"WE DON'T HAVE TO EXPLAIN ANYTHING"

AN INVENTION ROADBLOCKED THROUGH GOVERNMENT ABUSE
AN INVENTOR'S STORY

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PREFACE

John Maynard Keynes, the famous British Economist, wrote in the preface to the General Theory of Employment, Interest and Money, which he published in early 1936 in the midst of the Great Depression: "This book is chiefly addressed to my fellow economists. I hope that it will be intelligible to others. But its main purpose is to deal with difficult questions of theory, and only in the second place with the applications of this theory to practice. For if orthodox economics is at fault, the error is to be found not in the superstructure, which has been erected with great care for logical consistency, but in a lack of clearness and of generality in the premises."

This book, like the General Theory, does address difficult theory. But, unlike the General Theory which addressed the conduct of a national economy, a topic in the social sciences, this book addresses an invention and the associated technology in the field of pavement engineering, a topic in the far more disciplined physical sciences. The invention is a new form of pavement. Not unlike Keynes, I too discovered a flaw in the foundation on which the pavement engineering discipline resides. Once that flaw was delineated and a sound concept put in its stead, a whole new field was opened, in main part through my invention: the CRAM Pavement. This new field can now become extremely beneficial to our national interest, but only if the invention is allowed to come forth.

A problem does though arise in bringing forth the CRAM Pavement invention, not unlike the one faced by Keynes. New ideas particularly in established disciplines and industries often conflict too greatly with the interest of those who have control or perceive themselves as having control of that entity. History records the many tellings by the established interest of the follies in the ideas of those who dared to explore and challenge. The examples are abundant, but a few are written of in this story: Galileo Galilei on the behavior of the universe; John Ericsson on the design of steel ships for naval warfare; and, Charles Kettering on the electric self starter that revolutionized the auto industry.

These pioneers, amongst the hundreds that could have been mentioned who have brought forth ideas that have become of great value to our society, faced various forms of opposition unrelated to the science and technology that they explored. The three I have mentioned here have all been recognized as successful in their pursuits; although, Galileo's success was recognized by his main opposition in life only centuries after his death. This form of opposition, though non-scientific and non-technical, has been and is often camouflaged in technical vestments. Though the dress is false, it has effect on those not knowledgeable and certainly on those who have not the inkling to be informed.

The opposition against those who dared to bring forth the ideas that challenge the established interest has taken many forms. That offered against Galilei was direct to the point of bringing forth the full force of the law, simply for the perceived threat that his ideas posed. The opposition to Keynes was most subtle: it first sought to denigrate his theory and then to distort and confuse it while posing as in its support. To date, that opposition has been generally successful. The opposition against inventors like Ericsson and Kettering were generally more direct than against Keynes and his theory but less onerous then against Galileo.

The opposition to Ericsson was from the naval bureaucracy whose interests were more than a protection of their perceived political and social powers, it went to the sinister means of covering up the criminal negligence of one of their own. Only the pressing needs of the American Civil War brought Ericsson's ideas to fruition. Kettering had a similar form of opposition offered against him to that brought against Ericsson; but he operated free of the

influence of strong interests. The ease with which Kettering was able to introduce his self-starter and other important inventions of the first half of the 20th century is contrasted with the problems that Ericsson had in introducing the Monitor into the American navy. The opposition and its adverse influence that my colleagues and I have encountered is more similar to that encountered by John Ericsson in bringing forth his Monitor but there is much that harks back to that brought against Galileo.

Although there are many similarities in my endeavors to that of the other explorers of nature that are mentioned here, there are also differences. The most similarity to John Ericsson is that the purchasers of my invention are either government agencies or require the approval of a government agency. The difference is that my invention does not impact measurably on a nation's success in a pressing national emergency, as did the Monitor in the Union's American Civil War cause. It does though impact most measurably on our national economy, but clearly not in the manner or to the extent that the ideas of John Maynard Keynes do. A similarity to John Ericsson's success with the Monitor, it is hoped, is the role that the elected officials may play in the acceptance and consequent advancement of the CRAM Pavement technology.

I have chosen to write briefly about Galileo Galilei, John Ericsson and Charles Kettering in this book as their encounters help to detail and elucidate my story. Not in knowledge of the trials of these discoverers and inventors of the past, but rather just by nature, I approached the CRAM Pavement invention with certain trepidation: possibly, much the same as others whose discoveries and inventions fostered social and technologic advancements so important in our history. Unlike Keynes, I had not wedded myself to the previous ideas that govern the understanding and, in consequence, the design of conventional pavements. I did not have to break a bond with previously taught doctrine that often passes as theory as Keynes did. This was by accident, not by choice. I did not set out to make a career in pavement engineering. I was thrust into it several years after I had begun my professional career.

The encumbrance by existing doctrine, hypothesis or otherwise that I did not suffer is likely a similarity with the experiences of John Ericsson and Charles Kettering. Neither of them seems, at least from my research, to have been discouraged or confounded by the then existing unproved theories and ideas of the times, ideas that can and do often tie men's minds. This is not to say that the means by which I entered this new field of endeavor was the same as that which John Ericsson and Charles Kettering engaged theirs. For, I believe, there may have been differences, although such differences likely were not over-riding in importance in arriving at my invention.

These other discoverers and inventors too learned from others of the existing science and technology in which their endeavors were to make important advancements and were so encouraged; but, their entry into their new venture was possibly more voluntary than mine. That is to surmise on my part, and to do so may be incorrect, as once the interest of the inventor is tapped, disengagement becomes nearly impossible. That has been in part my fate with the CRAM Pavement. That seems to have been Ericsson's fate with the Monitor and it likely was Kettering's in his discovery of the self-starter and other applications of electrical and other technologies to the improvement of the motor industry. Galileo's continuation in his endeavors to explore the universe would have been under penalty of death. Such chastening can do much to disengage the interest of the most dedicated amongst us!

Whenever we make an important advancement, whether in an established technology or otherwise, we in effect open a door to a new room with all of its contents now to be

explored. The holdings of such a room need not be fully unknown to us before we enter and explore. Such a room, in a sense, has windows. Through those windows, we get inklings of what lies in store. Even though we have those windows, we do not know, certainly with fixed confidence, what we actually will find. There is risk in exploring the unknown. How well we can explore through the windows often determines how successful we are in fulfilling our expectations.

I had the theories that were forming in my mind. These, I had generated from my observations of the behavior of conventional pavements, particularly in light of my knowledge of the science and technology that could form a foundation for my invention. I was able to use existing scientific knowledge to aid in seeing how my invention might respond to the expected usage. I could and did examine the various materials and their behavior that comprised my invention under various usage in the laboratory and in the field, usage that would lend insight into the expected behavior of my invention. Additionally, I could associate other of my engineering experiences with that which reason suggested was also true of pavement systems. From an analytical perspective, I had available to me computers that could do high speed calculations and computer programs that were written for complex analysis of important if not critical aspects of the system I chose to examine.

As Keynes acknowledged the often impossibility to bringing one's ideas on a national economy to a conclusive test either formal or experimental, such is not true of a mechanical system such as my invention. Like Keynes, we too made great attempts to appraise members of our profession of my discoveries and the science and technologies that support my invention; but, only after we had completed the first construction. In hindsight, we were fortunate not to have appraised many in the industry until after we first had confirmed our expectations. Through full-scale usage, we were able to confirm that competent contractors with normal skills and conventional equipment could construct my invention much as they do the conventional pavement. We have also confirmed the excellent performance that my invention provides, to the extent that eighteen years of urban highway usage and nine years of heavy inter-modal yard usage can demonstrate. These contractors also confirmed the costs we projected for these constructions.

And, we have a Caltrans CRAM pavement experiment that though seriously flawed in its construction has, after 14 years of usage, clearly demonstrated a much superior performance to the conventional pavement. But, once Caltrans, a major state department of transportation agency, and the U.S. Department of Transportation were appraised of the CRAM Pavement, we were essentially stymied in our attempts to have this invention become part of the road transportation system. Certainly, Caltrans and the U.S. DOT had to be appraised of this important invention; but never in our longest nightmares could we have anticipated such sinister actions on their parts. What we offered was met mainly with indifference, as benign neglect is often the most effective means that those in power can use to resist challenges. But, as the battle pressed harder, the resistance made a transformation; from that being covert to that being overt. The weapons of distortions and untruths were now being augmented with outright lies.

The distortions and untruths first became Caltrans' weapons in their treatment and reporting of their experimental use of the CRAM pavement. Caltrans' false assertions were than propagated by the U.S. DOT who had cupidity in the Caltrans CRAM pavement experiment through its research funding. Caltrans and the U.S. DOT did not work alone. Many government funded professional researchers, often posing as independent consultants, also came forth to stop the CRAM Pavement invention. The first acts of the members of these groups were couched in more professional texts. However, when it appeared that the CRAM Pavement could break through these forms of barriers, these groups went beyond

mere technical innuendo. They resorted to distortion of scientific concepts and where they felt that to be insufficient, they resorted to duplicity.

The duplicity of an Oregon State University researcher together with a local agent of an asphalt pavement association and members of the Oregon DOT acting to forestall the Port of Portland from using the CRAM pavement on an inter-modal yard exposed Caltrans in its lies. This exposure has now allowed us to confront Caltrans in a court of law. Pursuing Caltrans, and most likely others including the U.S. DOT as formal discovery unfolds through the court is a very heavy burden on us a small group. Though, it is necessary to more formally confirm and to bring before the public many of the actions of the highway industry that are not only most egregious but are extremely costly and damaging to the public interest. These egregious actions become a measurable part of this story.

Thankfully, Caltrans, the U.S. DOT and University associated consultants were not aware of all of our activities. Had they been, the Port of Los Angeles most likely would not have the CRAM Pavement for a major inter-modal yard and we would not have the benefits of that pavement demonstrated so clearly. The Port's materials engineer sought us out for this construction as part of the Port's intent to investigate the suitability of various pavements for the heavy use demanded of their inter-modal yards. The Port has also agreed, at least tentatively, to allow their CRAM pavement to be used in a full scale-loading test. The opportunity for this test program has been brought forth to various government agencies including the U.S. DOT. But, not surprising, our efforts have been without success.

Over the years, we have appraised several members of the congresses, both at the Federal and the state levels, of the great potential value my invention has for the nation. We have estimated this value to exceed one-third of the national annual gross domestic product over the course of the next fifty years. The National Institute of Standards and Technology have confirmed that modest estimate. We have also appraised these congressional members of the irrational resistance by the government agencies and their associated consultants to the implementation of the CRAM pavement. Many of these elected officials are now aware of our court action against Caltrans and the basis for that action. But, any favorable responses by these officials still pends.

With these experiences behind, I have undertaken to write this book. But, unlike John Maynard Keynes, this book, which in its title "We Don't Have To Explain Anything" so fittingly portrays the contempt that many in government and their close associates have for the public, is written for the public. I have support for this decision. On various occasions, I have discussed the problems we have had in dealing with government agencies with regards to my invention with my father. His advice was much the same as that given by President Harry Truman to Senator Dale Bumpers, as Senator Bumpers offered in a speech before the senate in the recent impeachment hearings: "Put your faith in the American People."

Hopefully, members of the pavement engineering profession will read this book, as there is much in it for them to learn, and much they should learn if they wish to understand the behavior of pavement systems. It is even more so if they wish to provide the best service to their clients, which is ultimately the American Public. However, the pavement engineer's immediate clients are predominately, in one form or another, state and local government agencies that rely on the words of the agency staff, generally without challenge. And, the pavement engineers are often a part of the agency staff or a consultant to the staff chosen primarily to confirm the staff's position, not in regard to merit. The final decision though is or ought to be by the elected officials. The first usage of my invention was indeed decided by the elected officials. This means of government decision-making, so necessary in a

democracy, we have found, much to our dismay and to the detriment of the public, to be a most rare event.

I have included much science and technology in telling this story. An understanding of the science is helpful in gaining a perspective of my invention and of pavement engineering. But, a complete understanding of the science is not necessary to a recognition of the value of the CRAM Pavement; or to an understanding of the source of the resistance to implementing this most valuable invention; nor to an understanding of the means to overcoming this resistance. Nonetheless, the science and technology adds completeness to the story.

I have tried to tell the science in a plain, interesting and meaningful manner. I have, in this regard, tried to refrain from including mathematical formulas that seem to dominate so many books on science and technology. However, in a story that carries much that is scientific, it is unreasonable not to use mathematical expressions as they are an efficient and clear means of expressing important ideas and often necessary to grasp a scientific concept. Where I have felt the need for this form of communication, I have endeavored to place the mathematical formula in charts that also express the formula in graphical form. In that way, I believe that a clearer description of the concept is made. I may only hope that the reader will find this approach satisfactory.

Those who wish to explore the science through the more rigorous means associated with the more highly involved mathematical descriptions I refer to the many textbooks on the disciplines of soil mechanics and pavement engineering. Certain of these are referenced in the course of telling this story. I have also listed several of these in the bibliography for those so interested.

INTRODUCTION

Introduction to the Invention: This is a story about a technological advancement and an invention that portends great value for our society. The invention is exceedingly simple in form and in the means by which it is manufactured and put into service. As such, its manufacture and its cost are not in great debate although both of these have been used as ploys against allowing the adoption of this invention for public use. These things, the manufacture and the cost of production, have been confirmed on two full-scale projects. Whereas the invention is simple in form and in application, the science that foretells its material success is complex. This science draws on some of the most advanced theories regarding the behavior of engineering materials and their usage in complex structural systems. Although the theories are advanced, they are supported by much physical evidence. And, although the invention is part of a complex structural system, it too has much physical evidence in support of its immense superiority over the existing state of the art.

The invention I am writing about is the CRAM Pavement. The acronym stands for Contained Rock Asphalt Mat. CRAM is a multi-layered pavement structure that utilizes conventional pavement construction materials, but in a unique arrangement and in certain unique ways; the latter being a consequence of the former. The unique arrangement causes the CRAM pavement to behave in a beam-like manner. As such, it is a very efficient structure for distributing repetitive loads of heavy motor traffic onto the native ground while maintaining its own integrity. This unique arrangement also allows the most important material component of the CRAM pavement, a base asphalt layer, to be modified in a manner that materially enhance its resistance to the combined effects of the traffic loading and the natural effects of weathering.

The consequence of the unique arrangement and modification of the construction materials is that the CRAM pavement can be constructed for 50 to 75 percent of the cost of the "comparable" conventional pavement, while having inherent within it the ability to carry several times more loading before it mechanically fails. In other words, the CRAM pavement at 25 to 50 percent less cost to construct has several times greater mechanical life. Application of sound scientific concepts together with our computer analytical methods have clearly demonstrated the greatly increased mechanical life of the CRAM pavement over the replaced conventional pavement. The less formal application of our scientific knowledge indicates that this mechanical life can indeed be extended into real time. And, in consequence, the life potential of the CRAM pavement can easily exceed 50 years where the replaced conventional pavement has a useful life of 10 to 15 years at best. Savings from extended life provide by far the greatest value, typically as much as two to three times the initial construction cost.

The national value from this increased efficiency in the construction and greatly extended life is immense. Projected over a fifty-year period, application of the CRAM pavement to our roads, streets and highways provides an estimated value of $2.46 trillion in 1993 dollars. The immensity of this value may be better understood when compared with our gross domestic product, reported in Information Please Almanac as $6,379 billion for the 1993 calendar year. Stated otherwise, the value of the CRAM pavement over the next 50 years is 38.5 percent of our annual gross domestic product! Application of the CRAM pavement to our airports, seaports, parking facilities, and other uses of pavement increases this value even more!

But direct economic return is not the only value from the CRAM pavement. Our submittal to the National Institute of Standards and Technology at the direction of Vice President

Gore was under the guise of the energy savings that would accrue from the implementation of the CRAM pavement. This we had estimated in the NIST submittal to equal 47.95×10^{15} Btu over a fifty-year period. In more meaningful units, that is roughly 10 billion barrels of oil, or over a third of the total national energy usage per year! The immensity of these savings of our natural resources is clearer in view of the 30 million barrels of oil released from the nation's strategic petroleum reserve in September 2000 in response to the recent energy situation.

Additional value from the CRAM pavement not as easily quantified as direct economic return and energy savings is in reduced injury and loss of life from work zone accidents. As an example, the roughly 148 deaths attributed to Firestone's faulty tires on Ford's Explorer that occurred during the last four years pales in comparison to the loss of life in the work zone, presently roughly 700 per year nation wide. These deaths do not include those caused from potholes or other forms of pavement defects, physical features that likely interacted with those identified as attributed to Firestone's faulty tires.

Our studies into the characteristics of this unique pavement and the mechanisms that influence its behavior and in its ability to perform in the various traffic and environmental usage has led us to make many very positive claims for it. These features that we claim either are not inherent in the conventional pavement or are very difficult to achieve without compromising other attributes of the conventional pavement that are necessary to allow it to serve its intended function. Many of these claims that we make for this new pavement now have been verified but only in a very limited usage.

To the novice, after reading this story, this arrangement which characterizes the CRAM pavement may not seem to be so unique. Although, the consequence of this arrangement as necessary to the enhancement of the critical material comprising this new invention will be recognized, it will be understood as far less obvious. But, when these two insights are joined in the mind, the features that we claim for this new invention will not seem to be so equivocal. Similarly, it will be understood why these many advantages are claimed for the CRAM pavement and why they more likely can not be made inherent in the conventional pavement.

Impediments to Acceptance of the Invention: Why the CRAM pavement invention has not been put into favor for the public will be a question that will be difficult for most to fathom. A part of this story is in answer to this question. Undeniably, the complexity of the technology that foretells the success of the CRAM pavement may be argued as being in part the cause as it is difficult to understand. We have acknowledged this. However, much of our technology is founded on complex science that is not easily understood by most of us.

The word processing system that I used to write this story is in itself complex; and, I am sure that much of the technology behind it is similarly so. I certainly do not understand computer technology. Yet, I am able to use this very valuable invention to help me write this story. Obviously, the complexity of the technology in and by itself can not be argued as the cause of the failure to adopt the CRAM pavement. But, it also cannot be argued as not being a contributing factor to its adoption.

In this light, many might suggest that taking at least a cursory look at the computer devices that many of us have on our desks and tables, and the industry that fostered them in this regard would be helpful. And, in concept, I have in this story made such an inquiry. I am just not into learning about computers other than the mere necessity of how to use them. My views here as regards computers may not be so different from that held by many when

it comes to pavements. However, my views would certainly change if I were deprived of this computer device after I learned that I need not have been so!

Inquiry into inventions associated with numerous industries that have much in common with the computer industry do aid in drawing out the relevant encumbrances that distinguish the pavement industry from these other industries. One obvious difference, which the reader may have perceived, is the extensive involvement of government in the pavement industry. Some form of government agency purchases almost all pavements; or, their purchases, if not by a government agency, must have the approval of a government agency. And, the purchase orders for these pavements include their specifications, which prescribe the arrangement of the materials that form the pavement structure.

A private company purchased this computer I am using, and a private company developed the specifications for its manufacture. However, the purchaser and the developer of the specifications were not the same. Not having this separation between the preparer of the specifications and the purchaser certainly may be legitimately argued as an important factor in retarding the adoption of the CRAM pavement. And, it is. But, this has a similarity with the argument bringing forth the complexity of the technology. Whereas, it cannot be argued that essentially sole source purchasing by some form of government agency is not a contributing factor to adoption of the CRAM pavement, it is not the complete cabal.

All governments have a predisposition to including their own specifications in their purchase orders. They have to include specifications if they are to assure compliance. The specifications just do not have to be a sole product of the government. They can be developed by others or in joint consultation between the governing agency and others. Many government agencies have in many other instances where the government was a sole source purchaser used the specifications of others or had them developed jointly with others in what have been essentially sole source purchase industries. The military industry and the space program are just such examples.

It is granted that arguments may be made as to the incompetence of government purchasers in these sole-source-purchasing agencies, and many examples may be brought forth that support such arguments. The $600.00 toilette seat in the space program although clearly not the most relevant, may be the most memorized of such an example. However, arguments can also be made in support of the competence of sole source government purchases, and examples can be brought forth accordingly. The California State Water project, that is part of this story, I believe to have been such an example. In the course of this work, I have made inquires into other examples of sole source government purchases and my findings from these inquires too have become a part of this story.

Clearly, the answer to the problem as to why the CRAM pavement that portends such great value to the public has not been adopted is far more complex than can be relegated to a single causative factor. This problem and its answer, like the technology that foretells the material success of the CRAM pavement, are complex. To seek answers, I have researched many authors. One in particular that seemed to shed some light was Charles Frankel, in his book: “High on Foggy Bottom, An Outsider’s View of the Government”, where he chronicles his experience as Assistance Secretary of State in the Johnson Administration. In summarizing his experiences, which in part centered on the Vietnam War, the asinine basis for the continued involvement in that war and its incompetent if not totally profane conduct, Frankel wrote:

“We have not yet learned to measure the costs of foreign policy by an appropriate standard. We invoke something called ‘the national interest,’ and mean by it essentially the taking of

precautions that will keep possible adversaries at a disadvantage. And, since there is no limit to the damage they might want to do us, and no limit, in abstract theory, to their possible capacity at some time or other to do what they might imaginably want, there is no limit to the precautions which, in this view of the world, it is necessary and reasonable to take. And so, to ward off possible nightmares in the future, we have followed policies that involve us in nightmares in the present....

"Indeed, the largest cost of these policies...is their creation of a psychological environment that systematically undermines the authority of the government itself. They put the government at a distance from the citizens. They make it seem larger than life, harder to reach, more imperious and inhuman. As no less a philosopher than Spinoza observed, no one would expect that a government can act in accordance with the moral code appropriate to the conduct of individuals. Its problems are different."

The bureaucracies of state departments, defense departments and the military are not unique in their need to take: "precautions that will keep possible adversaries at a disadvantage." The state Departments of Transportation centralized through the Federal Highway Administration under the guise of the American Associations of State Highway and Transportation Officials have assigned themselves responsibility and authority for establishing what is acceptable in pavement engineering. Whereas, these agencies do invoke science, it is as a facade as regards the means of design of pavement structures. Simply by offering an alternative pavement structure, we became an adversary to this established system.

And, since *there is no limit to the damage that we through our CRAM pavement might want to do to this established interest, and no limit to our possible capacity at some time or other to do what we might imaginably want, there is no limit to the precautions which it is necessary and reasonable for the members of these organizations to take:* deceptions, fabrications, distortion of truths and out-right lies are simply means where necessary to fulfill the organization's mission. With rare exception, all of the government agencies and members of universities encountered in our endeavors acted in accord with this amoral mode: actions which most all of us would abhor in our fellow individuals. In fact, the title to this book derived from such depraved actions.

We as a nation tend to accept more and more these acts at all levels of our governments, a most dangerous tenant, as Professor Frankel tells but from the other side. "It is half-baked realism not to realize that there are limits to the capacity of most citizens to accept the actions of the State on the grounds of reasons of State. When these limits are exceeded or when citizens, in loyalty to the State, relax their standards, there are consequences. The moral authority of the government either declines or becomes something occult. That is the cost which the long drift of our...policy has begun to exact from us..."

For "reasons of State" was the basis for the actions against Galileo so fittingly expressed by Albert Einstein in his forward to Stillman Drake's translation of the Dialogue Concerning the Two Chief World Systems. Galileo's sin, as Einstein wrote, was simply his: "...passionate fight against any kind of dogma based on authority." And, for that sin, he was condemned to life imprisonment. Einstein wrote further in that forward: "Nowadays it is hard for us to grasp how sinister and revolutionary such an attitude appeared at Galileo's time, when merely to doubt the truth of opinions which had no basis but authority was considered a capital crime and punished accordingly. Actually we are by no means so far removed from such a situation even today as many of us would like to flatter ourselves; but in theory, at least, the principle of unbiased thought has won out, and most people are willing to pay lip service to this principle."

Einstein's words which he composed in 1952 were prescience to our experiences, as I tell directly of government officials and those in the universities that acted clearly in ways that most of us would find most abhorrent had those been acts as individuals unrelated to government. But, these acts were hardly less than "for reasons of State" though such cause was and never is acknowledged. "For reasons of State" must then take on the sinister meaning that it had in past times and other places. The examples are abundant: The Catholic Church's dealings with Galileo in 17th century Italy for the work from which I drew Einstein's cogent comments; The U.S. Government's dealings with Robert Oppenheimer on nuclear secrets a near half century ago. And the many dealings of the Russian government during this period that are only now becoming known, as told, for example, by Aleksandr I. Solzhenitsyn in the Gulag Archipelago.

Clearly, that flaw in our human nature that Galileo spent the greater part of a most valued life fighting and as Einstein recognized a half century ago is still so much a part of those in authority. As this story tells, through our elected leaders, we defer the test of new knowledge almost solely to the authority of the state bureaucracy with little if any challenge, who in-turn act most similar to those that confronted Galileo nearly four centuries ago. This is undoubtedly what Einstein meant when he wrote: "...we are by no means so far removed from such a situation even today...but in theory, at least, the principle of unbiased thought has won out, and most people are willing to pay lip service to this principle." This is form not substance. But, as I also write in this story, form has meaning even without substance, as it provides the stage for correction. That is my hope in part in telling this story.

The Story: I have included in this story my experiences with the California Department of Water Resources and the California Region of the U.S. Forest Service where together I spent thirteen and a half years. These experiences which preceded the invention of the CRAM pavement provide background to the discovery of important forming concepts: by the technical challenges they offered; and, by the knowledge I gained from these challenges. Additionally, while with DWR, I was able to combine formal studies at the University of California Berkeley and Davis campuses, which allowed me to gain a more complete understanding of the technical aspects of my work.

Also of importance to this story, particularly as I look back on the problems we encountered in advancing the CRAM pavement, were the insights into the bureaucratic structures that were availed to me. Important was the roles the members with their varying characteristics and behaviors played within theses two somewhat typifying but quite different government agencies. A third factor that these experiences first revealed to me was the roles played by the universities in research and development. To assure clarity at the risk of being superfluous, research and development is to bring about improvements to technology and the means by which that technology may be managed.

My singular experience during my government employment with an outside group on the application of research and development was with the Department of Water Resources when it engaged the University of California to aid in developing seismic resistant structures as part of the State Water project. That was a joint activity between the university and the various involved units within the department including the laboratory under my charge. In my opinion, this joint effort resulted in a successful application of the results. What may be most surprising though is the rarity of such contributions in the fruitful advancement of technology. Still rarer have been the individuals that have materially contributed to fruitful technological advancement.

The far more prevalent case is the example exhibited by the Caltrans CRAM pavement experiment. The 1,000-foot segment of CRAM pavement for this experiment was incorporated into a 10-lane-mile road-widening project on I-15 a few miles south of Corona, California in 1987. To state that this short segment of CRAM pavement was a seriously flawed experiment incompetently conducted would be unjust in the mildness of its criticism. In spite of the flawed construction, this short segment of pavement has demonstrated the CRAM concept of a beam-like action and the immense superiority of this action over the conventional pavement behavior; and, in the process, has provided unequivocal evidence of the CRAM pavement's superior performance.

Yet, the Caltrans central laboratory staff members pretend to not recognize this truth; although their recent actions to cover up the evidence belies that pretension. The Caltrans central laboratory was the same group that oversaw and allowed the improper construction and who failed to even remotely accomplish a proper documentation of the work: in the construction; and in a post-construction investigation. But, they have not been alone in their egregious acts!

The Federal Highway Administration, other state departments of transportation and universities have not only accepted erroneous and misleading statements from the Caltrans central laboratory without questioning their authenticity, they have actually embellished these erroneous and misleading offerings to the detriment of the CRAM pavement and the technology which underlies it. Of these, the FHWA is most culpable but not solely from its participation in this experiment through a Federal Highway grant program. More serious was its continual denial to members of Congress that this experiment was flawed. But, the flaws in the CRAM pavement experiment were known to FHWA. Such was acknowledged in an FHWA internal memo, which we subsequently obtained through the Freedom of Information Act.

The Caltrans CRAM experiment on I-15 is not the only demonstration of the CRAM concept of a beam-like action, fortunately. In 1983, the CRAM pavement was constructed for the first time on a segment of the Palos Verdes Drive South arterial roadway in the City of Rancho Palos Verdes, California. This is a small coastal community at the southwest corner of the Los Angeles basin. The construction of this first CRAM pavement was not as an experimental project but, rather, as a full-scale reconstruction of a segment of existing roadway. It consisted of a 10-inch pavement section; this is in comparison to the 22.5-inch section that would have been required had the Caltrans conventional design been implemented.

The difference in cost between the CRAM pavement and the Caltrans conventional pavement was $137,000. The bid price with the CRAM alternative was $255,000 whereas; the bid price with the Caltrans conventional pavement was $392,000. Eighteen years later, the CRAM pavement appears as good as when it was originally constructed. This can only be viewed as a most impressive accomplishment, particularly, when it is understood that the Caltrans conventional pavement normally requires major rehabilitation after 10 to 15 years in-service!

The Caltrans conventional pavement on I-15 required major rehabilitation in the ninth year following its construction. And, in June of 1998, Caltrans contracted a second major rehabilitation; this was only two years after the first major rehabilitation. Clearly, the second rehabilitation was needed. But, it was not necessary to contract it under emergency work order agreements! That emergency work order was only necessary to *quickly* cover the evidence that clearly showed the superior performance of the CRAM pavement! Fortunately, unknown to Caltrans, we had video taped the two pavements the month prior!

But, less than three years later, this pavement again shows serious distress, whereas the CRAM pavement shows no distress. The likely repair of the conventional pavement will again be an overlay. The overlay will also likely be under emergency work order, as they again must quickly cover this evidence.

The Palos Verdes project was commissioned without Caltrans knowledge. Only after the contract for this construction was let did we appraise Caltrans of this new method of pavement construction. As part of that appraisal, they were invited to review this new form of construction. They declined. That may have been fortunate; for when they became involved, they did everything in their power to stop others from using this technology: arguing that the CRAM pavement was experimental; and therefore should only be built in short segments! That was the Caltrans CRAM pavement experiment; a short segment that was neither controlled nor monitored during the construction!

The Port of Los Angeles asked to use the CRAM pavement in 1991. Their facilities are within a few miles of the CRAM Palos Verdes project. The Port constructed the CRAM pavement in a reconstruction of a 25-acre inter-modal yard in 1992. Caltrans was neither aware of this commissioning or of the construction, fortunately. The CRAM pavement for this project included a variation from the Palos Verdes project in consideration of the need to support parked loaded chassis and heavy top-loaders. It was 15 inches thick and was placed in lieu of a conventional 24-inch pavement section.

In the course of supporting the heavy top-loaders, the CRAM pavement at the Port of Los Angeles inter-modal yard has been subjected to a far more intense usage in its nine years than most freeways in their normal 20 year design life. The top-loaders are sophisticated forklifts that carry whole loaded truck containers and move them about the staging area. The Port's material engineer correctly testifies to the superior performance of this pavement over their conventional pavements.

The construction and the performance of the CRAM pavements for both the Palos Verdes and the Port of Los Angeles projects were thoroughly documented, as is appropriate when a new product is put in service. Additionally, this information has been wholly analyzed, in accordance with well-established principles of science and engineering. It is from this documentation and analyses that the strong claims about this new pavement arise. Although, simple observations of the construction and performance are often sufficient to draw many of the same positive conclusions that we have placed in the form of claims.

In spite of our excellent technical accomplishments and our marketing efforts, our opposition has remained successful in preventing the CRAM pavement from coming forth. Caltrans was the first to block this advancement shortly after the CRAM pavement was offered with a considerable monetary savings on the Irvine Boulevard project in Orange County, California. Caltrans drew additional support for their egregious action from a university group that chose dogma over established scientific knowledge.

Given the blind reliance that local agency staffs have on Caltrans certification of a new product, Caltrans mere treatment of the I-15 project assured blockage on any local government projects. These include the many streets, roads and parking areas that are such an important part of urban land development: projects that are financed fully by the private sector and, which constitutes the great majority of new pavement construction. The added cost in the construction of these flawed designs is passed directly to the future occupants, many are future homeowners. And, the excessive maintenance and reconstruction costs are later spread amongst these owners as well as the road users in various forms of higher taxes.

The success of the Port of Los Angeles project in its unique usage suggested inter-modal yards as an important marketing avenue for the CRAM pavement. However, here we also met an illogical resistance, not to dissimilar to that which we encountered with local government staffs. And, in the process, we again drew the bias of the university professors. In these large bureaucratic organizations, that was almost sufficient to prevent the CRAM pavement from coming forth in this market as well, but not quite! The tentative acceptance of the CRAM pavement by the Port of Portland would have been a break in this resistance, which could not be allowed by our opposition. They had their own spies.

Why this seemingly unfathomable opposition, when these ideas portend such value to the national interest? That question has answers in the stories of past inventors and discoveries that have brought forth ideas of great value to our society. The examples I have chosen, Charles Kettering, John Ericcson and Galileo Galilei, express these answers through their experiences. But, also, the answers are evident: in the relatively easy successes enjoyed by Charles Kettering in contrast to that of John Ericcson's belated success with the Monitor, the latter, only in consequence of the exigencies of war; and in the life imprisonment of Galileo. Kettering and Ericcson's stories are also important in how they relate to and contrast with mine.

Galileo's story shows that our experience is far from unique in demonstrating the extent this form of opposition is willing to go when having a fully authoritarian power behind it. The opposition faced by Galileo brought forth the evils that culminated in his trial and conviction solely in consequence of the threat they perceived from his ideas. Their objectives were clear: if they could not destroy his ideas, then they would destroy him. And, since they could not disconnect him from his livelihood, hard though they tried, they must destroy him through the then ultimate ruling authority, the Catholic Church. The similarities between our story and Galileo's are uncanny.

Galileo's story is fittingly introduced by our submittal to the National Institute of Standards and Technology. It brought forth: the most glaringly flagrant of the reviews by a university professor; blatantly erroneous testimony before the Oregon State senate transportation committee by the State DOT; and the duplicity of an Oregon State University researcher and a local agent of an asphalt pavement association. The latter were acting to forestall the Port of Portland from using the CRAM pavement. Those acts drew Caltrans most recent lies to assure the Port of Portland CRAM pavement remain forestalled.

Since our livelihood is our daily work, the more we are drawn into other frays without money, the more damage we incur onto ourselves, not a great secrete to our opposition. Their goals have always been clear since our involvement with Caltrans during the conduct of the CRAM pavement experiment: to have us set aside our goals with the CRAM pavement or face financial destruction by preventing us from obtaining any money, either through sales or government research funds. These were both easy chores on their part. But the latter was particularly so as all of our opposition either are bureaucracies of the state highway agencies and the Federal DOT or university professors. The latter do not simply associate closely with the former who control the government research funds but in fact participate directly in the decisions on the disbursement of these funds, most of which goes directly to themselves.

Book Content: This story is told in six parts. The first three parts describe the scientific background to the CRAM pavement invention, how the invention came about and our early success in bringing forth the first CRAM pavement for the City of Rancho Palos Verdes. The next two parts chronicles our many efforts to bring forth this technology and the

actions by government officials and their associates, many professors at the universities, that thwarted these efforts. In chronicling these events, I describe my technical experiences that led to other discoveries including the invention of the CTS Retaining Wall and the improved CRAM pavement at the Port of Los Angeles. The final part tells of the three past discoverers and inventors: Charles Kettering, John Ericcson and Galileo Galilie and how their stories relate and contrast with mine.

Part I provides a brief chronicle of my seven years with the Department of Water Resources State of California soil and rock mechanics laboratory but mainly describes the laboratory science and technology which was based on the fundamental discipline of soil mechanics. Chapter 1 provides a narrative of this period that began in the spring of 1964: the first year as a laboratory engineer; the next three years having technical and administrative charge of the more technical tests under the laboratory's charge; and the last three years as the laboratory supervisor. Certain of my experiences from this acquaintance with government organization during this period are also part of this chapter.

Chapters II and III describe the scientific concepts moderately different than as commonly presented in most textbooks on soil mechanics so as to emphasis attributes that make evident their important scientific underpinnings to pavement engineering and to the CRAM pavement invention. The pioneering work with liquefaction of soils under my direct supervision at the DWR laboratory is particularly relevant to the behavior of dis-aggregated materials whether they form the base of the pavement structure or an important ingredient in its manufacture. In consequence, the liquefaction of soils and the factors that influence this phenomenon are discoursed on to a moderate extent at the end of Chapter III.

Part II introduces the Geotechnical and Materials Engineering Branch of the California Region of the U. S. Forest Service where I spent the next six years and where I was introduced to the most advanced concepts of pavement engineering. This association began in the fall of 1971 and was a major change in my professional activities and experiences. It exposed me to a wide variety of engineering projects and to all of their different aspects of engineering: investigation, design, construction, and, in many cases, to evaluations of their performance, the latter often after it was discovered that the performance was less than satisfactory. I tell of this introduction in Chapters IV and V and include a tale of my first encounter with the despotic Caltrans character.

Though, the majority of my work with GME was in geotechnical engineering not pavement engineering, my introduction to pavement engineering brought forth a strong interest and in consequence, a strong fundamental knowledge of pavement engineering. Much of that knowledge derived from my research into the conventional pavement in response to my first chore in pavement engineering, to deploy the Mechanistic Method of Analysis on a pressing forest service project. That knowledge as it forms the scientific foundation to pavement engineering but also as it exposes the many flaws in its practice is the major topic of this part of this book, as revealed in the next paragraphs.

Chapter VI introduces the conventional pavement structure and brings forth the principal dogma that underlies the pavement engineering profession: that the load-carrying capacity of flexible pavements is brought about by ordering the highest quality materials at the surface and progressively lesser quality materials with depth in forming the pavement section. John McAdams' testimony before the British Parliament and the writings of one of his contemporaries were examined to determine if they provided a genesis to this dogmatic concept. That inquiry brought forth the many problems in design and material quality that plagued the British road building of the early 19th century, in many ways no less so today. These problems are also chronicled in this chapter.

Chapter VII introduces fundamental pavement engineering concepts: relating to the aggregate and asphalt concrete that comprise the pavement structure and the subgrade that supports the pavement structure. The concepts on the behavior of the subgrade soil and aggregates follow from the more fundamental principals of soil mechanics discoursed on in the DWR Experience. Contrasted is how these materials behave in the earth structures that were part of the State Water project and in a pavement structure.

The discourse on asphalt and asphalt concrete is most potent as it brings forth the fundamental properties of these important materials as they impact on the performance of an asphalt pavement. In doing so, unveiled is the critical problem faced by the pavement engineer in his use of the conventional asphalt pavement in identifying the proper amount of asphalt to assure the optimum performance of the asphalt concrete pavement. To use too much asphalt causes the pavement to prematurely rut destroying the ride quality and compromises the pavement's skid resistance. To use to little asphalt causes the pavement to prematurely crack leading to potholes and other distress features. This is the damned if you do and damned if you don't position that the pavement engineer working with the conventional pavement finds himself. It is told in the last section of Chapter VIII in discoursing on the "rich" and "dry" asphalt concrete mixtures.

Chapter VIII summarizes the Illinois Road Test, formally known as the AASHO Road Test, AASHO for American Association of State Highway Officials. This test performed approximately 40 years ago constitutes the bulk of the empirical database for design of conventional pavements and provides the fundamental data for defining the performance of a pavement system through the present serviceability concept developed as a part of this experiment. It also provides fundamental data on which the performance of any pavement structure can be judged as was used in projecting the expected performance of the CRAM pavement in part from its use in forming the AASHTO pavement design procedure.

Chapter IX describes the AASHTO and Caltrans pavement design procedures, the former reflecting the results of the AASHO Road Test. Chapter X explores results from the AASHTO and the Caltrans pavement design procedures and contrasts the striking differences in predicted life for the I-15 and the Palos Verdes conventional pavements these two different methods project. Unveiled is the still more striking difference between the performance predicted by these design procedures and the actual performance of the I-15 conventional pavement. These striking differences gave rise to the second major dogma that dominates the pavement engineering profession: that the asphalt pavement by its very nature can not be made permanent. The consequence of this illogical dogma, designing and constructing the pavement not to fail but rather to fail, may serve a more sinister basis: poorly performing pavements provide a steady revenue to those in the industry!

Chapter XI introduces the Mechanistic Method of Analysis and describes the fundamental mechanics forming this methodology as well as the engineering behavior of the various materials that make up the pavement structure and the foundation on which it resides. Revealed are the many complexities and problems associated with this methodology, largely in consequence of past faulty research. Chapters XII and XIII further exposes these failings while Chapter XIV discourses on the intelligent use of deflection measurements as pointing the way to removing many of the deterrents that limit the power of the Mechanistic Method of Analysis.

Chapter XIV chronicles a set of experiences that were to provide insight into the CRAM pavement invention and its subsequent improvement. The telling is of the forming of a unique pavement structure in which open graded asphalt concrete was placed directly atop

an asphalt sand sheet, an innovation that was rational in its arrangement of materials. What remained to bring forth the CRAM pavement invention was a recognition of the significance of this arrangement and to identify and adjust the materials to reflect this recognition, as told in Part III.

Part III chronicles the beginning and early years of my private sector experience beginning in early 1978 with my joining Converse Davis Dixon, a private engineering firm in Orange County, California. This period exposed me to some very interesting challenges that led to a series of discoveries and inventions including the CTS Retaining Wall and the CRAM pavement. It also exposed me to a series of projects in which engineering and science play an important role, but inconsequent of our human frailties, these important facets become intentionally confusing thus diminishing their importance to the decision process and in the end their value to the society at large. I tell of two of these events in chronicling this part of my story. Also divulged are insights into the geotechnical consultant's role in urban land development.

Chapter XV describes my final years with the Forest Service and my beginning in the private sector. In describing these final years, I include some of my experiences with government that were prologue to our experiences in bringing forth the CRAM pavement. Converse Davis Dixon, a geotechnical consulting firm, provided me with my first experiences in the private sector and exposed me to the shallow slope failures that were a serious plague on the land development industry in Southern California. In consequence of my background, I was able to apply sound scientific principles that quickly revealed the mechanism controlling the performance of these structures and that pointed to the appropriate technical solution. This investigation, told in Chapter XVI, provides a case study revealing a classical application of science in solving an important engineering problem of social importance.

Chapter XVII describes my beginning in private practice and introduces the reader to an experience that brought forth the CTS Retaining wall but also two projects involving the miss-use of science and technology: in exploring and treating a series of acid soaked petroleum sumps; and a condemnation case. Chapter XIX chronicles the first of these projects. Exposed is the immense waste in consequence of a host of conditions. Greed exercised by land developers and their customers. The failure of the local community leadership to act responsibly in the face of a pressing community problem. And, the most damaging, was the incompetence of the State and Federal governments in technical design.

Chapter XIX describes the condemnation litigation and the problems that lay persons have when required to make judgments on scientific theories mixed with innuendoes and quasi scientific theories, generally having little if any relationship to the subject at hand but do provide a source of confusion. However, it also provides the results of a post-mortem conducted twenty years later that exposed the truth of the conflicting theories. Insights into the behavior of professional organizations are also divulged in this telling.

Chapter XX introduces the CRAM pavement invention. In doing so, it identifies certain aspects that associate with the inventive process including the role of imagination and science, the latter providing a means of foretelling expectations as the invention moves from concept to reality. These ideas are clearly evident in this chapter as the discourse on the CRAM pavement invention unfolds: the science that allows us to understand the behavior of the two most fundamental but important structural elements, the beam and the arch, as they form in the CRAM pavement invention. Also included is the analytical examination of the CRAM pavement and its cost, and ends with the beginning process of reducing the invention to practice.

Chapter XXI describes the Palos Verdes project and in the process describes the turns and twist involved in bringing forth a new invention into the public sector. It also includes additional structural analysis of the CRAM pavement that was chosen as a suitable replacement for the planned conventional pavement and how this suitability or comparative CRAM pavement was selected. The construction of this first CRAM project is chronicled in pictures and words befitting of such a new device. Also chronicled are the non-technical facets that are so much a part of implementing a new device.

Part IV of this story begins with a description of our marketing plan to implement the CRAM pavement but only to be thwarted by Caltrans. Extensively chronicled are the actions by Caltrans in preventing the advancement of the CRAM pavement. As this part of the story reveals, it was not our plan that was flawed, as in hindsight there was little that we could and should have done differently in spite of our failure to achieve even modest success. The cause traces to the comportment of our present governments. These experiences expose the failure of many of our locally elected officials to exercise their responsibilities by deferring to the staffs who in turn defer to the state and Federal governments' staffs.

As such, our experiences with local governments and their failure to act responsibly is also told here, as it was those failures that brought forth Caltrans, first as a reviewer to a local government, and second, in the conduct of the Caltrans CRAM pavement experiment. The abusive actions by this State DOT backed by the Federal DOT and the disastrous consequences to us but far more so to the national interest in consequence of these actions constitutes the center of this part of the book. This part ends with a brief discourse on the research arm of the pavement industry, exposing its large draw on the public funds as a main cause in its continued action to prevent the advancement of all but the most trivial of technologic improvements.

Our marketing plan is told in Chapter XXII. It involved an extensive effort including preparation of an in-house technical publication, a technical brochure, a technical slide presentation and the hiring of a reputable and experienced marketing director. It also included appraising Caltrans central laboratory of the CRAM pavement, and its technical facets and merits. The outcome of this appraisal at this point was most favorable, on the surface, and resulted in the first formal field tests of the CRAM pavement.

Chapter XXIII chronicles the Irvine Boulevard project in Orange County, California, the first offering of the CRAM pavement after the completion of the Palos Verdes project. Contrary to our experience on the Palos Verdes project, where the decision on the CRAM pavement was made by elected officials, here in the administrative bureaucracy of this much larger local agency; the elected officials deferred their responsibilities to the staff. This deference of responsibility, as we were to discover to our dismay but to the much greater injury to the public, was now the norm. It is chronicled in certain detail here, as is the role Caltrans played in its first effort at blocking the CRAM pavement. What was foregone was a cost of $267,834.70 for the CRAM pavement in place of $497,971.63 for the conventional pavement, which, as also shown in this chapter, quickly required major rehabilitation!

Chapter XXIV describes the process by which Caltrans blocked the CRAM pavement on the Irvine Boulevard project including the offering of a report by researchers from the University of Kentucky. The Caltrans and Kentucky reports are examined here with their flaws exposed. But those flaws, glaring as they were when exposed to sound scientific knowledge, much reported by the South African Council for Scientific and Industrial

Research, since acknowledged by the Federal DOT as foremost in pavement research, carried the day as they remained hidden from public view. And, they successfully forestalled the advancement of the CRAM pavement. This is also told here, as is the SACSIR research important to projecting the expected favorable performance of the CRAM pavement surface layer.

In Chapter XXV, I tell of other new technologies that we had important involvement in. As I relay here, after Caltrans egregious acts on the Irvine Boulevard project, there was little we could do but wait on Caltrans to continue their facade of pretense of allowing a new technology to come forth into the highway industry in which they could not claim title. But, having still to make a living, we were fortunate to associate with a group from Texas marketing an application of Halliburton's Jet-grouting process. This led to our Diaphragm Anchored Slope Stabilization system, a unique device for improving unstable ground. This usage also portends many other beneficial applications in Civil Engineer. Also described is our advancement of the CTS Retaining Wall during this period.

In Chapters XXVI and XXVII, I tell of the Caltrans CRAM pavement experiment on I-15 south of Corona, California, in large part through the exchange of a series of correspondence. The first of these chapters exposes the acts of the Caltrans central laboratory that were solely to prevent our participation in the advancement of the CRAM pavement. These egregious acts caused a financial drain on us, hardly a secrete to Caltrans, whose objectives were to become clear, to prevent us from receiving any remuneration from the CRAM pavement. But, we had to endure. And this chapter tells of that endurance if not how we survived. But that too we did. And here I reveal the acts by Caltrans central laboratory to force us to set aside our goals with the CRAM pavement or face financial ruin.

Chapter XXVII extends this nightmare as it records Caltrans actions from being subversive to overt in its attempts to prevent us from advancing the CRAM pavement. The Caltrans post construction investigation of the Caltrans CRAM pavement experiment was the final act in this nefarious series of events. Though, incompetently conducted, Caltrans post construction investigation was sufficient to clearly demonstrate the flaws in their construction of this experimental segment of the CRAM pavement. Together with exposing these flaws, this chapter reveals the superior performance through narrative and pictures of the Caltrans CRAM pavement experiment over the conventional pavement in spite of the serious flaws in the construction of the former.

Chapter XXVIII chronicles a second attempt to market the CRAM pavement to local agencies. This telling gives further insight into the land development process and the large usage of pavements involved in these developments as well as the behavior of local government agencies, in part as they exercise their domination over the developers. Chronicled is a particularly noteworthy episode with the City of Carlsbad over the Palomar Airport road project that brought forth the admission of the blind reliance such staffs have on the sanctions of the higher level government staffs prior to acceptance of new technology. That admission was to the local news media. That episode also disclosed the consternation such confrontations spread amongst these local government staffs, particularly the staff leadership.

Chapter XXIX discloses the small-interconnected group that comprises the highway research group and the funds this group engenders. Those funds likely total into the hundreds of millions of dollars annually. Also disclosed are the lucrative character of these research grants and the failure of this research to provide even a modicum of improvement to the pavement system. The Strategic Highway Research Program is the most memorable example of this sad state of research. It is told in certain detail here with a brief discourse

on the Superpave system, the brainchild of this group that engendered over three hundred million dollars, much of which was as direct payment to them, simply to initiate this flawed system. Unveiled in the discourse on the SHRP research was the lack of a sound scientific method in forming Superpave. But, more importantly was the exposure of the abysmal performance of the nation's highways that traces directly to the gross incompetence of the national highway agencies.

Part V exemplifies the applications of sound scientific and engineering principles in furthering the development of the CRAM pavement, in part through the use of cement treated aggregate. The advancement with cement treated aggregate was conceived first for inter-modal yard usage and draws attention to the utility of this improvement to the CRAM pavement for heavy use highway construction as well. It follows with the implementation and control of the CRAM pavement at the Port of Los Angeles' Yang Ming terminal and the follow-up evaluation of this pavement and the further evaluation of the Palos Verdes CRAM pavement.

The evaluations of the Port of Los Angeles CRAM pavement and the further evaluation of the Palos Verdes CRAM pavement also demonstrates the importance of responding to unanticipated events in experimental evaluations. Such was the case when we encountered workmen repairing a segment of the Palos Verdes CRAM pavement, thus allowing us to assess the different weathering effects on the surface and base layers.

Also chronicled is the further advancement of the CTS Retaining Wall in Mexico under out technical supervision. This part of the story concludes with a selection of inter-modal yard constructions that contrasts the negative consequence of basing technical decisions on political and dogmatic factors rather than sound scientific and engineering principles, as was done in developing the CRAM pavement.

Chapter XXX further explores the beam like action of the CRAM pavement, both from the empirical and theoretical perspectives. The theory is generally basic, for example, including the simple beam theory normally presented in basic engineering mechanics textbooks but most relevant to the proof of the beam like action of the CRAM pavement. This theory is followed by established scientific theories describing the behavior of Portland cement layers and how these ideas prescribe the performance of these conventional pavements but more importantly how these theories give insight into the anticipated behavior of the cement treated aggregate in the CRAM pavement.

Chapter XXXI describes the Port of Los Angeles CRAM pavement: the philosophy behind its design, its construction and its usage and performance. As in the description of the construction of the Palos Verdes CRAM pavement in Chapter XXI, this construction is told from the immense documentation: in the still photos and video coverage as well as the normal construction tests that documented this work. Interspersed here is a brief discourse on the Seagirt Marine project, which incorporated a distorted form of the CRAM pavement. This account exposes the excessive costs in consequence of blindly following a flawed methodology.

Chapters XXXII identifies the formality that forms sound experimentation and applies this formality to an evaluation of the CRAM pavement and similar use conventional pavements with the difference in performance compared in words and in pictures. Revealed is the important role in discovery in recognizing and responding to unanticipated events. The consequence of one of these events was a most compelling proof of the CRAM pavement's beam like action. Remaining to be explored is the ultimate load carrying capacity of the

CRAM pavement. As also shown in this chapter, additional valuable knowledge this facet of the CRAM pavement may be achieved with an Accelerated Load Facility.

Chapter XXXIII provides evidence for our long-term performance claims in presenting the effects of aging on the physical behavior of the asphalt and asphalt concrete. Shown in pictures is the different weathering effects on the surface and base layers comprising the Palos Verdes project after 18 years in-service. This obvious physical difference is supplemented by research reported by the pavement industry on the phenomenological effects from the physical chemistry changes of the asphalt and the asphalt concrete in consequence of aging. The theories described here remain in the physical realm, as a most important quality of asphalt, known possibly from the beginning of the record of history is its sealant character. What we are able to demonstrate, well beyond any reasonable proof is that the base layer in the CRAM pavement does indeed form an impermeable barrier to air which is the catalyst in the destruction of the asphalt concrete in the conventional pavement.

Chapter XXXIV includes, in the sequence of events, the further discourse on the advancements in the CTS Retaining Wall particularly as we have incorporated it into residential construction in Tijuana, Mexico over the past 8 years. It includes the fundamental concepts of retaining wall design and construction, which provides an excellent background in demonstrating the many valued features of this unique form of construction. It also exemplifies the means of product development and the importance of sound oversight in implementing technology.

Chapter XXXV provides an excellent contrast with Chapters XXX through XXXIV that so strongly reflects its title. In Shams in Engineering, I present our encounters of what may be viewed as gross incompetence in the application of engineering principles. But, these applications go beyond that which is engineering to that which is administrative with the egregious tones that seem to accompany decisions in large organizational structures that lack accountability.

The Source of Titles: The title I have chosen for this book, being contentious, warrants explanation. Hopefully, the following paragraphs suitably serve this purpose.

As I began to formulate my notes into the fourth part of this book, I was searching for a title that would appropriately describe the experiences that I relay in that part. I acknowledged this search to Dave Purkis one day. Dave, who has associated with me on my work with the CRAM pavement since his graduation from college in 1983, responded with the word: "Roadblock." That word by itself is most informative as that indeed is what the groups we encountered did, they most consciously set out to block implementation of the CRAM pavement, which has its greatest utility to the national interest in the construction and reconstruction of our nation's roads. Those actions were indeed roadblocks.

When Dave suggested Roadblocks, I was also searching for a title for this book. Roadblocks was considered as one of the words that might form a part of a title. However, what kept running through my mind as I was writing this story and even more so as I was writing Part IV, was the comment by Max Alexander, a senior engineer in the Caltrans central laboratory and who had general charge of the Caltrans CRAM pavement experiment. Max was a paladin with a rather contemptuous nature. Those were undoubtedly characteristics that made him such an ideal choice from the Caltrans central laboratory leadership viewpoint to oversee the Caltrans CRAM pavement experiment. The book title: "We Don't Have To Explain Anything" was Max's contemptuous statement that ended that last conversation I had with him.

Max's statement was in response to a query on my part ending with the phrase: "How are you going to explain this?" I do not recall the exact query I addressed to Max in that last conversation. It could have been one of many as there were many aspects of their conduct of the Caltrans CRAM pavement experiment and the CRAM pavement that the Caltrans central laboratory could not rationally address in their attempt to imply that the CRAM pavement theory was flawed. But Max's statement was so telling of the attitude not only of Caltrans but of other state DOTs and even more so of the Federal Highway Administration and those that associate with them through Federal grant programs. Indeed, the upper staff people at the states and Federal levels of government clearly have the attitude that they do not have to explain anything.

This sinister attitude that is so prevalent in our higher-level government staffs is not without its basis, ominous though that basis may be. That basis, I have concluded, stems from the failure of our elected officials to hold the staffs accountable: to act in reasonable accord with their mission. Our experience has shown us that not only do these officials not hold the staff leadership accountable for their actions; but, they often do not require honest explanations for those actions. That we observed in our dealings with both the states and Federal governments, as told continually throughout this story.

In our strivings with the CRAM pavement, but also in part from periodic monitoring of C-span and other public forums as well as the news media, we have found that our elected representatives at all levels of governments tend to cow before the staff leadership. They complement them for the "wonderful job" they are doing as they approach the facade of an investigation into a department that has clearly abused its powers and acted in obvious contradiction to the elected officials' acts. This they do rather than exercise leadership in accordance with sound democratic principals.

These officials are elected by the electorate to oversee the staffs, to be blunt, to be their boss. That they can hardly do when they clearly evidence a fear of drawing the wrath of the staff management. These fears are real and to some extent understandable though hardly to be argued justifiable in a democracy. The action against Governor Deukmejian by the Professional Engineers in California government chronicled at the end of Chapter IV, though possibly the more blatant, best exemplifies this sinister action. The fact that Governor Deukmejian then proceeded to appoint the Caltrans Director from this group exemplifies also their considerable coercive power!