The Unwritten Laws of Engineering

Part 1 of 3:

WHAT THE BEGINNER NEEDS TO LEARN AT ONCE
By W. J. King and James G. Skakoon

TIMELESS ADVICE FOR ENGINEERS

The Unwritten Laws of Engineering by W. J. King was first published in 1944 as three articles in Mechanical Engineering magazine. It has been in print as a book ever since, becoming a classic of engineering literature. Recent editions, including a trade version, *The Unwritten Laws of Business*, have revisions and additions by James G. Skakoon. *Mechanical Engineering* magazine is excerpting laws from the book, presented in three articles just as in 1944, with comments from contemporary authorities.

For the first in the series, we start with "What the Beginner Needs to Learn at Once." Future installments will be "Relating Chiefly to Engineering Managers" and "Professional and Personal Considerations."

The originating author of *The Unwritten Laws of Engineering*, W. J. King, observed that the chief obstacles to the success of engineers are of a personal and administrative rather than a technical nature. King, a wartime engineer with General Electric and later a UCLA engineering professor, conceded that he and his associates were getting into much more trouble by violating the undocumented laws of professional conduct than by violating the well-documented laws of science. So he laid down some "unwritten" laws into house rules for professional conduct.

None of these laws is theoretical or imaginary, and however obvious they appear, their repeated violation is responsible for much of the frustration and embarrassment of engineers everywhere. Many laws were derived by King while directly observing four engineering departments. These have been supplemented, confirmed, and updated by King and others from numerous discussions, observations, and literature; they do not reflect the unique experience or characteristics of any one organization.

Many of these laws are generalizations to which exceptions will occur in special circumstances. There is no substitute for judgment and, in an emergency, vigorous initiative is needed to cut through formalities. But notwithstanding the infrequent striking exception, these laws cannot be violated too often with impunity.

{ IN RELATION TO THE WORK }

However menial and trivial your early assignments may appear, give them your best efforts.

Many young engineers feel that the minor chores of a technical project are beneath their dignity and unworthy of their college training. They expect to prove their worth in some major, vital enterprise. Actually, the spirit and effectiveness with which you tackle your first humble tasks will likely be carefully watched and may affect your entire career.

You may worry about where your job is going to get you—whether it is sufficiently strategic or significant—and you will do well to take stock of this from time to time. But by and large, if you perform your present job well, the future will take care of itself. It is also true that if you do not make a good showing on your present job, you are not likely to be given a chance to try something else more to your liking.

Karen Kelley counsels beginning engineers even before they finish college in the cooperative education program within Northeastern University's Mechanical and Industrial Engineering Department. "I can tell you, this is certainly a hot topic for both my employers and our co-op coordinators who are helping to shape young engineers' careers," Kelley said.

According to Kelley, who is a faculty co-op coordinator for one of the nation's largest engineering co-op programs, employers pay close attention to the enthusiasm, as well as the skill, that beginners bring to an assignment, even if it may seem menial. Furthermore, menial tasks could very well be unnecessary, so why not "challenge the system," Kelley said. "Develop new methods that might streamline the process and present them to others. Managers love when employees 'think out of the box' and save time and money."

Summing up the value of this unwritten law, Kelley said, "One employer told me this should be a 'law for life,' not just for early in your career."

Demonstrate the ability to get things done.

This quality is achieved by various means under different circumstances, but it can probably be reduced to a combination of three basic characteristics:

Initiative, which is expressed in energy to start something and aggressiveness to keep it moving.

Resourcefulness and ingenuity, or the faculty for finding ways to accomplish the desired result.

Persistence or tenacity, which is the disposition to persevere in spite of difficulties, discouragement, or indifference.

Persistence is sometimes lacking in engineers to the extent that their effectiveness is greatly reduced. Such dilettantes are known as good starters but poor finishers. Of these it is said, "You can't take their type too seriously; they will be all steamed up over an idea today, but by tomorrow will have dropped it for some other wild notion." Finishing a job may be worthwhile, if it has at least some merit, just for the sake of finishing it.

It is ironic, or perhaps telling, that despite normally sufficient effort, we were unsuccessful in finding a prolific entrepreneur or inventor who would respond with comments on this law. Everyone is busy these days and returning a call or an e-mail outside of normal responsibilities taxes one's time. But busy people get things done not only by being busy but also by carefully selecting what they do, and commenting for print wasn't selected. Likewise for you when demonstrating the ability to get things done, do not overlook the profit in selecting the right things.

Develop a "Let's go see!" attitude.

Throughout your career people will approach you to solve real-life problems they will have observed on devices or equipment for which you are responsible. A wonderfully effective response is to invite them to have a look with you. That is: "Let's go see!"

This phrase comes from a singularly insightful 1992 book about visual imagery, *Engineering and the Mind's Eye*. The author, Eugene Ferguson, was an engineer, university professor, and historian who wrote extensively about the history of technology. In the book, he states: "The engineer and the worker must go together to the site of

the difficulty if they expect to see the problem in the same light." He further explains that remaining at one's desk to speculate about causes and solutions, or to retreat to drawings, specifications, and reports won't provide the insight needed to solve a problem. That insight can only be developed by observing first-hand what might at once be too subtle and complex to imagine.

Ferguson went to see, even when many of us would shy away. According to author and historian David Hounshell, professor of technology and social change at Carnegie Mellon University, early employment for Ferguson included investigating dynamite accidents for DuPont. "One of his jobs after an explosion was to plot where the body parts landed, and to figure out what caused the explosion." Hounshell was a student and colleague of Ferguson's, and is a past president of the Society for the History of Technology, for which Ferguson was a founding member. Of him, Hounshell said, "He was always interested in things and how they operated. Whether they were attractive and worked well, or didn't work so well, he wanted to see what made them go."

Don't be timid—speak up—express yourself and promote your ideas.

Too many new employees seem to think their job is to do what they are told. Of course there are times when it is wise and prudent to keep silent, but as a rule, it pays to express your point of view whenever you can contribute something. The quiet, timorous individual who says nothing is usually credited with having nothing to say.

It frequently happens in any sort of undertaking that nobody is sure of just how a matter ought to be handled; it is a question of selecting some kind of program with a reasonable chance of success. The "best" scheme usually cannot be recognized as such in advance, so anyone who talks knowingly and confidently about the project will often be assigned to carry it out. If you do not want the job, say nothing and you'll be overlooked, but you'll also be overlooked when it comes time to assign larger responsibilities.

Kelley confirms this law to the Northeastern University co-op undergraduates she counsels: "I tell students this is the time to take a chance." Kelley said that speaking up speaks volumes about a beginner's interest in the topic or assignment. "Saying nothing makes the manager believe [an intern] is not invested or interested in the work," she said.

Kelley also noted that the opposite is true: "Sometimes my students will tell me their suggestion was pretty small so they almost didn't say anything." But she noted that these small ideas can sometimes make a very big impact on a project.

Strive for conciseness and clarity in oral or written reports; be extremely careful of the accuracy of your statements.

If there is one most irksome encumbrance to promoting urgency in the workplace, it is the person who takes a half-hour of rambling discourse to say what could be said in one sentence of twenty words. Engineers often surround the answer to a sim-ple question with so many preliminaries and commentaries that the answer itself can hardly be discerned; they explain the answer before answering the question.

To be sure, very few questions endure simple answers without qualifications, but the important thing is first to state the essence of the matter as succinctly as possible. There are times when it is important to add the pertinent background to illuminate a simple statement, but try to convey the maximum information in the minimum time.

Many engineers lose the confidence of their superiors and associates by guessing when they do not know the answer to a direct question. A wrong answer is worse than no answer. If you do not know, say so, but also say, "I'll find out right away." If you are still not certain, indicate the degree of certainty upon which your answer is based. A reputation for conciseness, clarity, and reliability can be one of your most valuable assets.

Good engineering requires good communication, according to Trevor Young, author of Technical *Writing A-Z: A Commonsense Guide to Engineering Reports and Theses*. "I see myself as an engineer, not a technical writer, and part of being a good engineer is being able to communicate in a way that is accurate, complete, and efficient."

Some recommendations for technical writers from Young's book, condensed here, include:

• Use serious, but normal, conversational language: avoid long convoluted sentences.

• Be precise: avoid fuzzy, ambiguous, or inexact statements.

• Be concise: get to the point promptly.

• Be explicit: avoid figures of speech and euphemisms.

• Use formal language: avoid colloquialisms, slang, inappropriate abbreviations, contractions, jargon, and exclamations.

• Get the emphasis right: structure ideas in sentences, lists, and paragraphs to convey not just the information, but also the relative importance of the ideas.

• Report results honestly and objectively.

Young, a senior lecturer in aeronautical engineering at the University of Limerick in Ireland, weighing in on the need for accurate reporting, said: "I see this as the essence of good engineering: to be appropriately accurate in the technical work and in the reporting of that work."

{ IN RELATION TO YOUR SUPERVISOR }

One of the first things you owe your supervisor is to keep him or her informed of all significant developments.

How much must a manager know? How many of the details? This is always a difficult matter for the new employee to get straight. Many novices hesitate to bother their superiors with everyday minutiae and this can be overdone. But more often than not, the manager's problem is to extract enough information to keep adequately posted.

It is much safer to risk having your supervisor say, "Don't bother me with so many details," than to allow your supervisor to ask, "Why doesn't someone tell me these things?" Your manager must account for, defend, and explain your activities to others, as well as coordinate these activities into a larger plan. Compel yourself to provide all the information that is needed for these purposes.

No matter how hard you try nor how good an engineer you become, unexpected evils will occur that you will dread having to inform your supervisor about. Although no manager delights in being surprised by unanticipated problems—even though you are obligated to report them without hesitation—you will improve your predicament immeasurably if you can also recommend solid solutions while presenting the problem. The best you can hope for in this dreaded situation is a solution that can be implemented with the greatest urgency.

Do not overlook the steadfast truth that your direct supervisor is your "boss."

This sounds simple enough, but some engineers never get it. By all means, you are working for society, the company, the department, your project team, your project leader, your family, and yourself—but primarily you should be working for and through your supervisor, the manager to whom you directly report.

You will no doubt encounter conflicts—you are assigned to a project team with a demanding leader, a corporate executive orders a task be done, and so forth. Whenever this happens, discuss it with your supervisor, whose job includes resolving conflicts.

You can serve all ends to best advantage by assuming that your supervisor is approximately the right person for that job. It is not uncommon for young engineers, in their impatient zeal or imprudent disrespect, to ignore or to go over or around their superiors. Generally speaking, you cannot get by whoever evaluates your performance, for he or she rates you in part on your ability to cooperate. Besides, most of us get more satisfaction out of our jobs when we're able to display at least some personal loyalty to our superiors, with the feeling that we're helping them to get the main job done.

Be as particular as you can in the selection of your supervisor.

For most neophyte engineers, the influence of the senior engineers with whom they work and, even more so, of the engineer to whom they report is a major factor in molding their professional characters. Long before the days of universities and textbooks, master craftsmen absorbed their skills by having been apprenticed to master craftsmen. Likewise, you will do well to use those with more experience, especially a well-selected supervisor, as your master, your mentor. A properly selected mentor will likely have been through gauntlets as severe as your present one, and will guide you better than you can guide yourself.

But, of course, you don't always get your preferred choice in a boss. What if yours turns out to be less than you hoped for? There are only two proper alternatives: (1) accept your boss as the representative of a higher authority and execute his or her policies and directives as effectively as possible, or (2) move to some other department, division, or company at the first opportunity. Consider the mischief created when you, disliking your leader, ignore or modify orders to suit your individual notions, or, worse, purposefully undermine your superior's authority.

While the above two alternatives still apply to today's workplace, mentoring outside of the traditional chain of command is now endorsed as another way to gain from the experience and knowledge of others.

Long-time management consultant, Theodore Ryan, now an adjunct professor in the Fuqua School of Business at Duke University, views today's best mentor/mentee relationships as bi-directional exchanges of knowledge, unlike those of the traditional master and apprentice. When choosing a mentor, Ryan said to choose "someone who has some complementary talents and experience that you don't have and is willing to share them, but also is willing to learn from you and to engage in an actual dialogue with you." Ryan explained how, nowadays, novices are often just as likely to impart new knowledge to a mentor as the other way around. "Sometimes it's obvious. The mentor knows things the mentee doesn't know, and that's great," Ryan said. But he also noted this: "There is much more of a collegial dialogue framework for great mentoring these days than there was earlier. It's really another source for continuous learning." So Ryan recommends choosing a mentor who wants that.

Ryan, whose experience includes leadership development and organizational consulting for a wide range of U.S. corporations and government agencies, also advises to screen potential mentors for shared human values and ethical principles. Asking questions about these topics might be uncomfortable, but Ryan said, "It's a nice way to see how open they'll be. That's pretty personal. It's a little bit sensitive. If the mentor welcomes those questions, then that's quite a sign that this will be an open dialogue."

But Ryan warned not to expect everything from just one mentor. "Don't ask for something that someone can't give you," he said. "There is specialization in everything. One of my premises is that you may have two or three different mentors for different reasons."

Whenever you are asked by your manager to do something, you are expected to do exactly that.

If your supervisor sends you off to perform a specific task, you have two possible responses: (1) you do it exactly as requested, or (2) you come back and talk it over some more. (Take special note of this law, for it applies to anyone with whom you have agreed on a task to be done or a course of action to be taken.) It is simply unacceptable either not to do it, or to do something different instead. If you become concerned in view of new data or events that the planned action isn't worth doing as originally assigned, you are obligated to discuss the entire matter again. State your intentions and reasons so that your manager can properly reconsider it.

Despite the responsibility to do exactly as instructed or agreed, you will sometimes want to prove your initiative by doing not only that, but also something in addition thereto; perhaps the next logical action has become clear; perhaps a promising alternative has come to light. Doing these within reason will make your drive and inventiveness immediately apparent.

The other side of this law is that you needn't be too eager to embrace agreed-upon instructions. In general, a program laid down by your manager, a department, a project leader, or a design team is a proposal rather than an edict. It is usually intended to serve only as a guideline, one that will have been formulated without benefit of the new information that will be discovered during its execution. The rule therefore is to keep others informed of what you have done, at reasonable intervals, and ask for approval of any well−considered and properly planned deviations.

{ REGARDING RELATIONS WITH COLLEAGUES AND OUTSIDERS }

Cultivate the habit of seeking other peoples' opinions and recommendations.

Particularly as a beginning engineer, you cannot hope to know all you must about your field and your employer's business. Therefore, you must ask for help from others. This is particularly useful advice during a confrontation of any sort; a good first question to ask is "What do you recommend?" Your confronter will usually have thought about it more than you have, and this will allow you to proceed to a productive discussion and avoid a fight.

A warning about soliciting others' opinions deserves mention. Condescending attitudes toward others and their opinions are gratuitous and unwelcome. If you have no intention of listening to, properly considering, and perhaps using someone's information or opinion, don't ask for it. Your colleagues will not take long to recognize such patronizing and to disdain you for it.

Promises, schedules, and estimates are necessary and important instruments in a well−ordered business.

Many engineers try to dodge making commitments. You must make promises based upon your best estimates for your part of the job, together with estimates obtained from contributing departments for theirs. No one should be allowed to avoid the issue by saying, "I can't give a promise because it depends upon so many uncertain factors." Of course it does. You must account for them, estimating best and worse cases, and then provide neither laughably padded nor unrealistically optimistic schedules. Both extremes are bad; good engineers will set schedules that they can meet by energetic effort at a pace commensurate with the significance of the job.

A corollary to this law is that you have a right to insist upon reasonable estimates from other departments. But in accepting promises from other departments, make sure that you are dealing with a properly qualified representative. Bear in mind that if you ignore or discount other engineers' promises you dismiss their responsibility and incur the extra liability yourself. Ideally, other engineers' promises should be negotiable instruments in compiling estimates.

Dorothy Kangas, a business process improvement specialist for The Nielsen Co., said that despite the many

tools and techniques available for managing a project, sound estimating of resources and schedules is fundamentally important: “Getting reliable estimates is key to creating and maintaining a project schedule.”

Kangas, who contributed to the Project Management Institute’s *A Guide to the Project Management Body of Knowledge*, has seen both extremes: “Engineers or project team members sometimes provide estimates based on the assumption that every task will be executed on time; that nobody goes on vacation, nobody is sick, and absolutely no other factors interfere with the scheduled activities. I’ve seen others try to pad every one of their tasks. Suddenly what seemed to be a realistic product development project will take twice as long as expected.” But Kangas noted this as well: “A good project manager probably knows which engineers are pessimistic and which are optimistic and tries to work the middle!”

One area that is often overlooked in planning projects, according to Kangas, is risk. “If there are uncertain factors, or risks, those should be compiled and managed according to their impact and likelihood of actually occurring,” she said.

Furthermore, according to Kangas, project risks and project issues are two different things; risks can be predicted and managed, whereas issues arise unpredictably throughout a project. So risk management activities should be scheduled into a project right from the start, but issues must be squeezed onto the schedule as they appear.

In dealing with customers and outsiders, remember that you represent the company, ostensibly with full responsibility and authority.

You may be only a few months out of college, but most outsiders will regard you as a legal, financial, and technical agent of your company in all transactions, so be careful of your commitments.

{ TO BE CONTINUED }

The Unwritten Laws of Engineering

Part 2 of 3:

RELATING CHIEFLY TO ENGINEERING MANAGERS
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TIMELESS ADVICE FOR ENGINEERS

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Every business era has a preferred management philosophy promoted by a prominent management guru, from Frederick Taylor to Peter Drucker to Tom Peters to Jim Collins. *The Unwritten Laws of Engineering* has no such backing. Neither is it a complete managerial philosophy.

Although prominent business executives have endorsed many of these managerial laws for all managers, not just for engineering, the endurance of the laws is perhaps their strongest endorsement—and they seem to work. W.J. King's words tell it best:

The following is a partial list of basic commandments, readily subscribed to by all managers but practiced only by the really good ones.

{ INDIVIDUAL BEHAVIOR AND TECHNIQUE }

Do not try to do it all yourself.

This is one of those elementary propositions that everyone endorses, yet many carelessly violate. It's bad business: bad for you, bad for the project, and bad for your employees. You must delegate responsibility even if you could cover all of the ground yourself. It isn't wise to have so much depend upon one person, and it's unfair to your subordinates. Executives should have their business organized so that they could be away on business or vacation at any time and still have everything move along smoothly.

A common justification for hogging the whole job is that subordinates are too young or inexperienced. It is part of your job to develop your subordinates, which includes developing initiative, resourcefulness, and judgment. The best way to do this is to load them up with all the responsibility they can carry without danger of serious embarrassment to any person or group. Self-respecting engineers resent being babied to where they cannot act

on a most trivial detail without approval from their manager.

On the other hand, it must be granted that details are not always trivial, and that it may sometimes require a meeting of an executive committee to change the length of a screw in a critically important mass-produced assembly. It is a matter of making sure not only that technical items are handled by engineers of appropriate competence and experience, but also that all considerations have been made.

Dorothy Kangas, a business process improvement specialist for The Nielsen Co., has seen first-hand the harm from a controlling manager. The manager "demanded that all communication go through him, and every document needed to have his signature," Kangas said. "After a period of time, it was clear he couldn't keep up with the pace of the project." He didn't trust his own team, according to Kangas, and they, in turn, quickly lost confidence in him and became resentful. The project fell behind in large part because of this controlling management style.

Kangas also said that managers need to use all available resources to plan and execute a project, whether they are in one's own department, elsewhere in the company, or even outside the company. And using resources appropriately also counts, Kangas said: "As a manager, recognizing the strengths and weaknesses of each team member as it relates to the project's activities will alleviate much of the angst and stress when deadlines draw near."

Every manager must know what goes on in his or her domain.

There is a similar law for beginners: *One of the first things you owe your supervisor is to keep him or her informed of all significant developments.* Be aware, however, that you cannot always depend on others—not subordinates, colleagues, nor your own manager—to keep you informed; you are responsible to keep yourself informed.

This applies primarily to major or significant developments and does not mean that you should attempt to keep up with every minor detail of activities assigned to subordinates. It becomes a vice when carried to the extent of impeding operations. Nevertheless, the more information managers have, the more effectively they can manage their business.

Every manager has his or her own methods that work. "Some will create highly structured, detailed reporting requirements, and some may manage by walking around with a clipboard and a pen," Kangas said.

Cultivate the habit of "boiling matters down" to their simplest terms.

The faculty for reducing apparently complicated situations to their basic, essential elements is a form of wisdom that must usually be derived from experience. But there seems to be marked differences between otherwise comparable individuals in this respect. Some people seem eternally disposed to "muddy the water," or can "never see the forest for the trees."

Perhaps one cannot correct this innate tendency simply by taking thought, but it appears to be largely a habit—a habit of withdrawing mentally to a suitable vantage point to survey a mass of facts in their proper perspective, or a habit of becoming immersed and lost in a sea of detail. Make it a practice to integrate, condense, summarize, and simplify your facts rather than to expand, ramify, complicate, and disintegrate them.

Many meetings, for example, get nowhere after protracted wrangling until somebody finally says, "Well, it all boils down simply to this...," or "Can't we agree, however, that the basic point at issue is just this...," or, "After all, the essential fact remains that...."

The mental discipline to instinctively impel one to the heart of the matter is one of the most valuable qualities of a good executive.

Cultivate the habit of making brisk, clean-cut decisions.

This is, of course, a difficult and important part of a manager's job. Some have a terrific struggle deciding even minor issues, mainly because they never get over being afraid of making mistakes. Normally, facility comes with practice, but it can be hastened by observing a few simple principles:

(1) Decisions will be easier and more frequently correct if you have the essential facts at hand. However, almost any manager can make decisions knowing all of the facts, whereas a good manager will make the same decisions without all the facts. So you might ask yourself: "Am I likely to lose more by giving a snap judgment or by waiting for more information?"

(2) You do not have to be right every time; nobody is.

(3) The very fact that a decision is difficult usually means that the advantages and drawbacks of the alternatives are pretty well balanced. It is likely better, in that case, to decide the matter now than to arrive at the best decision later. So take a position and see it through.

(4) It is futile to try to keep everybody happy. Give everyone a fair hearing, but after all have had their say, dispose of the matter decisively even if someone's toes are stepped on. Otherwise, everyone will be dissatisfied, and many may accuse you of straddling the issues.

The following questions are helpful in choosing a course of action when the factors are indecisive:

• Does it expedite and forward the undertaking, or does it only produce procrastination and delay?

• Is it fair and square and aboveboard?

• Is it in line with established custom, precedence, or policy? A good reason is generally required for a departure.

• Is it in line with a previous decision or understanding? Even a good reason for a change might not offset the unfortunate impression of instability.

• Can we accept the risk? How does the penalty compare with the gain for each of the choices?

• Are there suitable future alternatives or corrective actions if a decision turns out to be misguided?

Gary Klein, an author and a senior scientist at MacroCognition LLC, has observed indecision in leaders and managers. "They are afraid of making decisions, and so they hope that the situation will magically become clear," Klein said. "And sometimes that happens, which rewards their procrastination. More often, it doesn't happen, and they have missed windows of opportunity while chewing up time and energy."

Klein is an experimental psychologist who has written extensively on human cognition, intuition, and decision making, including his latest book, *Streetlights and Shadows: Searching for the Keys to Adaptive Decision Making*. According to Klein, excessive rumination often signifies a leader's fear of making a mistake. But this fear drains decision makers, as well as their colleagues and subordinates, and prevents them all from working on other high priority issues.

On the opposite side, never mistake the true meaning of, "Don't be afraid to make mistakes." Decisions that result in catastrophic consequences such as huge financial losses or personal injury will not be overlooked, and may be criminal. Those who coerce you into making decisions, despite whatever aphorisms they employ, will not accept a catastrophic result. Make clear-cut, swift decisions, but only if a mistake won't create wreckage for you and your organization.

{ MANAGING DESIGN AND DEVELOPMENT PROJECTS }

Learn project management skills and techniques, then apply them to the activities that you manage.

Your organization probably has, or certainly should have, standard procedures for its major engineering efforts such as developing new products or processes. You will also need to apply techniques commonly used for managing projects. Some of these include resource planning, calendar scheduling, and progress tracking. Simply stated, to manage projects properly you must plan your work, then work your plan.

The following formula for carrying out any engineering project seems to be more or less standard in the best engineering circles:

• Define your objectives.

• Plan the job by outlining the steps to be accomplished.

• Define the required resources, including people, money, and facilities.

• Prepare a definite schedule.

• Follow up; check on the progress of the work.

• Revise your schedule as required.

• Watch for bottlenecks, log−jams, and missing links; hit lagging items hard by applying additional time, money, and people.

• Drive to a finish on time.

Engineers can be disinclined toward project management, as Kangas confirms. “Many engineers look at the PM function as an ‘administrative’ function,” Kangas said. “And for the most part, indeed, it is.” But Kangas cited the example of a symphony orchestra: “Without a conductor, they may be hard pressed to start together, end at the same time, and create the flow of music that one would expect from world-class musicians.” A conductor isn’t an expert musician on every instrument, if any, just as a project manager isn’t an expert in every engineering discipline. But conductors—and project managers—still coordinate everyone’s playing.

Kangas also warns of a common pitfall in project management: scope. “Sometimes knowing the scope…clearly what is included and excluded, can be highly important,” Kangas said. She added that one of the processes covered by the Project Management Institute in its publication, *A Guide to the Project Management Body of Knowledge*, to which she contributed, is scope management. “What I find most disturbing is when PMs use the excuse that ‘the scope changed.’ ” Generally, Kangas said, an inaccurate scope results more from poor estimating, poor resource planning, or poor product definition at the start of a project than from any uncontrollable influence from outside the project team.

{ ON ORGANIZATIONAL STRUCTURES }

Make sure that everyone, managers and subordinates, has been assigned definite positions and responsibilities within the organization.

It is extremely detrimental to morale and efficiency when employees do not know what their jobs are or what they are responsible for. If positions are unclear, interminable bickering, confusion, and bad feelings are a likely result. Do not keep tentative organizational changes hanging over people; effect them as soon as they become reasonably clear. Changing them later is better than leaving people in poorly or erroneously defined positions.

"Make sure each employee has a job description, and that it's accurate and up to date," recommends Sharon Armstrong, a human resources consultant and trainer who has written several books for HR professionals, including *The Essential HR Handbook: A Quick and Handy Resource for Any Manager or HR Professional*.

Make sure that all activities and all individuals are supervised by someone competent in the subject matter involved.

In an engineering organization, at least ideally, every novice engineer working in a technological area will be supervised by a veteran seasoned in the same area. Neophytes can get themselves, their departments, their employers, and their supervisors into embarrassingly difficult spots if left on their own.

As a manager, you should offer your subordinates complete competence when overseeing their technical activities. If you are uncomfortable with or incapable of this responsibility, you'd better do something about it. A particularly good method to use, outside of directly learning what you need to know, is to complement yourself with other experienced people under your supervision, people who can properly judge what you cannot.

Although having an accomplished veteran directly supervising every novice might be desirable, it isn't always possible. "In the real world, not all departments are set up like that," Armstrong said. So, according to Armstrong, there are other ways to accomplish the necessary supervision of beginners. "Sometimes that is a supervisor, sometimes someone in another department…but the basic premise still remains that there should be someone that any worker can go to for guidance, for input, for direction." One possibility is a matrix organizational structure, which, according to Armstrong, is alive and well. "Two or more intersecting lines of authority can run through the same individual. Matrix management considerably leverages knowledge and skills, opening opportunities for employees to branch out from their usual offices and disciplines."

{ WHAT ALL MANAGERS OWE THEIR EMPLOYEES }

Never misrepresent a subordinate's performance during performance appraisals.

The most serious responsibility of managers is to review the performance of their subordinates. As a manager, you have the distinct obligation to do this as accurately as possible. Not only would misrepresentation be unfair to your subordinates, but it also would not be the least bit helpful to anyone involved.

Along the same line, it is your inalienable responsibility to talk things over with employees if—and as soon as—you become sincerely dissatisfied with their work, or you recognize deficiencies that are working against them. This won't be easy, and it requires much tact to avoid discouraging or offending an employee. But if you ultimately must fire a subordinate, you may have two pointed questions to answer: "Why has it taken you five years to discover my incompetence?" and "Why haven't you given me a fair chance to correct these shortcomings?" Remember that when you fire someone for incompetence, it means not only that the employee has failed, but also that you have failed.

Armstrong, whose latest book is titled *The Essential Performance Review Handbook*, warns about misrepresenting an employee's performance: "It can be very bad. There are legal issues around that." According to Armstrong, a manager needs to be honest with the employee to avoid creating the case for an employee of not having been helped—as he or she should have been—before being let go, if it comes to that. "There should never be surprises," Armstrong said.

Armstrong confirmed that this unwritten law is good advice, but emphasized the caveat about ongoing communication. According to Armstrong, managers must give coaching and counseling throughout the performance review cycle, not just during the performance review itself. "You should give positive reinforcement when you see employees doing the right thing and gently redirect them when that is appropriate," she said. "It's the manager's duty to help each employee be successful and to grow

professionally."

Make it unquestionably clear what is expected of employees.

Number one on the list of required communication between supervisor and subordinate is the explicit understanding of expectations on the job. All too often, managers avoid direct discussions and rely on implicit instructions, generalized goals, or corporate policies. It is not enough for you simply to hope for certain behavior or performance from your subordinates; more often than not you will be disappointed. Successful managers clearly set down goals and expectations with their subordinates, then follow up with monitoring and support.

Armstrong said that expectations and goals go together, but that "goals ratchet it up a bit, so it's kind of expectations on steroids. It's really having a clear idea at the start of any cycle exactly what you want the employee to do, and how you're both going to know at the end that it's been done." Armstrong is a fan of "SMART" goals, those that are Specific, Measurable, Attainable, Relevant, and Time-based, especially when these goals are defined with an employee's input. "If managers can get accustomed to helping their employees write SMART goals—and they should come from both sides of the desk—then there will be ownership on the part of the employee," Armstrong said. "It will be realistic for the employee if they're part of the writing of it as well, rather than having it trickle down to them, and then not feeling connected to it."

You owe it to your subordinates to keep them properly informed.

In the catalog of raw deals, next to responsibility without authority, comes responsibility without information. It is unfair to ask engineers to acquit themselves creditably when they are held responsible for a project without having adequate knowledge of its history, present status, or future plans. An excellent practice is to hold occasional meetings to acquaint employees with major policies and developments in the business of the department and the company.

An important part of the job of developing engineers is to furnish them with ample background knowledge and, as a rule, this involves a certain amount of travel. You will find it worthwhile to take or send a young engineer on a trip for what he or she can get out of the experience, regardless of how little he or she contributes directly. Likewise, when outsiders visit, it is good business, as well as good manners, to invite junior engineers to participate, even if their direct contribution is small.

Never miss a chance to commend or reward subordinates for a job well done.

Remember that your job is not just to criticize your people and intimidate them into getting their work done. A first−rate manager is a leader as well as a critic. The better part of your job is, therefore, to help, advise, encourage, and stimulate your subordinates. Along the same line, never miss a chance to build up the prestige of your subordinates in the eyes of others.

On the other hand, this is not to suggest perpetual lenience. By all means get tough when the occasion justifies it. An occasional sharp censure, when it is well deserved, will usually help to keep employees on their toes. But if that's all they get, they are apt to go a bit sour on the job.

Theodore Ryan, a Ph.D. psychologist who provided advice on selecting a mentor for the first *Unwritten Laws* excerpt, warned not to overlook your top performers when commending, advising, and encouraging subordinates, as managers too often do. "It's the sub-performers and marginal performers who get most of the feedback. Often, the best performers get rewarded by not getting as much positive feedback and as much developmental feedback," Ryan said. Ryan believes that putting extra time into the best performers can be among the most successful tools for recruiting, motivating, and retaining employees.

Ryan encourages expanding the ideas of commendation, reward, and critique into a team framework. According to Ryan, it should become part of a company's "best practices" for team projects. So at a project's start, critical points, and end, the team should ask, "How did it go? What went really well? What didn't? How can we approach this differently?" Ryan said that the ideal is "when all of us expect that we [commend, reward, and critique each other], so we all, individually and collectively, can get better. That really helps a team."

Always accept full responsibility for your group and the individuals in it.

Never pass the buck, or blame any of your employees, even when they may have let you down badly. You are supposed to have full control, and you are credited with the success as well as the failure of your group.

{ TO BE CONTINUED }

The Unwritten Laws of Engineering

Part 3 of 3:

PROFESSIONAL AND PERSONAL CONSIDERATIONS
By W.J. King and James G. Skakoon

TIMELESS ADVICE FOR ENGINEERS

The Unwritten Laws of Engineering by W. J. King was first published in 1944 as three articles in *Mechanical Engineering* magazine. It has been in print as a book ever since, becoming a classic of engineering literature. Recent editions, including a trade version, *The Unwritten Laws of Business*, have revisions and additions by James G. Skakoon. Mechanical Engineering magazine is excerpting laws from the book, presented in three articles just as in 1944, with comments from contemporary authorities.

The first two installments in this series were "What the Beginner Needs to Learn at Once" and "Relating Chiefly to Engineering Managers." We finish the series with some tips regarding personal and professional behavior in the workplace.

A number of empirical studies of on−the−job excellence have clearly and repeatedly established that emotional competencies—communication, interpersonal skills, self-control, motivation, pride in accomplishments, adaptability, integrity, and so on—are much more important for superior job performance than are cognitive and technical abilities. Daniel Goleman, in his book, *Working With Emotional Intelligence*, cites his own and others' studies that prove this. Summarizing one such study, he writes: "Emotional competencies were *twice* as important in contributing to excellence as were pure intellect and expertise." Yet most of the emphasis in the education and training of engineers is placed upon purely technical education.

This is not to suggest that native intelligence, academic training, technical knowledge, and circumstantial expertise are not valuable. They are; only engineers with engineering training and engineering expertise are equipped to perform engineering tasks reliably. But for the most part, engineers are adequately capable in these areas. If not, they almost certainly would have been discharged from the system, either by themselves or by others, long before they became employed as engineers.

It should be obvious enough that a highly trained technical expert with a good character and personality is more valuable as an employee—and probably a better engineer for it—than a sociological freak or misfit with the same technical training. One can rarely accomplish anything worthwhile without the voluntary cooperation of one's associates, and the quantity and quality of this cooperation is determined by "personality factors" as much as anything. Along with this need for one-on-one cooperation, facility with "soft" characteristics—everything from understanding contemporary society to following ethical behavior—can benefit you and your employer far beyond ordinary technical contributions.

The following personal and professional "laws" are drawn up from the purely practical point of view. As in the two preceding articles, the selections are limited to rules that are frequently violated, with unfortunate results, however obvious or stale they may appear.

{ LAWS OF CHARACTER AND PERSONALITY }

One of the most valuable personal traits is the ability to get along with all kinds of people.

This comprehensive quality defines the prime requisite of personality in any human organization. No doubt this ability can be achieved by various formulas, although it is based mostly upon general, good-natured friendliness, together with consistent observance of the "Golden Rule." The following "dos and don'ts" are more specific elements of a winning formula:

(1) Cultivate the ability to appreciate the good qualities, rather than dislike the shortcomings, of each individual.

(2) Do not give vent to impatience and annoyance on slight provocation. Some offensive individuals seem to develop a striking capacity for becoming annoyed, which they indulge with little or no restraint.

(3) Do not harbor grudges after disagreements involving honest differences of opinion. Keep your arguments objective and leave personalities out of it. Never foster enemies, for as E. B. White put it: "One of the most time-consuming things is to have an enemy."

(4) Form the habit of considering the feelings and interests of others.

(5) Do not become unduly preoccupied with your own selfish interests. When you look out for Number One first, your associates will be disinclined to look out for you, because they know you are already doing that. This applies to the matter of credit for accomplishments. But you need not fear being overlooked; about the only way to lose credit for a creditable job is to grab for it too avidly.

(6) Make it a rule to help the other person whenever an opportunity arises. Even if you are mean-spirited enough to derive no personal satisfaction from accommodating others, it's a good investment. The business world demands and expects cooperation and teamwork among the members of an organization.

(7) Be particularly careful to be fair on all occasions. This means a good deal more than just fair upon demand. All of us are frequently unfair, unintentionally, simply because we do not consider other points of view to ensure that the interests of others are fairly protected. For example, we are often too quick to unjustly criticize another for failing on an assignment when the real fault lies with the manager who failed to provide the tools to do the job. Most important, whenever you enjoy a natural advantage or hold a position from which you could seriously mistreat someone, you must "lean over backwards" to be fair and square.

(8) Do not take yourself or your work too seriously. A sense of humor, under reasonable control, is much more becoming than a chronically sour dead-pan, a perpetual air of tedious seriousness, or a pompous righteousness. It is much better for your blood pressure, and for the morale of the office, to laugh off an awkward situation now and then than to maintain a tense, tragic atmosphere whenever matters take an embarrassing turn. Of course, a serious matter should be taken seriously, but preserving an oppressively heavy and funereal atmosphere does more harm than good.

(9) Put yourself out just a little to be genuinely cordial in greeting people. True cordiality is, of course, spontaneous and should never be affected, but neither should it be inhibited. We all know people who invariably pass us in the hall or encounter us elsewhere without a shadow of recognition. Whether this is due to inhibition or preoccupation, we cannot help thinking that such unsociable chumps would not be missed much if we just didn't see them. Like anything else, this can be overdone, but most engineers can safely promote more cordiality in themselves.

(10) Give people the benefit of the doubt, especially when you can afford to do so. Mutual distrust and suspicion generate a great deal of unnecessary friction. These are derived chiefly from misunderstandings, pure ignorance, or ungenerously assuming that people are guilty until proven innocent. You will get much better cooperation from others if you assume that they are just as intelligent, reasonable, and decent as you are, even when you know they are not (although setting the odds of that are tricky indeed).

Never underestimate the extent of your professional responsibility and personal liability.

Upon becoming a member of the engineering profession, you accepted the responsibility of a professional, as well as any liability that accompanies that responsibility. Many engineers pretend that they can hide behind their employer's or their department's shield, or that they are powerless, mere cogs in the machinery, especially if something goes haywire. Although environmental and consumer safety concerns are every employee's responsibility, engineers are uniquely positioned with the power and knowledge to create, identify, avoid, and correct such problems—an incongruous reality. Regardless of the size of your employer, never forget that you contribute to making decisions, whether the results are good, bad, or catastrophic.

But you needn't be unreasonably anxious; you are in your position presumably because you can, with your engineering training, knowledge, and experience, identify and judge the risks inherent in your business. In this regard you will serve yourself, your employer, and your profession well if you follow a few simple guidelines:

• Approach all of your engineering systematically, especially when developing new products, processes, or equipment.

• Identify and apply the requisite expertise to all engineering activities.

• Be aware of and use applicable codes and standards.

• Use established procedures for design reviews and failure analyses.

• Keep records of your own and your department's engineering activities.

Charles Fleddermann, a professor of electrical and computer engineering at the University of New Mexico and author of the text, *Engineering Ethics*, added another tip for engineers concerned about liability: "One of your jobs … is to think like a total idiot and figure out, 'How is this product going to be misused.' Don't just think about how it will be used. Try to anticipate [its misuse] to the extent possible." Fleddermann said this requires a great deal of creativity, and he often assigns this as an exercise in his design classes. "They have a blast trying to figure out all of the crazy things that can happen."

According to Fleddermann, even if you meet all applicable standards, codes, and laws, you can still be liable for not conforming to accepted engineering practice. "A lot of people feel that if you do everything by the book, that's the end of your liability and responsibility." Fleddermann acknowledged that the term "accepted engineering practice" can be vague, but said, "You are responsible for knowing what that means."

Knowing what it means involves a great deal of networking, like attending conferences and talking with other engineers to find out what they do—basically, staying current in your field. Unfortunately, much of this information will be proprietary, Fleddermann said, but added, "Fortunately, I think, there is a culture in many disciplines in engineering of sharing at least safety-type information, so that product designs will be safe."

Let ethical behavior govern your actions and those of your company.

Despite the usual ambiguities and everyday quandaries of engineering, ethical behavior usually comes naturally to engineers. Societal values—the basis for ethics—are positively ingrained into most of us. Nevertheless, Fleddermann writes in his book: "Many times, the ethical problems encountered in engineering practice are very complex and involve conflicting ethical principles." Fleddermann cites the Ford Pinto's exploding gas tanks and the Space Shuttle *Challenger*'s failed solid booster joint as examples fraught with conflict and uncertainty.

Engineers need the courage of their convictions, including the courage to do what they know to be right without undue fear of criticism and without the need to explain their actions. If the reasons for your actions are sound, you should not worry about having to defend them to anyone. At the same time, you are ill-advised

to martyr yourself for every controversial matter in which you strongly believe.

Martin Luther King, Jr. said: “If a man hasn’t discovered something that he will die for, he isn’t fit to live.” True enough, but Oscar Wilde said: “A thing is not necessarily true because a man dies for it.” Martyrdom only rarely makes heroes, and in the business world, heroes and martyrs alike often find themselves unemployed.

All of which, Fleddermann explained, suggests that engineers could benefit from ethics training: “It’s very valuable for you to have thought about these things before you’re confronted. You don’t want to find yourself in an [ethically challenging] situation, and you have no clue what to do about it, and you don’t know what the [available] resources are. Sometimes you don’t even know that you’re in a situation that you shouldn’t be in.” So, ethics training, however you can get it and however much or little you get, is a necessary step toward recognizing and dealing with circumstances akin to Space Shuttle and Pinto disasters.

According to Fleddermann, among the most visible current topics that engineers must address are sustainable engineering and the globalization of the profession. “When you think about it, sustainability is actually an ethical issue,” he said. “Not only do we have to be aware of ethical issues and the way things are done in our own country, but we also have to be aware of how things are done in other countries.” As a vivid example of both issues, Fleddermann cited the post-disaster rebuilding of Haiti after January’s earthquake. “What is an engineer’s responsibility in terms of designing buildings in a place such as Haiti, where we all acknowledge that there’s not a ton of money?” Fleddermann asked. “And yet,” he said, “the risks are huge. I think that is a big ethical issue—how engineers respond in the future [to similar disasters].”

{ REGARDING BEHAVIOR IN THE WORKPLACE }

Be aware of the effect that your personal appearance and behavior have on others and, in turn, on you.

Permissiveness and dress codes aside, your appearance probably has a far greater influence on how you are viewed by those around you than you could ever imagine. Bear this in mind when you define and present your workplace image. Three rules of thumb will serve you well in this regard:

• Look at how those in the positions to which you aspire are dressed and groomed, then follow their lead.

• Dress appropriately for the occasion. When in doubt, slightly overdressing is prudent; being noticeably underdressed, for most people, is unbearably uncomfortable.

• Conservative clothing and grooming will never be wrong, at least in most engineering circles.

Despite the wide range of acceptable personal appearance found in our society, these common-sense points are hard to argue against in a professional workplace:

• Clothing, regardless of style, should be clean, well-fitting, and in good condition.

• Hair and nails should be clean and well-kept, again regardless of style.

• Your good personal hygiene will be appreciated by your colleagues.

• Perfumes and colognes should be used sparingly, if at all, in the workplace.

• Men should pay particular attention to shaving habits, beards, and mustaches. Others notice poor upkeep, even if you don’t.

Of course, we all know some very good engineers who are oblivious to such details; you can be sure that their apathy has been noticed. We all know some "wild" ones, who also must accept others' estimation of their image.

Sharon Armstrong, author of *The Essential HR Handbook: A Quick and Handy Resource for Any Manager or HR Professional*, likened our appearance and behavior, in today's parlance, to branding. "What type of image are we creating when we dress and go to work a certain way versus another way?" According to Armstrong, our brand is more than how we dress: "It's everything from work product, to appearance, to attitude, to collegiality…all those factors really go into your brand." Armstrong, a Washington, D.C., human resources consultant and trainer, summed up this unwritten law by saying, "It's being conscious of the impression you are leaving. That's the key."

Beware of what you commit to writing and of who will read it.

Be careful about who gets copies of your letters, memos, and messages, in whatever form or medium they are created, especially when the interests of other departments are involved. Engineers have been known to broadcast memoranda containing damaging or embarrassing statements. It is sometimes difficult to recognize the "dynamite" in these documents, but they are apt to cause trouble if they step too heavily into another domain or reveal serious shortcomings in others. If a document is distributed widely or concerns manufacturing or customer difficulties, you'd better get a higher authority to review it.

Once you have issued something in writing, despite your best attempts to the contrary, you will have relinquished control over it. To be safe, assume (1) that your documents might go to anyone and (2) that they will exist forever. Compose them accordingly.

Misplaced verbal assaults cause enough mischief, but putting emotional outbursts into writing is the worst conduct in this regard. Anger, malice, disrespect, and ridicule expressed in written documents toward another will be remembered long after you might wish they had been forgotten.

{ REGARDING CAREER AND PERSONAL DEVELOPMENT }

Analyze yourself and your subordinates.

Engineers and engineering managers need not be students of psychology—most are disinclined anyway. Nevertheless, it is enlightening to appreciate that people, including yourself, behave as they do not so much because they want to behave that way, but because that is how they are. Fundamentally, people see and react to things, and judge and decide things quite differently from one another. Even without fully understanding different personality types, simply recognizing that people are remarkably different will help you accept different personalities as normal, and not to view them as somehow wrong. A self-assessment using the Myers-Briggs Type Indicator is a recommended start for everyone.

Among the most important decisions for engineers to make about both themselves and their subordinates is when and how much managerial and administrative responsibility is appropriate. All too often increased executive and administrative responsibility is used to reward outstanding proficiency in any type of work. But this may be a mistake from either of two considerations:

(1) People are sometimes surprised to find that they are much less happy in a new, higher-level job. Engineers or scientists usually discover, sometimes to their dismay, that once they become managers they no longer have time to be engineers or scientists.

(2) By no means does it follow that a good engineer will make a good manager. Many top-notch technologists have been promoted to administrative positions much to their own and their employer's detriment.

These possible outcomes should therefore be considered carefully by the person threatened with promotion and by the person about to do the promoting.

Although certain personality types are more disposed to become managers in their careers, no personality characteristic precludes someone from managerial success. In reality, nobody successfully moving through an engineering career can avoid management and administration altogether. These are necessary parts of all job descriptions and a certain amount of managing projects and supervising others is satisfying for all but the most narrow-minded technologist. Further, as time goes by, many engineers find their interest in management changing, often increasing as their careers mature.

Douglass Wilde, emeritus professor of mechanical engineering at Stanford University, offered additional insight into the value of analyzing for personality in the workplace in his recent article, "Personalities Into Teams" (*Mechanical Engineering*, February 2010). According to the article, along with the pure technical expertise, people bring distinct personalities with correspondingly different ways of approaching and solving problems. The result is that "the application of those traits can be as important as combined technical knowledge to a team's success."

Wilde, author of *Teamology: The Construction and Organization of Effective Teams*, studied the effects of applying Jungian psychological theory (e.g. Myers-Briggs Type Indicators) to student design teams at Stanford University. The data clearly show that psychologically diverse teams perform better in the long run, despite an initial delay in effective communication and cooperation. "Such psychologically diverse teams carry out projects better because they have the full range of problem-solving approaches," Wilde said.

But industry cannot often mix and match team members for best effect; managers have who they have. For these situations, Wilde describes a "psychological organization meeting" during which the team maps itself psychologically, making sure that valuable cognitive modes are not overlooked. This can, for example, "draw attention to the quieter introverted modes of knowledge, imagination, analysis, and evaluation too often overshadowed by extraverted modes of experiment, ideation, organization, and community."

Maintain your employability as well as that of your subordinates.

It is the rare engineer who has a single employer for a whole career. So if your skills and knowledge are valuable only to your current employer, however invaluable they might seem, you are in trouble. Sooner or later, for one reason or another, your employer will no longer want to buy those skills, and you will have no place else to sell them.

Formal training—university classes, seminars, short courses, company-sponsored training—are a necessary part of a life-long employability plan. But your plan must also include more than a passing interest in your field by reading sales literature, trade magazines, and professional publications, and attending trade shows and professional conferences. All of this may well require sacrificing personal time and personal finances as well. Simply put, employers do not accept the full burden of employees' continuing education. The effort and dedication required to remain employable is in every engineer's best interest.

The author of *Engineer's Guide to Lifelong Employability*, Jean Eason, confirmed the need for an aggressive attitude toward employability: "For engineers staying with one employer, on-the-job training, reading trade publications, and attending conferences might be sufficient. For engineers looking to change employers, I find that engineers need the more formal training of degree or certification programs."

According to Eason, recipient of IEEE's Robert S. Walleigh Distinguished Contributions to Engineering Professionalism Award, engineers must compete for jobs with other engineers throughout their industry and throughout the world. Eason said that, if they need the same training, new grads are cheaper for employers than older engineers; and with advances in information and communication technology, geography doesn't matter. So overseas engineers might be cheaper still. Eason summed up every engineers' employability predicament by saying, "If you are going to stay employed, you need to do more than just 'keep up.' "

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The foregoing laws represent only part of the formula for a successful engineering career. However much natural interest you take in these principles—and each person has his or her own level—it will pay for you to contemplate at least a little of the "rules of the game."

Ethical Fundamentals

ASME has published a "Code of Ethics of Engineers," designated 15.7 among the society's policies. It can be found on the ASME Web site at www.asme.org/Governance/Nominating/Society_Policies.cfm.

Editor's note: *The Unwritten Laws of Engineering* is available for purchase online at http://catalog.asme.org/books/PrintBook/Unwritten_Laws_Revised.cfm.