speculate, in a modest way, that the learning of many patterns of knowledge

combined with intense, emotional resolve in research are two of the most basic ingredients for activating the creativity center of the brain.

As you have perceived, I have been protagonizing basic research as a critical stepping stone to innovation. The fundamental importance of basic research to innovation, understandably, is difficult for the non-technical manager to comprehend. The connection can be abstract and elusive. Somehow this connection must be conveyed more effectively if industrial research is to thrive. The funds that industry expends on research are directly related to upper management recognition of a favorable bottom-line influence.

On the other side, research people frequently have been aloof to the needs of industry. In the 1950s and 1960s, undirected basic research was common in industry (Wolff, 1981). This was a search for new knowledge without regard for the ultimate impact or the strategic goals of the business. This approach may have played an important role in destroying credibility between hard-nose businessmen and the puritans of research. This approach also bears some relationship to the man that traded in his 40-year-old wife on two 20-year-olds, and then found that he wasn't wired for 220. Though invaluable, undirected basic research is probably best left to universities.

After the demise of much industrial research in the 1970s, some renewed efforts in the 1980s have been *directed* basic research. Directed basic research is original technical work that advances knowledge in concert with business strategies. Perhaps by this approach a better connection to innovation can be established, and the credibility gap will begin to dissipate.

I have here described some of the problems and possible mechanisms of industrial innovation. I will summarize in the spirit of challenge so often advocated by W. D. Keller. Our innovative future does seem to be in the hands of the ancient gods. We must intercede and see to it that Apollo's curse on King Midas does not prevail such that the non-technical manager will appreciate the bottom-line value of basic research. We must strive to preserve the Dionysian spirit of surging vitality such that creativity and invention will flourish. We must work to maintain the Dionysian gift of the golden touch to King Midas such that inventions will prosper. And we must not neglect Janus' gift of Janusian thinking to be reminded of the unholiness of the creative process.

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