Journal of Pressure Vessel Technology

# Technical Editor's Page

This issue's Technical Editor's Page presents slightly abridged versions of two featured presentations given at the 1984 PVP Conference and Exhibition held in June in San Antonio, Texas. The first is entitled "The Roles of the Engineer," by H. E. Bovay, Jr., and was the plenary session lecture at the Conference.

Mr. Bovay is a member of the board and executive consultant to Bovay Engineers, Inc., a firm which he founded in 1946. He received a degree in civil engineering from Cornell University in 1936 and was the recipient of the NSPE-PEPP award in 1972, the ASHRAE/ALCO Medal for Distinguished Public Service in 1971, and the Toulmin Medal by the Society of American Military Engineers. He is a member of the National Society of Professional Engineers, Texas Society of Professional Engineers, and a Fellow of the Texas Engineering Foundation. Mr. Bovay is also a Fellow of the American Society of Civil Engineers, a Life Member and Fellow of the American Society of Heating, Refrigerating and Air Conditioning Engineers, a member of the American Road and Transportation Builders Association, American Concrete Institute, American Wood Preservers Forest Products Manufacturers Association, Tau Beta Pi and the National Academy of Engineering.

The second article is by A. O. Schaefer and represents a response given by him upon receipt of the 1984 Pressure Vessel and Piping Medal. His presentation is entitled "Materials, Properties and the Engineer." Mr. Schaefer, first executive director of Metal Properties Council, received the award "in recognition of over 60 years dedicated to the advancement of pressure vessels and piping technology, through his contributions and leadership in the fields of alloy production, vessel fabrication, codes development, standards development and sponsorship of materials research programs."

Mr. Schaefer received a B.S. in Chemical Engineering from the University of Pennsylvania in 1922. He began his career as a research metallurgist with the Midvale Company, Philadelphia in 1922. He later became vice president in charge of engineering and manufacturing. He was president and chairman of the board of Pencoyd Steel and Forge Company from 1956 to 1959 and held the position of vice president for metallurgy at the Struthers Well Corporation from 1960 to 1965.

Mr. Schaefer is active in the Pressure Vessel and Piping Division of ASME and was chairman of the Boiler and Pressure Vessels Committee's Subgroup on Castings, Forging and Bolting. He is a Fellow of ASME; a Fellow and honorary member of the American Society for Testing and Materials and the American Society of Metals; and a member of Theta Chi, Sigma Xi, Sigma Tau, Alpha Chi Rho, and Alpha Sigma Mu. He received ASME's J. Hall Taylor Medal in 1978. Mr. Schaefer is also the author of numerous papers on forgings and standards and holds patents for applications for special steel melting and metal for use at elevated temperatures.

**G. E. O. Widera**

## The Roles of the Engineer

**by H. E. Bovay, Jr.**

I'm honored to be your speaker at the plenary session. It is my desire to distill from my 50 years in engineering some ideas and challenges for us to consider and discuss as we face the future.

We have all agreed that the world is no longer flat and that our recognition of being a part of the universe and of the new frontiers of space, nuclear energy, communications, and other important affects on our lives provides all of us with real challenges and opportunities.

Most important for the future is the need for us to find a way for industry, government, professional organizations, universities and the public to work together as partners toward common objectives.

Engineers have a great and continuing need for communication. This becomes more important as time and an increasingly complex civilization has taken us from the beginning of the ASME Boiler Code—100 years ago—to the remarkable world in which we live today. The Engineer has become indispensable as the scope of engineering activity reaches all phases of living.

From 100 years ago—probably even from the beginning of time—mankind has used an engineering approach to lead the world into an orderly beneficial progress to make the world a safer, easier, happier place to live by applying a simple belief I have always had: that if an engineer can define a problem, he can solve it.

Expanding this principle into our complex world today leads us to the realization that engineers must take leadership roles in their technical abilities, profession, communication, and service to their fellow man.

We have at this meeting today an exceptional opportunity to consider the broadened scopes of the profession, and some important situations demanding this leadership.

This applies to engineering issues and to public issues. We must be concerned and furnish understanding and leadership for questions on energy, food, water, environment, armaments, industrial safety, infrastructure, health care.

Actually, the Boiler Code is a good place to begin any look at our profession. The code neatly symbolizes our contributions to society. ASME can be proud indeed of its "Century of Progress Through Voluntary Action."

Arthur Greene of Princeton University, an honorary ASME member, wrote in 1952: The ASME Boiler Code arose "in the fullness of time." It came from the rules, regulations and laws set up over more than 50 years before it was first published in 1914.

To appreciate the significance of the code, one needs only to recall some history.

Greene traced steam power from the writings of ancient authors, including Hero of Alexandria, to modern engineers. These included Edward Somerset. He produced a pump using steam from a boiler in *1663*.

Thomas Savery, in his patent of *1698*, made further refinements in steam power. The Savery boiler was cylindrical with dished heads. This provided a safer more economical pressure vessel for steam generation. Steam discharged from water in a vessel was forced into a vertical pipe leading to a delivery point at a higher elevation.

This primitive device was the first practical steam engine and it was applied usefully in a number of mines. Other historical giants include Thomas Newcomen and James Watt. Watt made an engine with a separate condenser based on a Newcomen model.

Technological improvements were followed by improvements in safety standards.

There was the work of the Franklin Institute and the passage of the federal act of July 7, 1933. This act provided "for the better security of the lives of passengers on board a vessel propelled in whole or in part by steam."

The Hartford Steam Boiler Inspection and Insurance Company was founded in 1866. Later the Fidelity and Casualty Company grew out of the 1876 organization of the Knickerbocker Plate Glass and Accident Insurance Company.

Insurance companies were kept busy in those early days.

Many terrible boiler explosions were reported in America and Europe during the 19th century. Operators were careless with safety valves and negligent about inspection.

One of the worst disasters in the 1800s was the explosion on the steamboat Sultana. About 1500 people died on the Mississippi River above Memphis on April 27, 1865.

Deaths caused by boiler explosions in the United States totaled 441 in 1868. The number remained high until about *1909*, when it began tapering off. It declined to *115* per year by 1932. Of course, 115 lives lost to boiler explosions is 115 too many. The ASME acted.

The result is extraordinary: We don't kill people with boilers anymore, even though boiler pressures have gone from atmospheric pressures to as high as 3500 psi.

Certainly, we would have never achieved the present-day standard of quality and safety without better overall knowledge of this complex subject on the part of many many engineers from all disciplines making a major contribution to the world we live in, including better metals, better metallurgy, better welding procedures, better stress relieving, better water treatment, and better control systems.

The first boiler code had 114 pages. Today's code is a 3 or 4-in-thick volume.

In the last century, technology experienced a Golden Age. The engineer was part of our society's great gains in personal freedom, health and living standards.

Poems were written to bridges . . . songs celebrated dams. One writer said about the Panama canal: "The tribes of men are led toward peace by the prophet-engineer."

Technology as king was dethroned in the fifties and sixties. Rachel Carson, in *Silent Spring*, said we poison birds. Ralph Nader said we design to kill. A generation of intellectuals said we planned obsolescence. Even our last great love affair with technology, the moon race, sparked complaints.

"If we can put a man on the moon," some people said, "why can't we rebuild our cities?"

Or feed the world?

Growth and technology, I'm convinced, will solve these problems. Yet we remain in a highly skeptical time. Many influential opinion leaders scorn the fruits of our profession.

Yet I'm excited at the prospects before us, too . . . *if* we can show our publics the true picture of the benefits of technology.

We have grand opportunities in many fields . . . including water resources, waste management, energy resources, food supplies, information, communication, transportation, health care and medical technology, sophisticated armaments, and infrastructure.

Each of these challenges require a more active social and political involvement by engineers.

Public understanding will be essential to us. We must communicate our ideas so that public will support, and use our leadership. Many engineers are already aware of these social obligations.

I saw an example of this at the National Academy of Engineering symposium of June 30, 1983. Let me read the following from the symposium:

> "No technological issue is more prominent today on flickering television screens or in the columns of magazines and newspapers than the effect of technological change on employment . . .
>
> "The nation is presented with a dilemma – long lines of unemployed workers released from declining industries while the automated factory of the future complete with robot takes form. The indication is that, to remain competitive, U.S. industry will need to continue to automate. But changes can mean loss of jobs. The dilemma becomes reality . . . ."

The symposium statement goes on:

> "Some see an era of limited work availability and a need to share jobs with a concommitant increase in leisure activities. Some see high-technology America as a service society. Others take the view that the United States, as a great power, cannot afford to be predominantly a service society because it cannot be dependent upon other nations for its basic industrial output . . .
>
> "What is necessary is an improved understanding of the processes at work so that public policy formulation can take place with an improved understanding of possible outcomes," the National Academy concluded.

In November the National Academy technical session also had full and searching sessions on computers, on advances in structural materials, on new frontiers in biotechnology, and in transportation technology.

These are examples of how engineers can contribute, not only as individuals, but as groups and as societies and academies toward informing the public and furnishing strong leadership.

Engineers must take an active, dynamic role to encourage government at all levels to apply the best, most cost-efficient technology to our problems on a timely basis.

We need to be more involved, more active, more persuasive. As some of you know I have worked for many years urging a defined National Energy Policy. We engineers are missing a golden opportunity to lead the development of our nation's energy policy. The United States is not prepared to solve its energy problem. The annoyances and ill tempers of the gas lines a few years ago are just a dim memory today.

Recent attacks on oil shipments in the Persion Gulf underline the Western World's vulnerability to another oil shortage.

We're in bad shape if another disruptive energy crisis develops.

A new book by the Research Council says our energy policy ignores the complexity of individual and organizational behavior, and treats energy as just another commodity.

One major problem, the book argues, is that energy policies have been based on the notion that energy users – individuals and organizations – will act in their own economic self-interest. This is not too bad – oil consumption did drop when prices soared. But it is simplistic. It is little help in formulating policy . . . or in fine-tuning emergency responses.

Remember the free energy audits offered by many utility companies across the country? Widely promoted with no strings attached, the audits would seem to be too good to pass up.

But acceptance rates have been in the neighborhood of 2 percent to 5 percent, leaving the experts bewildered.

Why would people turn down an apparently irresistible offer of something for nothing. Does this mean energy users are irrational? No.

One analyst describes the problem as invisible energy. You and I turn off lights in our houses. But lightbulbs consume little energy. Far more is lost in inefficient water heaters, or poorly insulated attics.

We often aren't bothered by what we don't see.

Even more important is the matter of world population and food supply.

Many prolific nations have already attempted public birth control programs – India, Pakistan and Korea. Their success has been questionable.

Historically, birth rates slow as a country's standard of living rises. Several Third World authorities say it is not realistic to expect a decline in birth rate until a higher standard of living is achieved.

We have a Catch 22: low living standards produce high birth rates, and high birth rates keep the standard of living low. So when we consider food, we must remember the supply must grow for population to grow.

Engineers throughout this process are often silent. Why?

Maybe some of us don't get involved because infrastructure or food production or energy consumption isn't our specialty.

Perhaps some of us think it is a conflict of interest.

So we do nothing.

Yet who is more qualified than an engineer when we're talking about infrastructure? Who can devise the best, most cost-effective solutions?

Every city council should have an engineer as a council person.

We should vastly increase our political lobbying efforts, make more effective use of political action committees, and state our case honestly and openly to the American people.

The popular book, *Megatrends*, reminds us of our world trade deficits of more than 100 billion dollars per year, our need to rebuild infrastructure and the structural changes in our economy.

As Ted Turner puts it, "Action today should come from anticipating tomorrow's trends." And I have said that "People do not know what they want until they know what they can have." Who can explain this better than the engineer?

Jack Green, the President of the Texas Society of Professional Engineers, in one of his editorials, quoted John Kennedy. "We would not be able to meet the challenges of the modern world were it not for the trained engineers who develop and build the products and systems that contribute to the welfare, safety, and advancement of all Americans. Our engineering capabilities are crucial, not only to the progress of the United States, but to helping others achieve their hopes for a better and fuller life in freedom."

Last year, in his Star Wars speech, President Reagan renewed our country's commitment to technology and education.

The chore of educating enough engineers to process all our new knowledge is formidable. Between 6000 and 7000 scientific articles are written every day and technological information doubles every five years.

Current high school graduates do not have the intellectual tools for this changing society. This is the first generation to graduate less skilled than its parents. Engineering societies are trying to cope with this situation. For example, ASME efforts with high schools and NSPE math counts programs.

We must prepare ourselves to handle new methods in technology in all areas of engineering by researching and studying the best possible solution for each project.

I've said before, if industry acts before public opinion is aroused, it can often save itself considerable expense and achieve a more respected standing in the community.

This is a sound engineering principle: Determine the facts. Then take action to improve future operations.

This is surely the best public relations practice an industry or a profession can achieve.

Engineers are highly respected by the public because of our ethics and our dedication to society. We need to use this good image and our excellent minds to lead the public toward better life.

Peter Drucker says:

> "The effectiveness of the engineer depends as much on his ability to make other people understand his work as it does on the quality of the work itself.
>
> "We must force ourselves to organize our thoughts to be economical with language, and to give meaning to every word.
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> "We must work at this by participating in meetings, giving talks, writing papers, and carrying out all forms of communication available to us so that our publics really do understand how we fit into society. This is the only way we will obtain public understanding, acceptance, and support."

Engineers are influencing everyone, whether we realize it or not. Let's consider the word infrastructure. That was our word for many years to denote the transportation, utility, and other systems which make up a modern civilization. Now politicians are using it to describe their goals for their countries. Lawyers are using it to interject themselves into the public awareness. Its use by other professions makes me realize what an impact the engineer has on the world.

Other professions may play with the word.

Engineers work in a real world.

In this real world, streets and sewer lines are collapsing, bridges are falling apart, transportation systems are crumbling.

We all know that new technology doesn't come cheap. In the next 10 years, according to one estimate, U.S. corporations will require more than three *trillion* dollars to pay for new equipment. Paying for new technology and other essentials will strain capital formation resources. Technical decisions facing top managements will be inextricably linked with those of corporate development, growth, innovation and, in fact, survival itself.

From my vantage point, I can see technological changes ahead. There will be new and increased managerial challenges and opportunities for top management. It is timely that we engineers focus attention on the technical decisions that must be treated as corporate decisions by top management.

It is also timely for us to make sure the American public and the political leaders of our country also realize this: These technical decisions affect the political decisions of our nation and our leadership of the free world.

Again, our role is evident.

In the United States engineers are nomadic educated professionals. This is good for accomplishment and for world leadership. Now we must add to our stature by being more active in the leadership of business and government.

We should learn to speak in one voice on some issues. There are more than 100 engineering societies. Can you believe that? No wonder we can't speak in one voice, even on major issues. We're too fragmented.

As Winston Churchill said in the years before World War II, addressing the British Parliament, "If you will not fight when you can easily win, the day will come when you must fight with all odds against you and your chances of survival are small." This is a fight for natural resources and economic security we can win, but the time to step forward is now so that we won't have all the odds against us and so that our chances of survival won't be small.

We should promote a stronger, more centralized professional organization to serve all of us . . . and serve our nation, too. The same spirit in which we developed the Boiler Code should be applied to other pressing issues.

Before Franklin Roosevelt was elected president of the United States in 1932, our nation did not expect or receive strong federal financing and management of our infrastructure. Highways were built by cities, countries, and states. Bridges to connect them were paid for by collecting tolls.

We should consider returning to fundamental approaches in each locality.

Another suggestion would be to move all the departments of government, except State and Defense, to cities around the country, where their personnel would work under the watchful eyes of the citizenry. The first thought that might occur to you if such a plan were to be adopted, would be to move the departments to our largest cities; for instance, Commerce to Chicago, Treasury to Atlanta, Interior to Denver, Energy to Houston and Agriculture to Kansas City. It might be wiser to move them to smaller cities, where they can be watched even more closely by interested observers and their every action reported in the local press.

Perhaps we ought to get involved in international trade issues.

No area of our society or our political system should be off limits to our creativity and our honest and ethical concerns.

Despite nuclear warheads, food may be the ultimate weapon. The engineer is the hope for the future in this regard. We must use our ability to improve lands, drainage and water supply. Our involvement in genetic engineering can increase food production.

You have seen and felt my enthusiasm for engineering. I dreamed of being an engineer when I was six. I have the privilege of 50 years in the profession. Now I have the honor of standing before this outstanding organization, the ASME Pressure Vessels and Piping Division.

Inscribed beneath Robert E. Lee's bust in the Hall of Fame are the words: "Duty is the sublimest word in our language. Do your duty in all things; you cannot do more. You should never wish to do less."

I'm sure you feel just as Lee felt. I know that you, in taking up the challenge from one generation to the next, will build on our foundation. You have the talent, ability, dedication and ethics to make this happen. I look forward to enjoying your successes.

## Materials, Properties, and the Engineer

**by A. O. Schaefer**

After spending 44 years making steel forgings and castings and pressure vessels and piping, it seemed natural to become active, during so-called retirement, in an organized attempt to understand the properties of the materials engineers use, and to improve the understanding between engineers and materials experts. This last includes both metallurgists and materials scientists, which makes it a pretty good trick in itself. It has now been 18 years since I started this. The Metal Properties Council was incorporated in 1966.

Of course, the serviceability of pressure vessels and piping, just as any other engineering structure, depends upon their being properly made and fabricated of suitable materials. Finally, and very importantly, they must be properly used. All elements in this team effort must contribute their knowledge, expertise, and conscientious attention. All must assume liability for success or failure, and not look to blame the latter on somebody else. A very important factor common to all of these elements is knowledge of the properties of the materials from which pressure vessels and piping are made.

The knowledge of the properties of materials is one of the most important things in the world because almost everything we make or use depends upon materials if it is to function. Some years ago it was common to see in many offices dealing with tool steels, a steel engraving of a picture which depicted the toolmaker sitting on the throne in the completed temple of Solomon. His justification was that no one who contributed to the building of that great edifice could have done anything without the tools he made for them. Solomon agreed with him, and let him sit there.

If Solomon were alive today, he might have carved on the great walls of his throne room the admonition to strive to understand the materials you must use.

This is of tremendous importance, particularly today, for three very good reasons:

1. We are demanding more from materials. Modern science and engineering utilize components and structures which are not only stressed beyond former limits, but are subjected to a bewildering variety of environments including atmospheres (liquid and gas), extreme ranges of temperatures, pressures, causing gradients and cycles.

From our venturing into space and in our success in harnessing the atom, as well as by drastically changing concepts of product liability, we now must have complete reliability. Human lives, often a great many human lives, may be at stake. Failure cannot be allowed to happen. Over-design is, of course, self-defeating in a competitive world.

2. Materials are changing. The disposition of ores throughout the earth's crust is being further revealed by modern geology. That disposition in a number of cases indicates problem areas and difficulties. There are economic problems which are self-evident. The nations of the world, as now constituted, must consider this distribution of raw materials from strategic veiwpoint as well as from an economic one. The United States, for example, has ample resources of molydenum; but it has practically no chromium. Chromium has become well-nigh indispensible in the production of heat and corrosion-resistant alloys.

For many years, the steel industry in the United States enjoyed copious quantities of superb iron ore in the haemetite deposits of Minnesota. The best of these vast resources have now been used, and the ore extracted from these mines must be processed to enrich it before it is economic to feed it to the blast furnaces or other prime processes for extraction of iron from ore. Much of the steel industry in the United States utilizes ore imported from South America and Canada. Aside from the "mini-mills" which live on scrap metal, the few steel mills built in the U.S.A. in the last 25 years have been built in seaports on the East Coast.

Geographic distribution of raw materials accounts for strategic considerations in the utilization of materials as well as economic factors of importance.

Aluminum is perhaps the most generously distributed metal, but present processes demand bauxite ore and in the United States we import that. Aluminum ore in the United States is almost entirely of the clay and Kaolin variety. Recovery from this is not economic at this time.

These are two examples of the changing world of metallic ores which will serve to illustrate the point. Ore from different locations in the world contain other elements in varying degrees, some of which may end up in the steel, and hence affect the properties.

Within the last several decades we have witnessed great changes in the manufacture of metals from ores. Here is a second course for changes in the properties of steels. Continuous production of steel from iron is predicted and is demonstrably possible. It is not yet economic, but the historic blast furnace has been replaced in some plants. The open hearth has almost disappeared in recent years as steel is made by other processes, not only better economically, but better with regard to the quality of the product. Vacuum treatment of molten steel has helped eliminate some impurities in addition to gases.

Electrolytic extraction of aluminum from fluorides appears to offer savings in the vast amount of electric power required by the classic Hall process to accomplish the same thing.

Continuous casting has become common, particularly in steel and aluminum. Various improved electric methods of melting have contributed to modern steel making.

The point that I wish to make is that the utilization of formerly unmined ores, the changing, melting, and refining processes all have their effects on the properties of the product that engineers use. This is not always apparent in the well-known characteristics of the metal such as hardness or tensile strength. The subtle, but important differences become apparent only as we test for the more sophisticated properties and methods of testing – properties at elevated or cryogenic temperatures, corrosion and erosion properties, fatigue, fracture toughness, etc., including fabricability, weldability, machinability, etc.

3. Methods of testing are changing, and new tests are being developed. Testing equipment today is far different from that used 60 or 70 years ago. Tension-testing equipment in those days was an entirely mechanical process. A load on a specimen was balanced by weight on a scale beam. A skillful operator could spin the wheel and the weight would move out on the beam at pretty nearly the right rate as the specimen was subject to increasing tensile loading. A quick eye was needed to read the scale when yield and rupture took place.

The notched Charpy test remains a practical but not at all scientific means to measure fracture toughness in steel. Correlation between laboratories some years ago was not good. Much of this was due to the method used to machine the notch, but also a large part was due to other factors in the test machine setup. A team from Watertown Arsenal made a major contribution some years ago in setting forth a means of calibrating Charpy test equipment – alignment, foundation, weight, etc. Instrumented Charpy tests are even more repeatable.

Elevated temperature creep testing has been improved by more uniform heating of specimens, by greatly improved temperature measurement, by better alignment and by accurate strain measurement. A prominent investigator in creep characteristics once remarked that existing creep data should be replaced every 10 years.

There has been continuous progress in the measurement of fatigue characteristics of materials, and of fracture toughness.

Already there are signs of more fundamental change in the concepts of just exactly what are engineering properties of materials, how they can be measured, how they can be used.

We refer glibly to the tensile strength of steel, but we really are speaking of the numbers we get from a standardized test specimen which is removed from a stated location in a piece of steel to be tested and which is stressed to rupture in one of several conventional types of machines. Disregarding such details as alignment, rates of strain, surface condition, the conventional test specimen doesn't always fail in the same manner (crack initiation may be external or internal) and stress and strain distribution vary in specimens as the test progresses depending upon such factors as the surface condition, the size of the specimen, the microstructure, irregularities in the metal, etc.

Yet tensile strength is considered one of the simplest and best understood properties of engineering materials.

Incidentally, there are few failures in service due to simple overloading or overstressing.

The test specimen we use may or may not truly represent the component or part in which the material is used. The matter of test bar location and orientation is not too impressive in this respect considering that distribution of properties in large masses depends on a complex manner upon a number of factors. At best we provide the engineer a comparison of the results of several conventional tests with results obtained in a similar manner from other material, including that on which there is previous experience.

Two good examples of materials admittedly needing better means of appraisal are casting and weldments. Metal may be cast in such a manner that it is sound, dense, and free from impurities. Effective heat treatment can result in microstructure that is reflected in excellent known materials property characteristics. Many castings, particularly those of large size, are complex in that they contain sections of differing thicknesses, which can be fed by the molten metal at differing rates, and which solidify at differing rates. While modern nondestructive testing, it cannot, at least yet, provide structural information which can be interpreted as indicative of mechanical properties.

There is a hope that in the not-too-dim future, such nondestructive methods can be used to provide information about the structure which will meaningfully supplement the information we get from our conventional tests. In other words, there is hope we may some day know actual meaningful characteristics of the materials we are using of extrapolations from the results of conventionalized testing.

Another common example of the shortcomings of our present techniques is provided by weldments. The historic test of a weldment is provided by tests taken right across the weld. About the only genuine piece of information obtained from breaking such a specimen in tension is the relative strength or weakness of the three recognized zones of metal – the base, the heat-affected zone, and the weld method. Perhaps the fusion line or surface provides a fourth.

So, here is a summary of our insecurity in a changing world. Metals (or materials) will be made by evolving processes from changing raw materials. Improved testing methods will give us more accurate (?) data on conventional as well as newly developed methods of test selection and conduct. We are searching for better ways to express our concepts of the properties of materials.

In recent years, in the steel world, we have learned of the far-reaching effects of some elements in small quantities. Copper in steel contributes to embrittlement when the steel is exposed to irradiation. Sulfur and hydrogen are undesirable in most steels, but particularly in turbine and generator rotor forgings. Nitrogen, boron, arsenic, selenium, tellurium, and other elements have adversely affected some of the mechanical properties of steels. High-strength, low-alloy steels are based on the effectiveness of a pinch of this and a pinch of that.

Widespread use of the spectograph has opened the way for analysis of steels including determination of more elements. Increased use of scrap, use of ores from new sources, have resulted in increasing the "incidental alloying elements" present in steel, particularly in that coming from the burgeoning mini-mills.

This all points to the need for a lot more knowledge and reliable data than we have right now. We can all be thankful that, at this critical juncture in the history of materials, along came the computer which we can hope will enable us to unravel it.

We all have a part to play in generating valid and meaningful data as needed in our fields of interest, in evaluating and interpreting that data so that it may be properly used, and in contributing that data to the world to make possible meaningful appraisal.

For many years we have heard of the world's tremendous losses due to corrosion. Recently some attention has been given to the extent of our losses due to other reasons. A figure attributable to John Rumble indicates 1982 losses in the U.S.A. alone due to fracture as almost 120 billion dollars. It is estimated that over 50 percent of that could have been saved by a better knowledge of materials and utilization of the knowledge we already have.