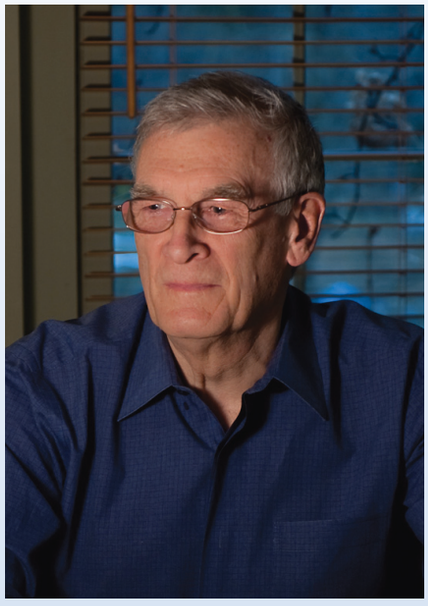
This feature in *MP* highlights experiences, opinions, and advice from NACE International's Fellows, who are honored for their distinguished contributions in the field of corrosion and its prevention. NACE Fellows make up a broadly based forum through which technical and professional leaders serve as advisors to the association. This month, *MP* is pleased to publish the contribution of Peter Elliott, FNACE, who was named a NACE Fellow in 1998.



The Human Factor

Like many corrosion technologists, I first became aware of corrosion when something failed! Taken for granted—at that time—were facts that stainless steel solved all problems and that a good coat of paint hid everything it needed to, notably the rust that was fast destroying the underlying steel product or the car. Cynical? Maybe. But in reality, corrosion control requires more than an awareness to corrosion; it requires a willingness—no, a necessity—to take appropriate action at the correct time. The human factor plays a significant role in materials performance or failure.

There are strong parallels with the medical profession; procrastinating or avoiding regular visits with a doctor reflects a lack of real-time monitoring. Prescribed (and taken at the right time) medications (chemical inhibitors) can effectively control a system. Surgery and joint replacement (cutting, welding, and inserting new materials) are more desperate but necessary measures. In the absence of awareness, good communication, and correct actions, it is sometimes too late to do anything—except address the consequences (Figure 1).

During the 1960s (with ICI [Metals] Division–IMI, in England), I researched materials for aerospace and gas turbine applications. Risk and reliability factors were of paramount importance and awareness of corrosion was high. The corrosion group was developing titanium alloy applications, including platinized titanium anodes, that were to be of considerable value to many sectors of industry. I became very aware of corrosion and better aware of its control. I was soon to realize how important it was to ensure that an anode was connected to the structure or pipeline it was intended to protect!

My years as a professor at the Corrosion & Protection Centre at the University of Manchester Institute of Science and Technology (UMIST) commenced with a hands-on corrosion survey of the chemical process industry that was inspired by the late Professor T.K. (Ken) Ross. This voyage through an industry that by its very nature should be fully aware of corrosion put things into perspective, but it introduced me to a further human factor (non-recognition of corrosion) that I witnessed through an individual who stated "We never get corrosion problems in *our* company!" He was serious! It later transpired that the "corrosion" losses were considered

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FIGURE 1

Urea reactor; active weep holes ignored for ~1 month until the reactor exploded and became embedded in the ground. Operator did not appreciate the significance of the in-built device that wasn't weeping—it was "crying" for attention.

The Essential Fellow

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FIGURE 2

Human factors compromising intended design functions: temporary loss (non-galvanized bolt wrongly used); partial edging toward total loss (inexperienced and non-supervised welding of stainless steel vessel); and, total loss of design function (untrained plant operator misread instrumentation).

FIGURE 3

Repeat errors: design detail error in fossil fueled boiler (second same-cause failure); unintended galvanic couple.

as high maintenance costs. The person was unaware of the now historically important U.K. Government Report on Corrosion[1]—the forerunner of similar surveys[2] in the United States and other countries—which concluded that annual corrosion losses in the United Kingdom represented about 3.5% of the gross national product. Significantly, about one quarter or more of the financial losses to corrosion could be saved by the "better use of *current* knowledge and techniques." This was good advice for a document that in those days sold for about $1!

During the 1970s, as a member of the U.K. Government Committee on Corrosion, Working Party on Education & Training, we made significant strides in disseminating information to industry with specific emphasis on integrating corrosion control into overall designs.[3] A series of seminars provided to invited industrial management personnel was particularly illuminating and successful in creating more awareness to corrosion and its control—notably with respect to the human factor. The seminar was called "We never get corrosion problems in our company!" Despite the sustained effort, problems caused by human errors continued—and still do so; intended design function can so easily be compromised with direct implications on plant and equipment availability (Figure 2).

My next major realization regarding corrosion control arose during televised interviews in the still-popular BBC television series, "Top Gear," and the ITV series, "Tomorrow's World," that occasionally airs on PBS. This was the revelation that corrosion, like crime, cannot be fully eliminated. The economic and realistic approach is to recognize the problem and keep it under control. The good news is that modern technology provides considerable opportunities to assess risk and maintain reliability in operations using computerized monitors, remote controls, and smart management techniques. Such approaches frequently eliminate the "human factor" by relying more on technology and automation (machines vs. humans) but problems can still occur if "fail safe" designs are negated by human behaviors. Diagnostics can identify causes but experience reflects that history repeats itself (Figures 2 and 3).

My membership with NACE International exceeds 25 years. Enticed first by past President John Trim and later married to Patricia Burke, I (like Pat) became involved with many NACE committees. NACE membership created opportunities and founded friendships that enabled me to pursue interests in materials utilization and a determination to disseminate information through training and communication.

Failures—catastrophic or not—may be directly attributed to the human ele-

ment, but these dwarf in comparison to the overall scenario of successful materials performance, which benefits significantly from education and training programs that have seen considerable growth in recent years. Methods to integrate real-world experiences into basic education and training are to be encouraged and will surely be of considerable value in safeguarding a future that faces severe economic constraints. Productivity is influenced by the measures necessary to control (sometimes eliminate) corrosion that vary from industry to industry. There are significant differences between plants that adopt the "avoid failure" approach, the "keep-it-working" approach, or the "let-it-fail-then-replace-it" approach!

The future is challenging. Management will continue to be frustrated by insurers who argue that corrosion is classed as a process of ordinary wear, tear, or gradual deterioration (i.e., no insurance coverage), and lawyers who argue the subtleties of unknown, unexpected, unintended, or fortuitous events and conditions. The human factor is ever present. Informed people will recognize corrosion problems and ways to avoid or control them. There should be less revelations like, "Why must history repeat itself?"

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References

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3 "Guides to Good Practice in Corrosion Control," Corrosion Education and Training Working Party, U.K. Government Dept. of Industry and the Central Office of Information, HMSO, England (1979-1982).
4 C.O. Smith, "Human Factors in Design," *ASM Handbook*, Vol. 20, Materials Selection & Design (Materials Park, OH: ASM, 1997), p. 126. MP